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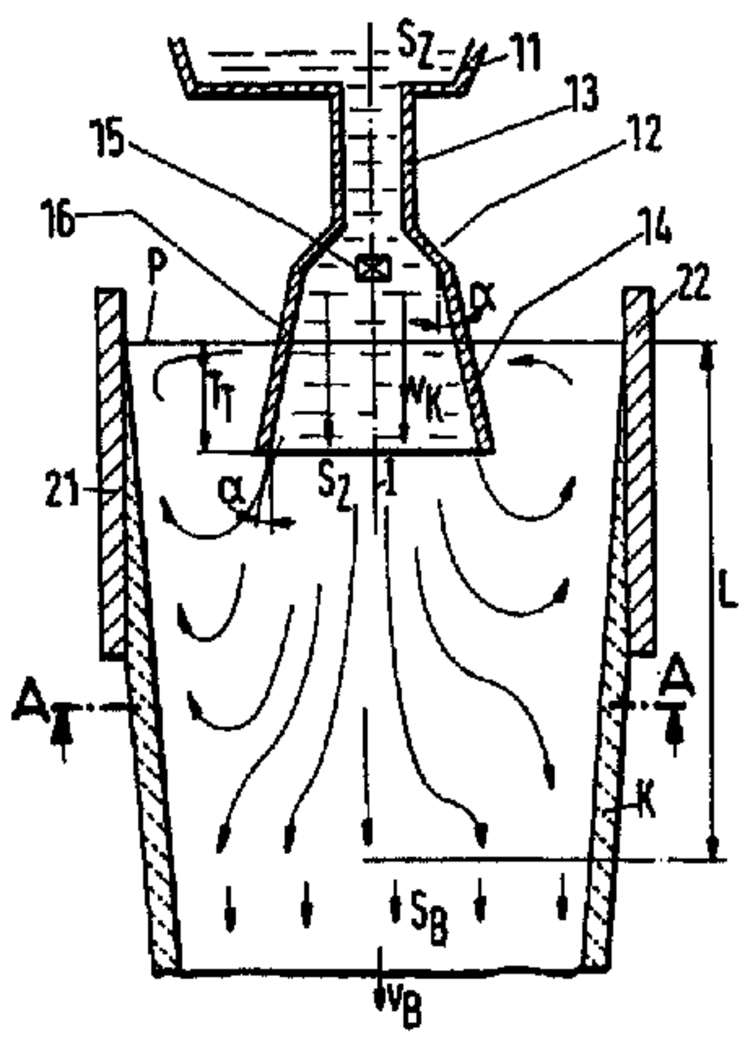
(54) **PROCEDE ET DISPOSITIF POUR LA PRODUCTION DE BRAMES**

(54) **METHOD AND DEVICE FOR PRODUCING SLABS**




(57) L'invention concerne un procédé pour la production de brames présentant une épaisseur D > 100 mm à des vitesses de coulée v < 3 m/min, dans une installation de coulé continue dans laquelle la coulée provenant d'un réservoir est acheminée dans une lingotière par l'intermédiaire d'un busette de coulée, et d'où est extraite, côté bec, une croûte solidifiée de barre de coulée entourant un cratère liquide dans un cadre de guidage de barre, notamment une installation de coulée continue courbe. La coulée acheminée pénètre dans la lingotière à une vitesse ($v_K$) qui se trouve, par rapport à la vitesse d'extraction de barre ($v_B$), dans le rapport $v_K : v_B = 6 : 1$ à $60 : 1$, et les filets liquides de la coulée acheminée sont guidés de telle manière qu'ils pénètrent dans le cratère liquide à une profondeur L < 2 m par rapport au niveau de la coulée, sous forme d'un large front présentant en section un profil rectangulaire. L'invention concerne également un dispositif pour la production de brames.

(57) The invention relates to a method for producing slabs having a thickness D of > 100 mm at casting speeds v < 3m/min. in a continuous casting installation, in which melt is fed to a casting die from a container by means of a submerged nozzle, from which a casting cup encompassing a crater is drawn out into a strand guide frame on the mouth side, specially a bow-type continuous casting machine. According to the invention the fed melt enters the casting die at a speed ($v_K$) which, in relation to the strand draw-out speed $V_B$, is $v_k : v_B = 6 : 1 - 60 : 1$ and the flow filaments of the fed melt are guided in such a way that they penetrate the crater at a depth L < 2 m in relation to the melt level in the form of a large face with a rectangular profiled cross-section. The invention also relates to a device for producing slabs.

Abstract

The invention relates to a process for producing slabs having a thickness D > 100 mm, and at casting speeds v < 3m/min, in a continuous casting installation in which melt is supplied to a permanent mold from a storage reservoir via an immersion nozzle and from which, on the aperture side, a strand shell enclosing a liquid crater is withdrawn into a strand guidance frame, in particular a bow-type continuous casting installation. According to the invention, the melt supplied enters the permanent mold at a speed ($v_K$) whose relationship with respect to the strand withdrawal speed ($v_B$) is:

$v_K:v_B$ = 6:1 to 60:1, and

the flow filaments of the melt supplied are guided in such a way that, with regard to the melt level, they penetrate into the liquid crater over a length L < 2 m over a wide front and with a profile which is rectangular in cross section. The invention furthermore relates to an appliance for producing slabs.

Herewith Figure 1.

FILE, ~~PIN IN~~ THIS AMENDED
~~TEXT~~ TRANSLATION

# Method and device for producing slabs

## Description

The invention relates to a process for producing slabs having a thickness D > 100 mm, and at casting speeds v < 3m/min, in a continuous casting installation in which melt is supplied to a permanent mold from a storage reservoir via an immersion nozzle and from which, on the aperture side, the strand shell enclosing a liquid crater is withdrawn into a strand guidance frame, in particular a bow-type continuous casting installation, and to a suitable appliance for so doing.

Steel Research 66 (1995) No. 7, pp. 287 to 293 "Flow dynamics in thin slab caster molds" has disclosed a test layout in which an immersion nozzle which is attached to a tundish projects into a permanent mold. The permanent mold used here, with a thickness of approximately 80 mm, is the typical size for an installation for producing thin slabs and, during use of an immersion nozzle (Fig. 10) which has an open aperture, exhibits a central jet which projects deep into the liquid crater of the slab.

In a further configuration (Figure 4), a baffle element, which diverts the liquid melt toward two openings on the narrow sides of the immersion nozzle, is provided at the aperture of the immersion nozzle. Figure 5 shows that two partial streams are produced, which together with high energy of each individual flow filament, lead to turbulence in the melt.

DE 43 20 723 has disclosed a submerged nozzle, in particular for casting thin slabs, which has a lower section comprising side walls which are guided parallel to one another. Before entry to the lower section, a transverse web is provided, which diverts the melt flow in the direction of the widening of the lower flow shaft. The narrow sides of this immersion nozzle, which is provided in particular for thin slab installations, are guided parallel to one another.

The immersion nozzles which are known from the publications mentioned above produce a casting jet which, at a relatively high speed, penetrates into the liquid crater to corresponding depths.

In view of the above-mentioned prior art, the object of the invention is to provide a process and a corresponding appliance for producing slabs, in which concentrations of impurities are avoided and in particular acid-gas-resistant steel goods can be cast even in bow-type continuous casting installations.

The invention achieves the object by means of the defining features of process claim 1 and of appliance claim 5.

According to the invention, the liquid melt which is supplied to the permanent mold enters the liquid crater of the slab over a wide front and at speeds which are higher than the strand withdrawal speed. With regard to the cross section, the melt supplied has a rectangular profile and even at a depth of no more than 2 m in the liquid crater has already reached the same speed as the slab.

The speed $v_K$ of the melt supplied, which enters the permanent mold, has the following relationship with respect to the strand withdrawal speed $v_B$:

$v_K:v_B$ = 6:1 to 60:1.

In an advantageous configuration of the invention, the liquid melt supplied is guided into the liquid crater with an entry profile which is formed as a rectangle, the clear width d of the rectangle having the following relationship with respect to the narrow side of the permanent mold D:

d:D = 1:3 to 1:40

and the breadth b of the rectangle has the following relationship with respect to the wide side of the permanent mold B:

b:B = 1:7 to 1:1.2.

The flow filaments leaving the immersion nozzle flow into the liquid crater at a width angle of $\alpha$ = 15 to 30°

with respect to the slab withdrawal direction. With regard to the side D of the permanent mold narrow side, the liquid melt supplied impinges on the liquid crater over a depth T = 0.1 to 1.5 x D. The immersion nozzle used for this purpose has narrow side walls which, with regard to the center axis, open out conically at an angle $\alpha$ of 15 to 30°. The free cross section a of the aperture of the casting section of the immersion nozzle has the following relationship with respect to the internal cross section A of the permanent mold:

a:A = 1:30 to 1:300.

In this case, the clear width d of the casting section of the immersion nozzle has the following relationship with respect to the narrow side D of the permanent mold:

d:D = 1:2 to 1:40.

The profile produced in the permanent mold by means of the proposed process moreover has a positive effect on the movement of the melt in the region of the melt level in the permanent mold and on its behavior with regard to the mold powder.

When casting according to the invention, it was surprisingly established that the known differences in concentration over the cross section of the slab did not occur and that the degree of purity, based on nonmetallic inclusions, was significantly improved.

The proposed process makes it possible to produce slabs for steel goods where there are high demands both with regard to the nonmetallic degree of purity and also with regard to the freedom from segregation, as required, for example, for acid-gas-resistant steel goods.

Furthermore, when casting according to the invention, the reduced speed at which the steel flows into the liquid crater situated in the strand shell reduces the total solidification time. As a result, it is possible, on the one hand, to increase the specific casting capacity of the installations, or, on the other hand, to reduce the specific secondary cooling with a view to improved surface quality.

An example of the invention is portrayed in the appended drawing, in which:

Figure 1 shows the immersion nozzle/permanent mold region of a continuous casting appliance, and

Figure 2 shows a side view of a bow-type continuous casting installation.

Figure 1 shows a storage reservoir 11 to which an immersion nozzle 12 is attached. The immersion nozzle 12 has a tubular section 13 and, on the aperture side, a spade-shaped section 14 having the narrow sides 16 and the wide sides 17. A restrictor 15 is provided in the transition region between the two sections of the immersion nozzle.

On the aperture side, the spade-shaped section 14 extends into a permanent mold 21, which is filled with melt S and has narrow sides 22 and wide sides 23, to a depth $T_T$.

In the upper part of the figure, the flow filaments of the melt S are illustrated with the melt $S_Z$ supplied and the liquid crater $S_B$. It can be seen that the flow filaments, with regard to the wide sides, penetrate to a depth L into the melt S, which is surrounded by a strand shell K. The melt filaments are supplied at a speed $v_K$. In the region of the narrow sides 18 of the immersion nozzle, the melt filaments are at an angle $\alpha$ to the center axis I and move relatively early toward the narrow sides 22 of the permanent mold and, in the region of the level P of the melt, seek to move toward the center of the permanent mold 21.

The lower part of the figure shows the view AA, illustrating the permanent mold 21, which has the narrow sides 22 and the wide sides 23 which form a rectangle of the breadth B and the thickness D and the surface area A.

The immersion nozzle 12, with the wide sides 17 and the narrow sides 16 which form a rectangle of the breadth b and the thickness d and the surface area a, is arranged centrally in the cavity of the permanent mold 21.

Figure 2 diagrammatically depicts a section through the continuous casting installation, in this case a bow-type continuous casting installation, having the storage reservoir

11 and the immersion nozzle 12 with the tubular section 13 and the spade-shaped section 14, here the wide sides 17. A restrictor 15 is arranged in the transition region between the sections 13, 14 of the immersion nozzle.

The aperture of the section 14 of the immersion nozzle projects into the melt S, which is situated in the permanent mold 21, to a depth $T_T$.

The wide side walls 23 of the permanent mold 21 are illustrated; their aperture-side end has formed a strand shell K of the slab, which shell surrounds the melt S down to the depth of the liquid crater tip $S_S$.

The strand guidance rollers 24 are arranged downstream of the permanent mold 21.

The melt $S_S$ supplied penetrates into the liquid crater $S_B$, which is situated in the permanent mold, at a speed $v_K$, specifically to a depth T with respect to the wide sides 23. The liquid crater is then at a speed $v_B$, which corresponds to the withdrawal speed of the slab and thus also of the strand shell K.

List of references

Melt supply

| | |
|---|---|
| 11 | Storage reservoir |
| 12 | Immersion nozzle |
| 13 | Tubular section |
| 14 | Spade-shaped section |
| 15 | Restrictor |
| 16 | Immersion nozzle narrow sides |
| 17 | Immersion nozzle wide sides |

Continuous casting appliance

| | |
|---|---|
| 21 | Permanent mold |
| 22 | Permanent mold narrow side |
| 23 | Permanent mold wide side |
| 24 | Strand guidance rollers |

| | |
|---|---|
| I | Center axis |
| K | Strand shell |
| P | Level |
| S | Melt |
| $S_z$ | Melt supply |
| $S_B$ | Liquid crater |
| $S_S$ | Liquid crater tip |
| T | Melt penetration depth narrow side |

$T_T$ Immersion nozzle immersion depth

L Melt penetration depth wide side

$v_K$ Melt supply flow speed

$v_B$ Liquid crater flow speed

$\alpha$ Opening angle

a Immersion nozzle aperture free cross section

A Permanent mold internal cross section

d Casting section clear width

D Clear width of permanent mold narrow sides

Patent claims

1. A process for producing slabs having a thickness $D > 100$ mm, and at casting speeds $v < 3$m/min, in a continuous casting installation in which melt is supplied to a permanent mold from a storage reservoir via an immersion nozzle and from which, on the aperture side, a strand shell enclosing a liquid crater is withdrawn into a strand guidance frame, in particular a bow-type continuous casting installation, wherein the melt supplied enters the permanent mold at a speed ($v_K$) whose relationship with respect to the strand withdrawal speed ($v_R$) is:

$v_K:v_R$ = 6:1 to 60:1, and

wherein the melt supplied is guided in such a way that, with regard to the melt level, it penetrates into the liquid crater over a length $L < 2$ m over a wide front and with a profile which is rectangular in cross section.

2. The process as claimed in claim 1, wherein the liquid melt supplied flows into the liquid crater with an entry profile which is formed as a rectangle, the clear width (d) of the rectangle having the following relationship with respect to the narrow side of the permanent mold (D):

d:D = 1:3 to 1:40

and the breadth (b) of the rectangle having the following relationship with respect to the wide side of the permanent mold (B):

b:B = 1:7 to 1:1.2.

3. The process as claimed in claim 1 or 2, wherein the melt facing toward the narrow slides (D) of the permanent mold flows into the liquid crater at an angle ($\alpha$) of $\alpha$ = 15 to 30° with respect to the slab withdrawal direction.

4. The process as claimed in one of the preceding claims, wherein the liquid melt supplied via the immersion nozzle impinges on the liquid crater over a depth (T), where T = 0.1 to 1.5 x D.

5. A continuous casting appliance for producing slabs made as claimed in process claim 1, having a storage reservoir from which the melt is guided, via an immersion nozzle, into a permanent mold with a clear width (D), where D > 100 mm, and this immersion nozzle has at least one casting section with an elongate cross section including a restrictor element which reduces the speed and flow shape of the main flow of melt entering this casting section, wherein the casting section which has an elongate cross section is configured in such a way that the narrow side walls are at an angle $\alpha$ = 15 to 30° with respect to the center axis, which angle opens out in the direction of flow.

6. The continuous casting appliance as claimed in claim 5, wherein the free cross section (a) of the aperture

of the casting section of the immersion nozzle has the following relationship with respect to the internal cross section (A) of the permanent mold:

a:A = 1:30 to 1:300,

the clear width (d) of the casting section of the immersion nozzle having the following relationship with respect to the narrow side (D) of the permanent mold:

d:D = 1:2 to 1:40.

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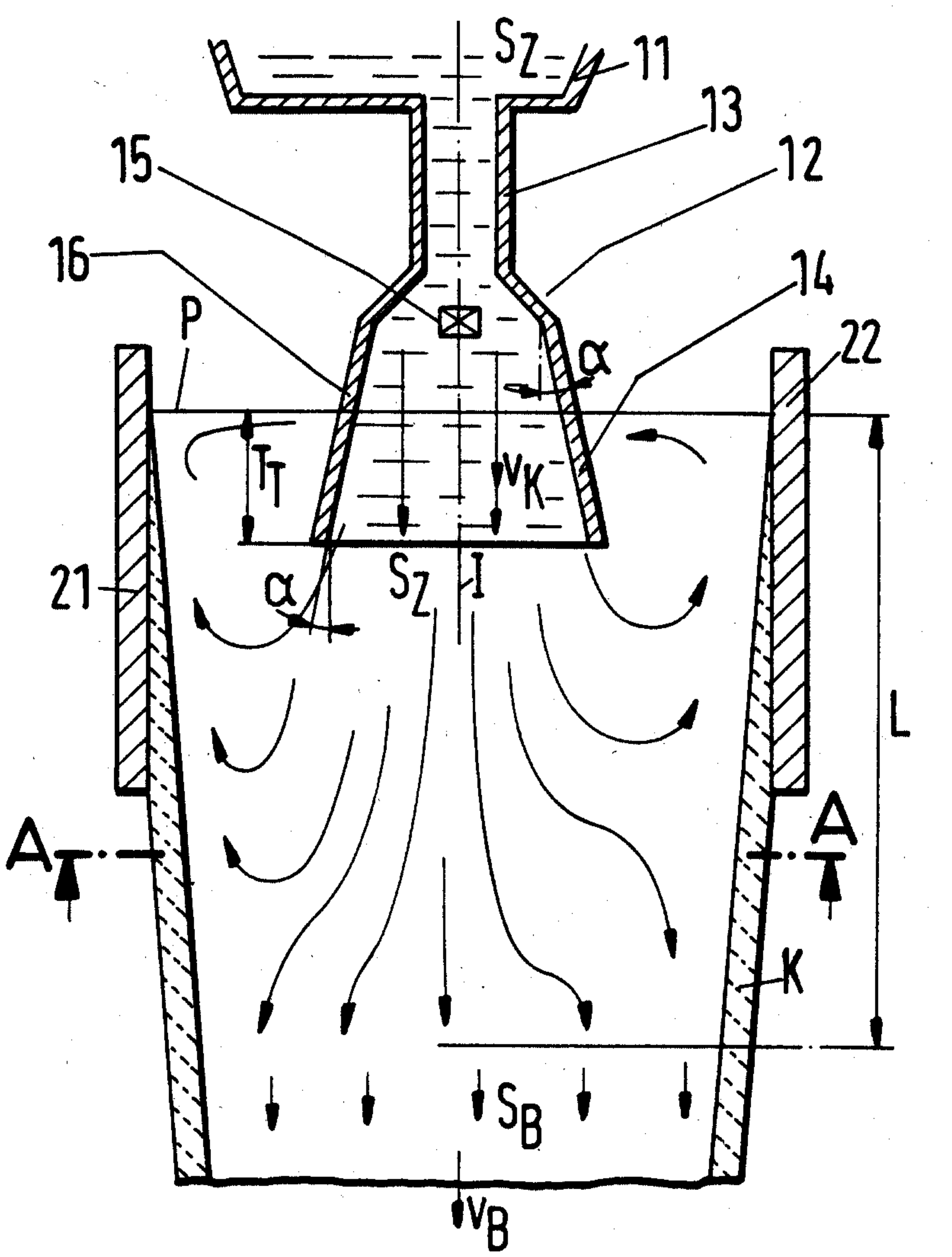
Fig.1


SZ
11
13
15
12
16
14
P
α
22
TT
vK
21
α
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I
L
A
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K
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(A-A)

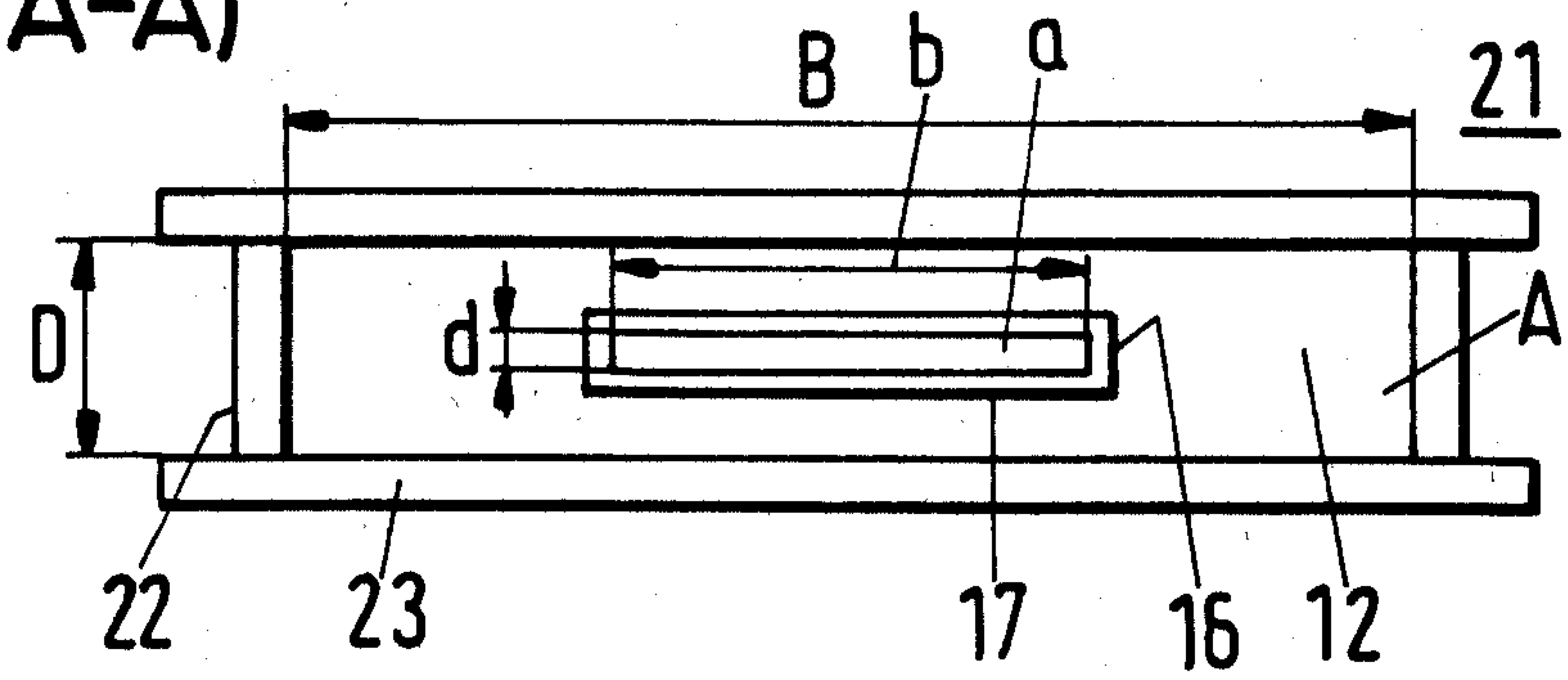
B
b
a
21
D
d
A
22
23
17
16
12

Fig.2