AUSTRALIA

CONVENTION

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Patents Act 1990

REQUEST FOR A STANDARD PATENT

AND NOTICE OF ENTITLEMENT

The Applicant identified below requests the grant of a patent to the nominated person identified below for an invention described in the accompanying standard complete patent specification.

[70,71]Applicant and Nominated Person:

Usinor
Immeuble "La Pacific", 11/13 Cours Valmy, La Defense 7, 92800 Puteaux, FRANCE

Thyssen Stahl Aktiengesellschaft
Kaiser-Wilhelm-Strasse 100, D-47100 Duisburg, GERMANY

[54]Invention Title:

SIDE WALL FOR CLOSING OFF THE CASTING SPACE OF A PLANT FOR THE TWIN-ROLL CONTINUOUS CASTING OF METAL STRIP, AND CASTING PLANT THUS EQUIPPED

[72]Actual Inventors:

Wilhelm Schmitz
Dieter Senk
Guido Stebner
Rolf Simon
Christophe Ganser
Jean-Michel Damasse
Patrice Vicente
Dominique Themines

[74]Address for Service:

PHILLIPS ORMONDE & FITZPATRICK
367 Collins Street
Melbourne 3000 AUSTRALIA

[31,33,32]

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Applicant states the following:

1. The nominated person is the assignee of the actual inventor(s).

2. The nominated person is the applicant of the basic application.

3. The basic application was the first made in a convention country in respect of the invention.

The nominated person is not an opponent or eligible person described in Section 33-36 of the Act.

4 September 1998

Usinor, Thyssen Stahl Aktiengesellschaft
By PHILLIPS ORMONDE & FITZPATRICK
Patent Attorneys for the Applicant
By David B Fitzpatrick

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SIDE WALL FOR CLOSING OFF THE CASTING SPACE OF A PLANT FOR THE TWIN-ROLL CONTINUOUS CASTING OF METAL STRIP, AND CASTING PLANT THUS EQUIPPED

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(71) Applicant(s)
USINOR; THYSSEN STAHL AKTIENGESELLSCHAFT

(72) Inventor(s)
WILHELM SCHMITZ; DIETER SENK; GUIDO STEBNER; ROLF SIMON; CHRISTOPHE GANSER; JEAN-MICHEL DAMASSE; PATRICE VICENTE; DOMINIQUE THEMINES

(74) Attorney or Agent
PHILLIPS ORMONDE & FITZPATRICK , 367 Collins Street, MELBOURNE VIC 3000

(57) Claim

1. Side wall (11) for closing off the casting space (6) of a plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls (5, 5′), of horizontal axes, the cylindrical lateral surfaces of which define a casting space (6) whose width at the nip (7) determines the thickness of the strip, the said side wall (11) having an active part (3) intended to rub against the end faces (4) of the rolls (5, 5′) during casting and to face the said casting space (6), characterized in that the dimensions of the said active part (3) are such that its lower edge (12) is intended to lie a distance (d) equal to at least 1 mm above the nip (7) when the side wall (11) is mounted on the casting plant.

2. Side wall according to Claim 1, characterized in that the said lower edge (12) has a rounded portion (13) facing the casting space (6).

3. Side wall according to Claim 1 or 2, characterized in that the said lower edge (12) has a chamfer facing the casting space (6).

4. Side wall according to one of Claims 1 to 3, characterized in that the said active part (3) is mounted on a support plate (2), and in that the said support plate (2) comprises at least one duct (14) which passes through it and opens into the space (15) that lies between the support plate (2), the end faces (4) of the rolls (5, 5′) and the nip (7), it being possible for the said duct (14) to be connected to means for injecting a cooling fluid.

5. Plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls (5, 5′), of horizontal axes, the cylindrical lateral surfaces of which define a casting space (6) whose width at the nip (7) determines the thickness of the strip, and two side walls for closing off its casting space, characterized in that the said side walls are of the type according to one of Claims 1 to 4.

6. Plant according to Claim 5, characterized in that it comprises means for spraying a cooling fluid onto the region of the strip above the nip (7).

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Name of Applicant:

Usinor, Thyssen Stahl Aktiengesellschaft

Actual Inventor(s):

Wilhelm Schmitz
Dieter Senk
Guido Stebner
Rolf Simon
Christophe Ganser
Jean-Michel Damasse
Patrice Vicente
Dominique Themines

Address for Service:

PHILLIPS ORMONDE & FITZPATRICK
Patent and Trade Mark Attorneys
367 Collins Street
Melbourne 3000 AUSTRALIA

Invention Title:

SIDE WALL FOR CLOSING OFF THE CASTING SPACE OF A PLANT FOR THE TWIN-ROLL CONTINUOUS CASTING OF METAL STRIP, AND CASTING PLANT THUS EQUIPPED

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The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

MYO 97/153

SIDE WALL FOR CLOSING OFF THE CASTING SPACE OF A PLANT FOR THE TWIN-ROLL CONTINUOUS CASTING OF METAL STRIP, AND CASTING PLANT THUS EQUIPPED

The invention relates to the continuous casting of thin metal strip, performed directly from a liquid metal. More specifically, it relates to the lateral closing-off of the casting space of so-called "twin-roll casting" plant used in particular for casting steel or ferrous-alloy strip.

In this type of plant, whose application to the casting of steel strip a few mm thick is being industrialized, the casting space is delimited, on the one hand, by the internally cooled cylindrical lateral surfaces of two horizontal rolls close together and rotated in opposite directions about their axes, against which rolls the liquid metal begins to solidify and, on the other hand, by plates made of a refractory material pressed by elastic means against the plane ends (known as "end faces") of the rolls. These plates laterally close off the casting space so as to prevent liquid metal from leaking from the plant. Their lower edge is located below the "nip", that is to say the region where the surfaces of the rolls are closest together and the width of which approximately corresponds to the desired thickness of strip.

The side closure plates absolutely must be greatly preheated prior to casting, so as to prevent the liquid metal from solidifying against them during the filling of the mould (the bottom of which, during the filling operation, is closed off by a part called a "dummy bar" which is extracted from the casting space when the rolls begin to rotate and carries the start of the strip with it) and in the first moments of casting. However, even if such a precaution is taken, the side walls constitute a thermally tricky point in the machine in that they inevitably create, in their

vicinity, an area from which the extraction of heat from the liquid metal is abnormally high. This is, in particular, the case close to the rolls which, as they are internally cooled by the circulation of water, tend to cool the side walls near the areas where contact takes place. This may result in the steel solidifying on the margins of the rolls significantly more quickly than on the portions of the rolls which are closer to their central regions, and this may be a source of problems. This is because normally the "shells" of metal which solidify on each of the rolls, and whose thickness at a given point increases gradually as the roll rotates must, in order to form the strip, meet up either exactly at the nip or very slightly below this level. If this meeting of the shells occurs too significantly lower down than the nip, there is a risk that the strip will not be solid enough as it leaves the rolls and that it will crack. There is also the risk that it will have internal porosity. Conversely, if the shells meet upstream of the nip, in particular under the influence of excessively cold side walls, the thickness of the solidified strip at the nip exceeds the nominal width of the nip. It is then necessary for the rolls to be parted in order to prevent them from applying a rolling load to the strip, which is something they are not designed to do. This parting of the rolls is a source of defects in the strip, which defects are associated with the resulting changes in thickness and the way in which the product solidifies. Another consequence of the abnormal conditions of solidification of the strip near the side walls is the high pressure exerted by the solidifying metal on the lower part of the side walls. It often happens that this pressure is high enough to make the side wall retreat over at least part of its height, and this can locally destroy the sealing of the contact between rolls and side walls. Liquid metal can then escape from the casting space.

The object of the invention is to provide a configuration of casting plant that makes it possible to create strip-solidification conditions near the side walls which are not liable to disrupt the uniformity of the casting process. It should also limit the phenomenon of the retreating of the side walls.

The subject of the invention is a side wall for closing off the casting space of a plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls, of horizontal axes, the cylindrical lateral surfaces of which define a casting space whose width at the nip determines the thickness of the strip, the said side wall having an active part intended to rub against the end faces of the rolls during casting and to face the said casting space, characterized in that the dimensions of the said active part are such that its lower edge is intended to lie a distance equal to at least 1 mm above the nip when the side wall is mounted on the casting plant.

Another subject of the invention is a plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls, of horizontal axes, the cylindrical lateral surfaces of which define a casting space whose width at the nip determines the thickness of the strip, and two side walls for closing off its casting space, characterized in that the said side walls are of the type previously described.

As will have been understood, according to the invention, the active part of the side wall, that is to say its part which is in contact either with the end faces of the rolls or with the liquid metal enclosed by the casting space, is interrupted not below the nip as is conventional, but above it. Thus an empty space is left on each side of the nip, in which space the metal is not in contact with any refractory material and therefore exerts no pressure on the side walls. Thus, the metal present facing this empty space cannot cause

the side walls to retreat, even if its solidified fraction is abnormally high. Furthermore, this empty space gives the solidified or solidifying metal the possibility of extending towards the outside of the casting space, this limiting the forces that the margins of the rolls have to withstand.

The inventors have noticed that the conditions of the cooling of the steel inside the mould, with the usual casting parameters, were such that from a level which may lie a few cm above the nip, the solidification of the metal on the edges of the casting space, although not yet complete, is already far enough advanced for there to be no significant leak of liquid metal towards the outside of the machine, even if the metal is not retained by the side walls. From this they deduced that it was possible to dispense with the lower part of the side walls of the prior art. Dispensing with these makes the casting machine more able to tolerate slight deviations in the strip-solidification process. Indeed, with the invention, a thickness of solidified shells on the margins of the rolls that was a little higher than anticipated in the last few mm or cm before the nip no longer causes the side walls to retreat or the associated risks of loss of sealing in the upper levels of the casting space. Furthermore, the parts of the strip which have solidified in excess have the possibility of extending laterally if the rolls exert a compressive force on them, this making the need to part the rolls in order to minimize the stresses they have to withstand appreciably less probable.

The invention thus affords greater stability in the casting conditions, and this contributes to better overall quality of the strip and greater reliability of the casting plant.

The invention will be better understood from reading the description which follows, which description is given with reference to the following appended figures:

- Figure 1 which depicts diagrammatically from the front (Figure 1a) and from the side (Figure 1b) in section on Ib-Ib a side wall for twin-roll continuous casting according to the prior art;

- Figure 2 which depicts diagrammatically from the front (Figure 2a) and from the side (Figure 2b) in section on IIb-IIb, a side wall for twin-roll continuous casting according to the invention.

The side wall 1 according to the prior art and depicted diagrammatically in Figure 1 comprises a support plate 2 into which is set the active part 3 of the side wall 1, that is to say its portion which, during casting, is intended to come into contact with the end faces 4 of the rolls 5, 5′ (of which only the outlines have been depicted in dotted line in Figure 1a), liquid steel that the casting space 6 of the machine will enclose and, below the level of the nip 7 where the rolls 5, 5′ are the closest together, some solidified strip. Means (not depicted) known per se press the side wall 1 against the end faces 4 of the rolls 5, 5′. By virtue of springs or rams these allow the side wall 1 to be withdrawn temporarily should metal infiltrate between its active part 3 and the end face 4 of a roll 5, 5′, or excessive force be exerted on its lower part by the solidifying strip. Reference may, in particular, be made to document EP-A-0,698,433 for the description of a (non-limiting) example of such means. In the embodiment depicted, the active part 3 is split into two portions. The portion 8 in a double arc of a circle which, when the side wall 1 is mounted on the machine, constitutes the area of contact with the end faces 4 of the rolls 5, 5′, the immediate vicinity of this contact region and the region surrounding the nip 7 is made of a first refractory material. Its essential quality is high hardness so that it can withstand as well as possible the rubbing of the end faces 4 of the rolls 5 and 5′ and (around the nip 7) of the solidifying or already solidified strip. It is, for example, made of SiAlON® or boron nitride. It may

consist of a single piece or of several contiguous pieces secured together. Its lower edge 9 is located below the level of the nip 7 so as to close off the casting space 6 completely at the side. The remaining portion 10 of the active part 3 is made of a refractory material which has a high insulating capability, such as silica or alumina. The active part 3 of the side wall 1 projects with respect to the support plate 2 by a thickness at least equal to its maximum tolerable wear during casting, for example 10 mm. During casting, the portions of the active part 3 which are in contact with the end faces 4 of the rolls 5, 5′ wear essentially by rubbing, the consequence of this being that little by little the other portions of the active part 3, which wear only at a more moderate rate because they are in contact only with the liquid or solidifying steel, slightly penetrate into the casting space 6. As an alternative, the entire active part 3 of the side wall 1 may be made as a single piece.

In Figure 2 which depicts a side wall 11 according to the invention mounted on the casting plant, the elements which are common to those of Figure 1 are denoted by the same references. According to the invention, for the reasons which have been stated, the lower edge 12 of the active part 3 of the side wall 11 which provides contact with the rolls 5, 5′ and closes off the lower part of the casting space 6 is located not beneath the nip 7, but this time a distance "d" above it. This distance "d" may be very small, as small as 1 mm, if it can habitually be achieved that the growth of the solidified shells on the margins of the rolls 5, 5′ can be controlled with great accuracy and if the proportion of solid material present in the metal which is not yet fully solidified in this region of the casting space 6 can go very quickly from 0 to 100%. These parameters depend, in particular, on the grade being cast. Grades of steel with the highest contents of carbon and of miscellaneous alloying elements, such as stainless

steels, have solidification ranges (the difference between the liquidus and solidus temperatures) which are broader than those of ordinary grades of steel or nickel-iron alloys, and this makes control of their solidification conditions more tricky. Above all, this broad solidification range means that a significant amount of solid material starts to be observed near the side wall 11 at relatively high levels of the casting space 6. For these steels with a broad solidification range, it is therefore necessary to provide a distance "d" which is longer than in the case of grades which have a narrow solidification range and which solidify quickly once the liquidus temperature is reached. In practice, a distance "d" of between 10 and 40 mm is suitable for the most common grades of stainless steel cast in the form of strips 3 mm thick using rolls 1500 mm in diameter and casting rates of the order of 1 m/min. The optimum choice of the distance "d" also depends on the ferrostatic pressure in the lower part of the casting space, therefore on the geometry of the casting plant and on the nominal level of the surface of the liquid steel present in the casting space. Thus, good results have been obtained with a distance "d" of from 1 to [illegible]m on a machine fitted with rolls 600 mm in diameter, when casting low-alloy carbon steels and iron-silicon alloys.

As a preference, in order to reduce the mechanical stresses exerted on it and which may lead to its swift and uncontrolled degradation, the lower edge 12 of the active part 3 of the side wall 11 which faces the casting space 6 has no sharp corner, but a rounded portion 13 whose radius of curvature may, for example, be of the order of 10 to 20 mm. The same function may be fulfilled by chamfering the lower edge 12, to an inclined plane, for example at 45°.

It is also possible to envisage the possibility of cooling the region of the strip by spraying a fluid (water, liquid argon or nitrogen, etc.) between the lower edge of the active part 3 of the side wall 11 and

the nip 7. This cooling can be carried out constantly so as to ensure that the margin of the strip is always far enough solidified that it will not tear and allow liquid metal to escape. It may also be performed only when the onset of such tearing of the margin is observed, or when the monitoring of the casting parameters raises a suspicion that there are risks that such tearing may occur. As means of conveying the cooling fluid to the region of the strip, use may be made, for example, of one or more ducts 14 passing through the support plate 2 and opening into the space 15 that lies between the support plate 2, the end faces 4 of the rolls 5, 5' and the nip 7. However, other means of conveying fluid, which may possibly be independent of the side wall 11, such as one or more nozzles which may be placed under the side wall 11 and directed towards the region of the strip, may also be envisaged.

A mark of the efficiency of the invention is the number of retreats of the side wall that are observed during casting. Thus, it has been observed that this number could be divided by three over a casting run, by comparison with the use of side walls which descend as far as underneath the nip. The improvement is even more significant when one considers the first few minutes of casting, during which the operation of the casting machine is not yet perfectly stabilized. These observations were made when casting austenitic stainless steel of type SUS 304 cast in strips 3 mm thick with a distance "d" equal to 25 mm and a roll diameter of 1500 mm.

The fitting of such side walls to an existing casting plant may, if need be, require a number of modifications to be made to the dummy bar so that the entire casting space 6 is closed off laterally as it is being filled, before the start of casting.

It goes without saying that the application of the invention is not restricted to the specific configuration of side wall which has been given by way

of example, but applies to any other configuration which allows an interruption of the active part above the nip.

Of course, the invention applies not only to the twin-roll casting of strip made of steel and other ferrous alloys, but of any other metal that can be cast using this method.

CLAIMS

The claims defining the invention are as follows:

1. Side wall (11) for closing off the casting space (6) of a plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls (5, 5'), of horizontal axes, the cylindrical lateral surfaces of which define a casting space (6) whose width at the nip (7) determines the thickness of the strip, the said side wall (11) having an active part (3) intended to rub against the end faces (4) of the rolls (5, 5') during casting and to face the said casting space (6), characterized in that the dimensions of the said active part (3) are such that its lower edge (12) is intended to lie a distance (d) equal to at least 1 mm above the nip (7) when the side wall (11) is mounted on the casting plant.

2. Side wall according to Claim 1, characterized in that the said lower edge (12) has a rounded portion (13) facing the casting space (6).

3. Side wall according to Claim 1 or 2, characterized in that the said lower edge (12) has a chamfer facing the casting space (6).

4. Side wall according to one of Claims 1 to 3, characterized in that the said active part (3) is mounted on a support plate (2), and in that the said support plate (2) comprises at least one duct (14) which passes through it and opens into the space (15) that lies between the support plate (2), the end faces (4) of the rolls (5, 5') and the nip (7), it being possible for the said duct (14) to be connected to means for injecting a cooling fluid.

5. Plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls (5, 5'), of horizontal axes, the cylindrical lateral surfaces of which define a casting space (6) whose width at the nip (7) determines the thickness of the strip, and two side walls for closing

off its casting space, characterized in that the said side walls are of the type according to one of Claims 1 to 4.

6. Plant according to Claim 5, characterized in that it comprises means for spraying a cooling fluid onto the region of the strip above the nip (7).

DATED: 3rd September, 1998

PHILLIPS ORMONDE & FITZPATRICK

Attorneys for:

USINOR and THYSSEN STAHL AKTIENGESELLSCHAFT

David B Fitzpatrick

MYO 97/153

SIDE WALL FOR CLOSING OFF THE CASTING SPACE OF A PLANT FOR THE TWIN-ROLL CONTINUOUS CASTING OF METAL STRIP, AND CASTING PLANT THUS EQUIPPED

Abstract

The subject of the invention is a side wall (11) for closing off the casting space (6) of a plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls (5, 5′), of horizontal axes, the cylindrical lateral surfaces of which define a casting space (6) whose width at the nip (7) determines the thickness of the strip, the said side wall (11) having an active part (3) intended to rub against the end faces (4) of the rolls (5, 5′) during casting and to face the said casting space (6), characterized in that the dimensions of the said active part (3) are such that its lower edge (12) is intended to lie a distance (d) equal to at least 1 mm above the nip (7) when the side wall (11) is mounted on the casting plant.

Another subject of the invention is a plant for the continuous casting of metal strip of the type comprising two internally cooled counter-rotating rolls (5, 5′), of horizontal axes, the cylindrical lateral surfaces of which define a casting space (6) whose width at the nip (7) determines the thickness of the strip, and two side walls for closing off its casting space, characterized in that the said side walls are of the above type.

Figure for the abstract: Figure 2

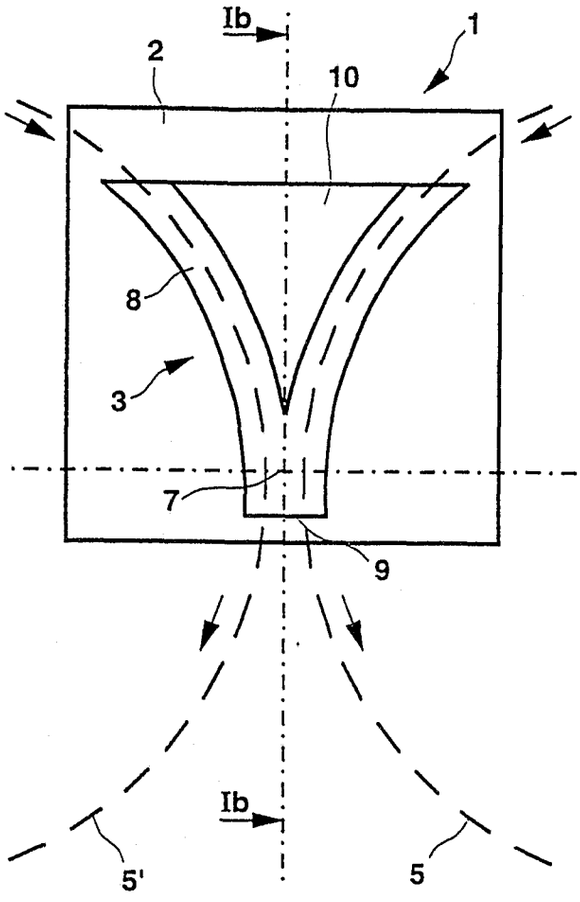

Fig. 1a

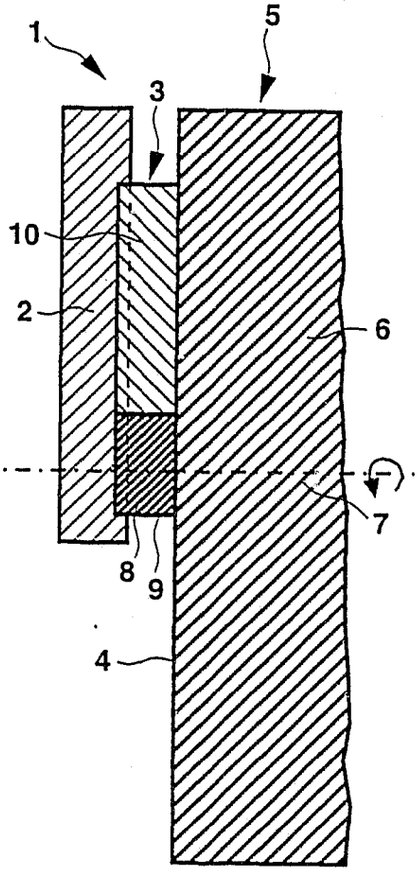

Fig. 1b

Fig. 1
(art antérieur)

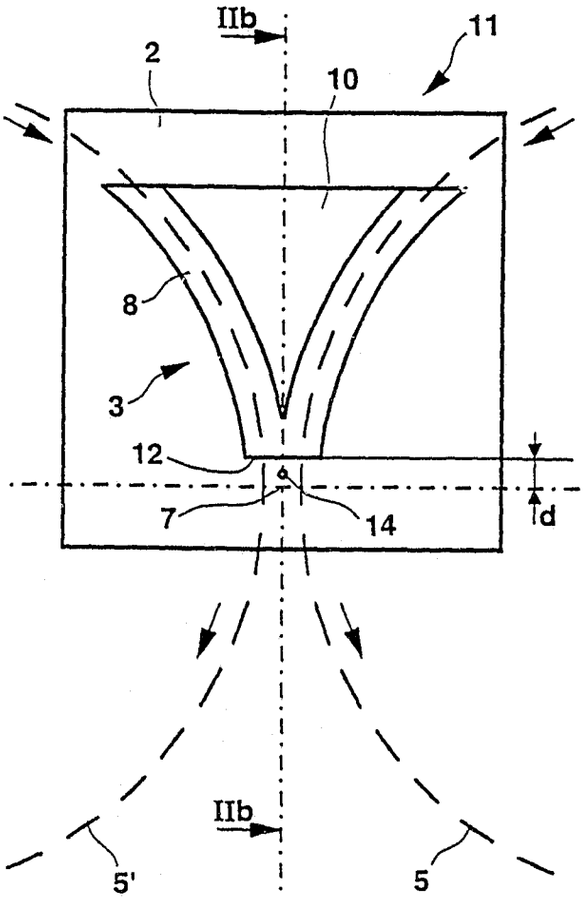

Fig. 2a

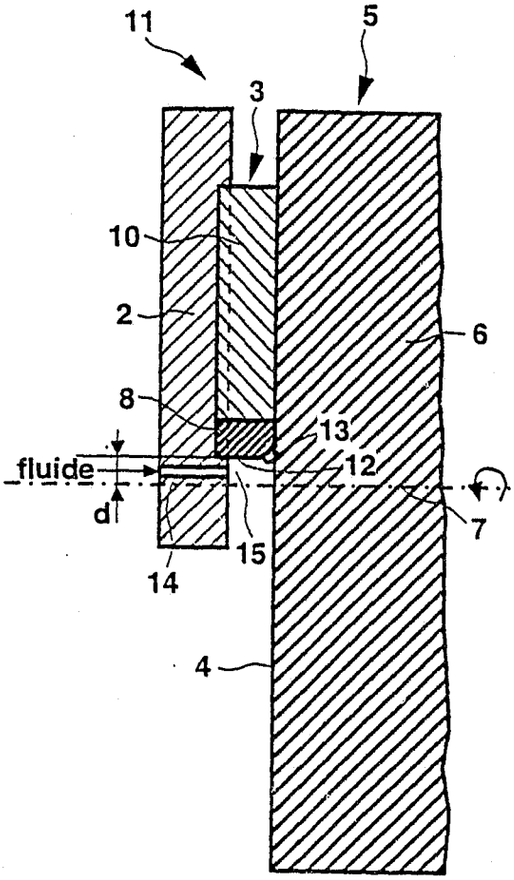

Fig. 2b

Fig. 2

END