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(54) **Device and method for the continous casting of a bimetallic strip through a twin roll casting machine**

Vorrichtung sowie Verfahren zur Erzeugung von dünnem Bimetallband mit einer 2-Rollen-Giessvorrichtung

Appareil et procédé de coulée continue de bande bimétallique par coulée entre deux cylindres

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- **PATENT ABSTRACTS OF JAPAN vol. 012, no. 137 (M-690), 26 April 1988 (1988-04-26) & JP 62 259641 A (MITSUBISHI HEAVY IND LTD), 12 November 1987 (1987-11-12)**
- **PATENT ABSTRACTS OF JAPAN vol. 016, no. 157 (M-1236), 16 April 1992 (1992-04-16) & JP 04 009251 A (TOSHIBA CORP), 14 January 1992 (1992-01-14)**
- **PATENT ABSTRACTS OF JAPAN vol. 1995, no. 06, 31 July 1995 (1995-07-31) & JP 07 068349 A (NIPPON STEEL CORP), 14 March 1995 (1995-03-14)**
- **PATENT ABSTRACTS OF JAPAN vol. 016, no. 414 (M-1303), 2 September 1992 (1992-09-02) & JP 04 138847 A (NIPPON STEEL CORP), 13 May 1992 (1992-05-13)**
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- **PATENT ABSTRACTS OF JAPAN vol. 016, no. 137 (M-1231), 7 April 1992 (1992-04-07) & JP 03 297542 A (NISSHIN STEEL CO LTD;OTHERS: 01), 27 December 1991 (1991-12-27)**

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Description

Field of the Invention

[0001] The invention refers to continuous casting of a bimetallic strip through a twin roll casting machine.
In particular the invention deals with a distributor device of the molten metal components on the crystallizing rolls and the corresponding utilization method, in order to prevent the mixing of the above mentioned metals, to keep separated and distinguished their respective meniscuses and thus to ensure a clear separation at the metals interface in the cast product.

Background of the Invention

[0002] The methods used for the continuous casting of bimetallic strip through a twin roll casting machine, starting from different molten metals, are known from the technique.
The solutions in which two pouring nozzles, one for each type of metal, are used to obtain a strip plated either on both sides or on one side only, are particularly well known.
More precisely, patent JP 5277659 describes a method to plate the strip on both sides and considers two pouring nozzles of different lengths which discharge the molten metals at different levels into their respective baths between crystallizing rolls and the containment side plates.
An evident disadvantage of this solution is the unavoidable mixing of the two liquids and therefore the fact that it is not possible to have a distinct start of solidification for each molten metal, or a semi-skin for each metal, and thus to obtain a clear separation interface between the two metals in the cast product.
Patent JP 5277661 is an attempt at solving these inconveniences. It considers a separation wall to keep the two molten metals separated. This solution, however, has big limitations as well: as a matter of fact, there is nothing to prevent the liquid under the wall from flowing through the gaps between the same wall and the rolls into the bath above and vice versa. There are therefore the same inconveniences as with JP '659.
Patent JP 4009251, on the contrary, describes a device to plate the strip on one side only and considers two nozzles of the same length which discharge their respective molten metals at a higher level than the roll's profile. Moreover, a vertical separation wall, placed on the centre line of the two rolls, should ensure the separation between the two liquid baths. Not even this patent, however, can give any guarantee to prevent the liquids from getting mixed. It furthermore does not allow to plate both sides of the strip.
To avoid these inconveniences, the Applicant has studied, designed and constructed the device as described hereinafter.

Summary of the Invention

[0003] The main object is to construct a distributor device for the molten metals in association with a method of utilization which can guarantee a clear separation interface between the inner and the outer layers, as well as the absence of any defects in the cast strip.
[0004] Another object of the present invention is to cast a strip plated on one side only or on both sides.
[0005] According to the invention there is provided a device for continuous casting a metallic strip through a twin roll casting machine, said metallic strip having a metallic coating on at least one side thereof, according to the characterising features of claim 1. Further advantageous embodiments are subject matter of dependent claims. Further, the invention provides a method of continuous casting a metal strip through a twin roll casting machine, said metallic strip having a metallic coating on at least one side thereof by using a distributor device, according to claim 9.
[0006] With the device and the method according to the invention the production of a strip having a low carbon core coated on both sides with stainless steel has remarkable advantages mainly for the automotive and the electrical appliances industry. For this type of steel strip the galvanizing process of the steel sheet is indeed no longer necessary, and this facilitates above all the pressing of the steel sheet itself. Also, a thinner layer of protective paint is required with a resulting reduction in costs and in terms of environmental impact of the galvanizing and painting process.
[0007] The device and method according to the present invention allows to cast a bi-metallic strip with a total thickness in the of 1-5 mm range through a twin roll continuous casting machine, whose width can range from 500 - 1500 mm starting from the molten component metals as e.g. carbon steel and stainless steel. The stainless steel coating in the cast strip can vary from 5 % to 25 % of the total strip thickness.

Brief Description of the Drawings

[0008]

Fig. 1: shows schematically a vertical section through the crystallizing rolls and the distributor means and features of the cast control;

Fig. 2: shows an enlarged vertical section through one crystallizing roll and the associated half distributor means;

Fig. 3: shows a section similar to Fig. 1, however with a modified distributor means without a side-wall; and

Fig. 4: shows a view similar to Fig. 3 with a further embodiment of distributor means.

Detailed Description of the Preferred Embodiment

[0009] Fig. 1 shows partly and schematically crystallizing rolls 1 a and 1 b of a twin roll casting machine for continuous casting a metallic strip. Arrows D and E indicate their turning directions, respectively. Above the crystallizing or casting rolls 1 a, 1 b there is provided a distributor means 5, which distributes molten metals A through a nozzle or pipe 6 from a central under-tundish 3 and molten metals B and C through a nozzle or pipe 4a, 4b from under-tundishes 2a or 2b, respectively, on the crystallizing rolls 1 a, 1 b to provide a metallic strip 18 made of three metals A, B and C.

[0010] The crystallizing rolls 1 a, 1 b are arranged parallel to each other at a given distance d which substantially defines the starting thickness of the cast product or strip. The rolls 1a and 1b define a substantially V-shaped top space, and the distributor device 5 is placed in this substantially V-shaped top space and mounted between a non-shown front wall and the rear wall 40 perpendicular to the axis of the crystallizing rolls 1a, 1b.

[0011] With the arrangement of fig. 1 the strip 18 is coated on both sides. The strip core contains metal A, e.g. low carbon steel, while the two lateral sides contain metals B and C which may be e.g. stainless steel to form the strip coatings on both sides.

[0012] In the first embodiment shown in figure 1, the distributor device 5 is made up of two spaced vertical walls 7a, 7b, which define a centre chamber 30 for the molten metal A, intermediate walls 8a, 8b, which define with the two spaced vertical walls 7a, 7b, two lateral chambers 31 for the molten metal B and C, respectively, and side walls 9a, 9b, which define with said intermediate walls 8a, 8b, two small spaces 33, respectively, which communicate with said lateral chambers 31 through openings 10a, 10b, respectively, provided close to a bottom portion 35. The side walls 9a, 9b are shorter than the intermediate walls 8a, 8b and define a passage for liquid metal B or C, discharged into the lateral chambers 31.

[0013] The liquid metal B and C forms a meniscus 21a, 21b, respectively, in the substantially V-shaped top space. The intermediate walls 8a, 8b with bottom openings 10a, 10b and the side walls 9a, 9b are suitable to reduce the kinetic energy of the molten metal B, C coming from the under-tundishes 2a, 2b, respectively, thus ensuring a substantially flat and turbulence-free "lateral" meniscus 21a, 21b. A meniscus 20 is formed in the centre chamber 30, containing the molten metal A.

[0014] The level of the meniscus 20 of the centre chamber 30 is monitored by a sensor means 38. Further, there are sensor means 38a for the meniscus 21a and 38b for the meniscus 21b. The sensor means 38, 38a and 38b are connected to a control unit 39 for individually feeding molten metals A, B and C to the centre chamber 30 and the lateral chambers 31 in response to signals of said sensor means 38, 38a, 38b to maintain the meniscus 30 and 21a, 21b on a predetermined level. According to figures 2 - 4 there is a level difference Δh between the said meniscus 20 of the centre chamber 30 and the meniscus 21a of the lateral chamber 31, which is kept constant through the sensor means 38 and the control unit 39 as described above. The difference Δh depends on casting parameters, e. g. speed, etc., and on the properties of the metals to be matched, e. g. density, viscosity, etc. The levels of the three meniscus 20, 21a, 21b are individually controllable through the above mentioned sensor means 38, 38a, 38b and the control unit.

[0015] The casting of the metallic strip 18 by using the distributor means 5 for different molten metals is now described with reference to figure 2, which shows only half of the device 5 and casting machine of figure 1, i. e. the right portion. According to figure 2, molten metal B which is confined between the vertical wall 7a and its respective crystallizing roll 1a, comes into contact with a cool surface of the roll 1a itself and starts to solidify forming a semi-skin S_{1a}. The semi-skin S_{1a} formation takes place in the circumference arc, which extends from a contact point P_1 of the lateral meniscus 21a with said roll 1a up to the point P_2 which corresponds to the vertical downward extension of the vertical wall 7a.

[0016] The point P_2 is called "double point", and above the double point P_2 only the formation of the semi-skin S_{1a} takes place until reaching its maximum thickness at P_2. Below the point P_2 the solidification of molten metal A, contained in the centre chamber 30 starts, and semi-skin S_{2a} begins to form over the semi-skin S_{1a}. A point of minimum distance between the rolls 1a, 1b is called the "kissing point". In correspondence with this point, the semi-skins S_{2a}, S_{2b}, which have been previously formed on the two rotating crystallizing rolls 1a, 1b, combine to form the desired plated strip 18, which is made of the metal A in its core or centre part and, in figure 2, of metal B on its right surface.

[0017] The width of the centre chamber 30 determines the position of the double point P_2, and the position of the double point P_2 defines the final thickness of the semi-skin S_{1a} and therefore the thickness of the strip coating. In correspondence with the double point P_2, a gap 19 is formed between the vertical wall 7a and the casting roll 1a. The rotation of said roll 1a causes the dragging of the molten metal B contained in the side space 37 below the bottom portion 35. This creates a dynamic pressure on said metal B in said passage gap 19. Owing to this additional pressure, a none desired passage of molten metal B from said lateral space 37 into the centre chamber 30 might take place through said gap 19 resulting into a mixing with the molten metal A. In order to avoid such drawback, the level of the centre meniscus 20 is kept higher than the side meniscus 21a by the amount Δh, as mentioned above. In this way, there is provided a hat of metal A which determines a ferrostatic pressure on the gap 19, which is sufficient to compensate the total pressure determined by the molten metal B in the same zone. Therefore, the passage of metal B through the gap 19 is prevented, and the semi-skin S_{2a},

which is formed below the point P_2, does not contain any unwanted traces of the other metal.

[0018] Figure 3 corresponds essentially to figure 2. However, the distributor device 5 is modified to have no side wall 9a. Figure 4 is similar to figure 3, however with a further modified distributor means 5, wherein the side wall 9a and a part of the bottom portion 35 outside the lateral chamber 31 are omitted.

[0019] The distributor device as shown in figure 2, 3 and 4 can be used only for a half for strip coating on one side only. In this case, the upstream feeding system includes only two under-tundishes 2a or 2b, 3 with their respective nozzles 4a or 4b, 6.

Claims

1. A device for continuous casting a metallic strip through a twin roll casting machine, said metallic strip having a metallic coating on at least one side thereof, comprising
   a distributor means (5) for different molten metals (A, B, C), said distributor means (5) being provided between the crystallizing rolls (1a, 1b) above their kissing point, said distributor means (5) comprising:

   a front wall and a rear wall (40) perpendicular to the axis of the crystallizing rolls (1a, 1b);
   two spaced vertical walls (7a) defining together with the front and rear wall and the surfaces of said crystallizing rolls (1a, 1b) a centre chamber (30) for receiving a first molten metal (A); **characterised by**
   at least one intermediate wall (8a) extending outside one of the vertical walls (7a) from a bottom portion (35) to define with the associated vertical wall (7a) a lateral chamber (31) for a second or a second and a third molten metal (B, C), respectively,
   each intermediate wall (8a) comprising at least one opening (10a).

2. The device according to claim 1, wherein each opening (10a) is provided close to the bottom portion (35).

3. The device according to claim 1, wherein the front wall (40) and the rear wall (41) are side plates.

4. The device according to a proceeding claim, comprising at least one side wall (9a) extending outside said at least one intermediate wall (8a) from said bottom portion (35) close to the casting rolls (1a, 1b) to form a small chamber (33), respectively.

5. The device according to claim 4, wherein each side wall (9a) is shorter than each intermediate wall (8a) and defines a lateral passage for the second or third molten metal (B, C) contained in the lateral chamber (31) once the side wall (9a) has been passed.

6. The device according to a proceeding claim, wherein a lower end of each vertical wall (7a) defines a gap (19) with respect to the crystallizing roll (1a), said gap (19) linking said centre chamber (30) with a lateral space (37) formed beneath the bottom portion (35) receiving molten metal having passed the side walls (9a).

7. The device according to a proceeding claim, **characterised by** providing a meniscus (21a) formed in an even manner in the lateral space (33) between the outside of the crystallizing roll (1a) and the intermediate wall (8a) by the second or third molten metal (B, C), once a side wall (9a) has been passed.

8. The device according to a proceeding claim, **characterised by** providing a level of the meniscus (21a, 21b), which is lower (Δh) than the level of a meniscus (20) of the centre chamber (30).

9. The device according to a proceeding claim, **characterised by** sensor means (38) for the level of the meniscus (20) of the centre chamber (30) and sensor means (38a, 38b) for the level of a meniscus (21a) in at least one lateral space (33), and a control unit (39) for individually feeding molten metals to the centre chamber (30) and at least one lateral chamber (31) in response to signals of said sensor means (38, 38a, 38b).

10. A method of continuos casting a metallic strip through a twin roll casting machine, said metal strip having a metallic coating on at least one side thereof by using a distributor device according to claim 1, comprising the following steps:

    feeding a first molten metal to the centre chamber to obtaining a central meniscus;
    feeding a second or a second and a third molten metal, respectively, to a lateral chamber, respectively, to obtain at least one lateral meniscus; and
    maintaining the level of the central meniscus compared to the level of at least one lateral meniscus by an amount Δh higher, which is determined by casting parameters and properties of the metals to be matched.

Patentansprüche

1. Vorrichtung zum kontinuierlichen Gießen eines Metallbandes über eine Doppelwalzen-Gießmaschine, wobei das metallische Band eine metallische Beschichtung an wenigstens seiner einen Seite aufweist, bestehend aus

einer Verteilungseinrichtung (5) für verschiedene geschmolzene Metalle (A, B, C), wobei die Verteilungseinrichtung (5) zwischen den Kristallisierungswalzen (1a, 1b) oberhalb ihrer Stelle mit minimaler Entfernung vorgesehen ist, wobei die Verteilungseinrichtung (5) eine Vorderwand und eine Rückwand (40), die senkrecht zu der Achse der Kristallisierungswalzen (1a, 1b) angeordnet sind, und zwei beabstandete vertikale Wände (7a) aufweist, die zusammen mit der Vorderwand und der Rückwand und den Oberflächen der Kristallisierungswalzen (1a, 1b) eine Mittelkammer (30) zur Aufnahme eines ersten geschmolzenen Metalls (A) bilden, **gekennzeichnet durch** wenigstens eine Zwischenwand (8a), die sich außerhalb einer der vertikalen Wände (7a) von einem Bodenabschnitt (35) zur Bildung einer seitlichen Kammer (31) mit der zugeordneten vertikalen Wand (7a) für ein zweites oder ein zweites und ein drittes geschmolzenes Metall (B, C) jeweils erstreckt, wobei jede Zwischenwand (8a) wenigstens eine Öffnung (10a) aufweist.

2. Vorrichtung nach Anspruch 1, wobei jede Öffnung (10a) nahe zu dem Bodenabschnitt (35) vorgesehen ist.

3. Vorrichtung nach Anspruch 1, wobei die Vorderwand (40) und die Rückwand (41) Seitenplatten sind.

4. Vorrichtung nach einem vorangehenden Anspruch mit wenigstens einer Seitenwand (9a), die sich außerhalb der wenigstens einen Zwischenwand (8a) von dem Bodenabschnitt (35) nahe zu den Kristallisierungswalzen (1a, 1b) zur Bildung einer kleinen Kammer (33) entsprechend erstreckt.

5. Vorrichtung nach Anspruch 4, wobei jede Seitenwand (9a) kürzer als jede Zwischenwand (8b) ist und einen seitlichen Durchgang für das zweite oder dritte geschmolzene Metall (B, C), das in der seitlichen Kammer (31) enthalten ist, bildet, sobald die Seitenwand (9a) passiert worden ist.

6. Vorrichtung nach einem vorangehenden Anspruch, bei der ein unteres Ende jeder vertikalen Wand (7a) einen Spalt (19) bezüglich der Kristallisierungswalzen (1a) bildet, wobei der Spalt (19) die Mittelkammer (30) mit einem unterhalb des Bodenabschnitts (35) gebildeten seitlichen Raum (37) verbindet, der geschmolzenes Metall aufnimmt, das die Seitenwände (9a) passiert hat.

7. Vorrichtung nach einem vorangehenden Anspruch, **dadurch gekennzeichnet, dass** ein Gießspiegel (21a) vorgesehen ist, der gleichmäßig in dem seitlichen Raum (33) zwischen der Außenseite der Kristallisierungswalze (1a) und der Zwischenwand (8a) durch das zweite oder dritte geschmolzene Metall (B, C) gebildet ist, sobald eine Seitenwand (9a) passiert worden ist.

8. Vorrichtung nach einem vorangehenden Anspruch, **dadurch gekennzeichnet, dass** ein Pegel eines Gießspiegels (21a, 21b) vorgesehen ist, der niedriger (Δh) liegt als der Pegel eines Gießspiegels (20) der Mittelkammer (30).

9. Vorrichtung nach einem vorangehenden Anspruch, **gekennzeichnet durch** Sensoreinrichtungen (38) für den Pegel des Gießspiegels (20) der Mittelkammer (30) und Sensoreinrichtungen (38a, 38b) für den Pegel eines Gießspiegels (21a) in wenigstens einem seitlichen Raum (33), und **durch** eine Kontrolleinheit (39) zum individuellen Einspeisen von geschmolzenen Metallen zu der Mittelkammer (30) und wenigstens einer Seitenkammer (31) abhängig von Signalen der Sensoreinrichtungen (38, 38a, 38b).

10. Verfahren zum kontinuierlichen Gießen eines Metallbandes durch eine Doppelwalzen-Gießmaschine, wobei das Metallband eine metallische Beschichtung an wenigstens einer ihrer Seiten unter Verwendung einer Verteilungseinrichtung gemäß Anspruch 1 aufweist, bestehend aus den folgenden Schritten: Zuführen eines ersten geschmolzenen Metalls zu der Mittelkammer, um einen mittigen Gießspiegel zu erhalten; Zuführen eines zweiten oder jeweils eines zweiten und eines dritten geschmolzenen Metalls jeweils zu einer Seitenkammer, um wenigstens einen seitlichen Gießspiegel zu erhalten; und
Aufrechterhalten des Pegels des mittigen Gießspiegels im Vergleich zu dem Pegel von wenigstens einem seitlichen Gießspiegel um einen höheren Betrag Δh, welcher durch Gießparameter und Eigenschaften der zu vereinigenden Metalle bestimmt wird.

Revendications

1. Dispositif de coulée continue de bande métallique à travers une machine de coulée à deux rouleaux de coulée, ladite bande métallique comportant un revêtement sur au moins une de ses faces, comprenant :

un dispositif de distribution (5) pour différents métaux en fusion (A, B, C), ledit dispositif de distribution (5) étant disposée entre les rouleaux de cristallisation (1a, 1b) au-dessus de leur point de distance minimale, ledit dispositif de distribution (5) comprenant :

une paroi avant et une paroi arrière (40) perpendiculaires à l'axe des rouleaux de cristallisation (1a, 1b) ;

deux parois verticales espacées (7a) définissant ensemble avec la paroi avant et la paroi arrière ainsi qu'avec les surfaces desdits rouleaux de cristallisation (1a, 1b) une chambre centrale (30) pour recevoir un premier métal en fusion (A) ;

caractérisé en ce qu'il comprend au moins une paroi intermédiaire (8a) s'étendant à l'extérieur de l'une des parois verticales (7a) depuis une partie inférieure (35) pour définir, avec la paroi verticale associée (7a), une chambre latérale (31) pour un second métal en fusion, ou un second et un troisième métal en fusion (B, C), respectivement,
chaque paroi intermédiaire (8a) comportant au moins un orifice (10a).

2. Dispositif selon la revendication 1, dans lequel chaque orifice (10a) est ménagé à proximité de la partie inférieure (35).

3. Dispositif selon la revendication 1, dans lequel la paroi avant (40) et la paroi arrière (41) sont des plaques latérales.

4. Dispositif selon l'une quelconque des revendications précédentes, comprenant au moins une paroi latérale (9a) s'étendant à l'extérieur de ladite ou chaque paroi intermédiaire (8a) depuis ladite partie inférieure (35) à proximité des rouleaux de coulée (1a, 1b) afin de former une petite chambre (33), respectivement.

5. Dispositif selon la revendication 4, dans lequel chaque paroi latérale (9a) est plus courte que chaque paroi intermédiaire (8a) et définit un passage latéral pour le second ou troisième métal en fusion (B, C) contenu dans la chambre latérale (31) une fois que la paroi latérale (9a) a été franchie.

6. Dispositif selon l'une quelconque des revendications précédentes, dans lequel une partie inférieure de chaque paroi verticale (7a) définit un intervalle (19) par rapport au rouleau de cristallisation (1a), ledit intervalle (19) faisant la liaison entre ladite chambre centrale (30) et un espace latéral (37) défini au-dessous de la partie inférieure (35) recevant du métal en fusion ayant franchi les parois latérales (9a).

7. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé par** l'établissement d'un ménisque (21a) formé d'une manière uniforme dans l'espace latéral (33) entre l'extérieur du rouleau de cristallisation (1a) et la paroi intermédiaire (8a) par le second ou le troisième métal en fusion (B, C), une fois qu'une paroi latérale (9a) a été franchie.

8. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé par** l'établissement d'un niveau de ménisque (21a, 21b), qui est plus bas (Δh) que le niveau d'un ménisque (20) dans la chambre centrale (30).

9. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé par** des moyens de détection (38) concernant le niveau de ménisque (20) de la chambre centrale (30) et des moyens de détection (38a, 38b) concernant le niveau de ménisque (21a) dans au moins un espace latéral (33), et un module de commande (39) pour alimenter individuellement en métaux en fusion la chambre centrale (30) et au moins une chambre latérale (31) en réponse à des signaux reçus desdits moyens de détection (38, 38a, 38b).

10. Procédé de coulée continue d'une bande métallique à travers une machine de coulée à deux rouleaux, ladite bande métallique comportant un revêtement métallique sur au moins une de ses faces, au moyen d'un dispositif de distribution selon la revendication 1, comprenant les étapes suivantes :

alimenter la chambre centrale avec un premier métal en fusion pour obtenir un ménisque central ;
alimenter une chambre latérale avec un second, ou un second et un troisième métal en fusion, respectivement, pour obtenir au moins un ménisque latéral ; et
maintenir le niveau du ménisque central par rapport au niveau d'au moins un ménisque latéral d'une quantité supérieure Δh, qui est définie par les paramètres et propriétés de coulée des métaux à combiner.

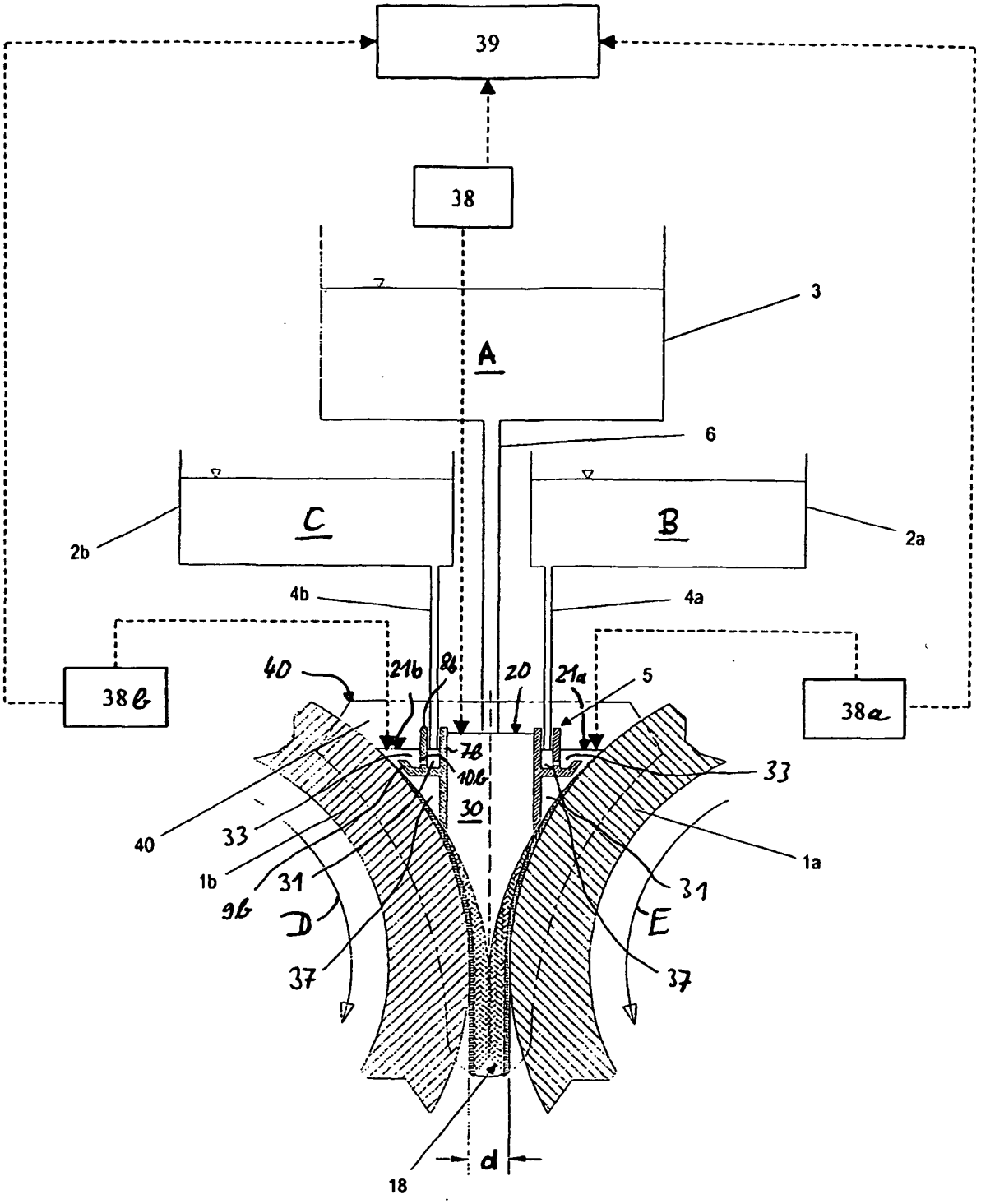

39
38
3
A
6
C
B
2b
2a
4b
4a
38b
38a
40
21b
8b
20
21a
5
7b
10b
30
33
1b
31
9b
D
37
1a
E
d
18

Fig. 1

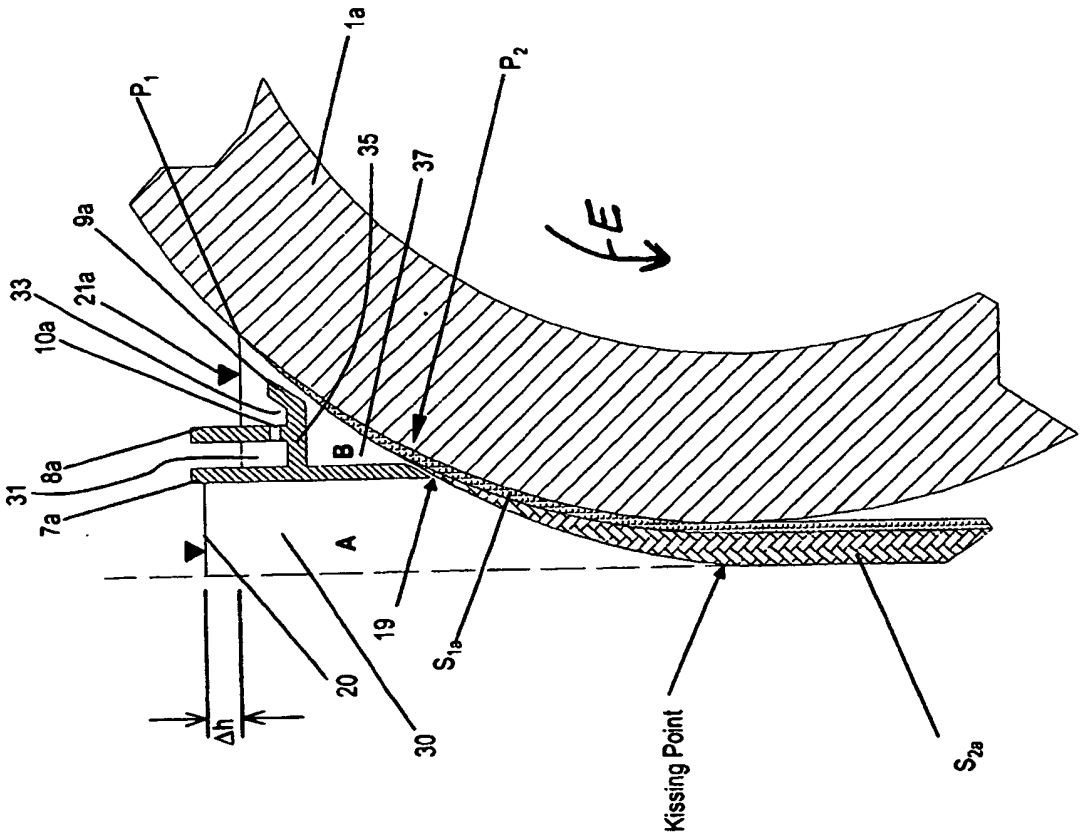

1a
P1
P2
35
37
9a
21a
33
10a
8a
31
7a
B
A
19
20
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Δh
S1a
Kissing Point
S2a
E

Fig. 2

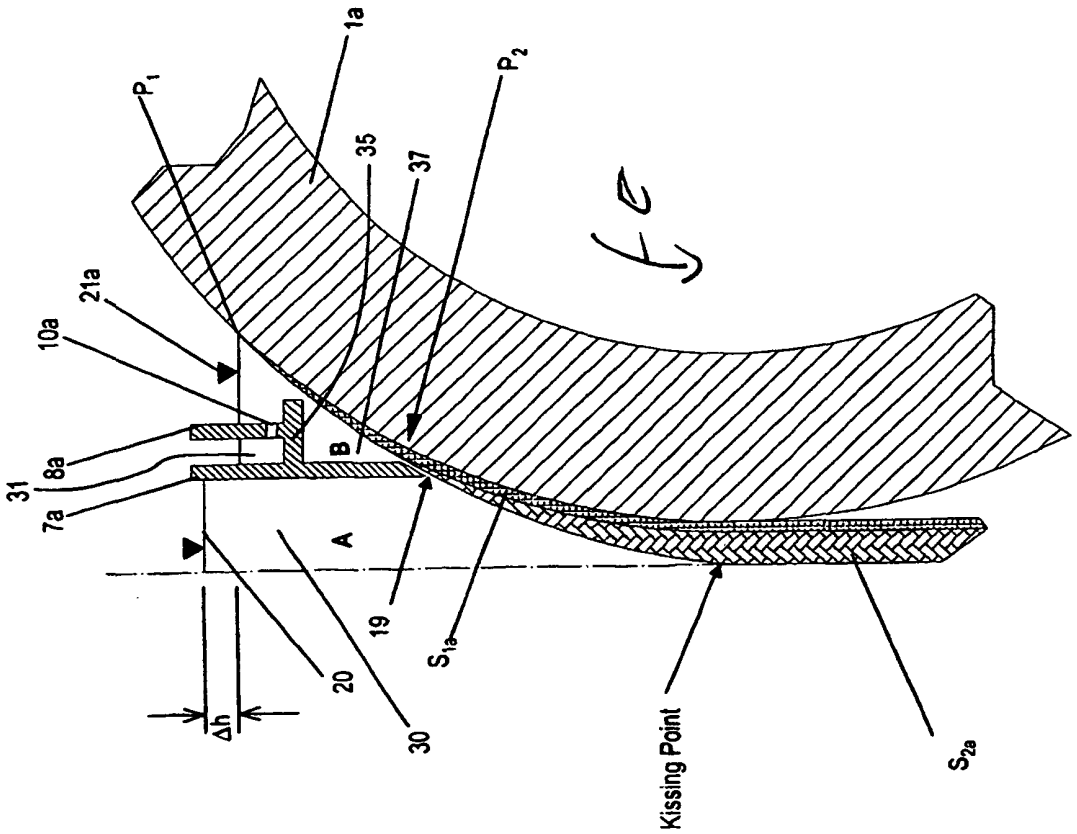

1a
P1
P2
35
37
21a
10a
8a
31
7a
B
A
19
20
30
Δh
S1a
Kissing Point
S2a

Fig. 3

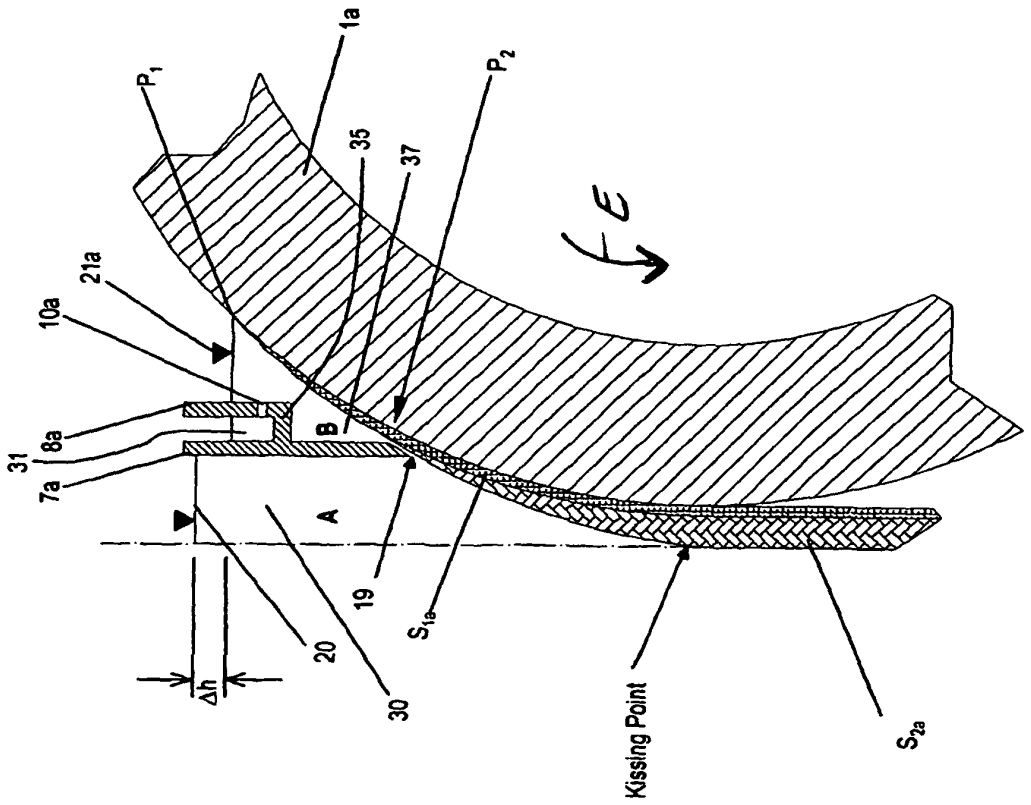

1a
P1
P2
35
37
21a
10a
8a
31
7a
B
A
19
20
30
Δh
S1a
Kissing Point
S2a

Fig. 4