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(54) **METHOD OF OBTAINING DOUBLE-LAYERED CAST PIECE.**

(57) A method of producing a double-layered cast piece by injecting molten metals (13A, 14) of different compositions into molten metal pools (1A, 1B) which are separated vertically from each other by a DC magnetic field zone (2A) provided in a casting mold (1), which method comprises inserting an alloy wire (12) into a shorter immersion nozzle (4), which is provided on a continuous casting tundish (3), through a through bore in a tundish stopper (6) to melt the wire (12), mix the resultant molten alloy with a molten metal (13) in the nozzle (4) and produce a molten metal (4) of a uniform concentration, supplying this molten metal (4) from a discharge port of the shorter nozzle (4) to an upper molten metal pool (1A) while supplying a molten metal (13) as it is from a longer immersion nozzle (5) provided in the continuous casting tundish (3) to a lower molten metal pool (1B), and cooling and solidifying the molten metals in these pools into a double-layered cast piece.

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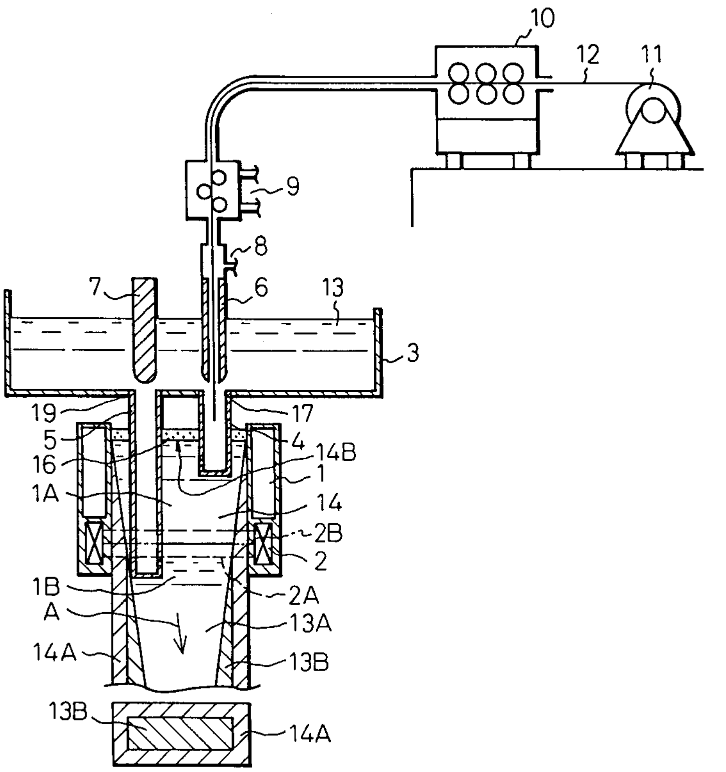
Fig.1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16
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2
1B
2A
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14A
13B
13B
14A

FIELD OF THE INVENTION

The present invention relates to a process for continuously casting a double-layered slab whose surface layer and internal layer are composed of steel compositions different from each other, wherein two kinds of molten steels having compositions different from each other are poured into an upper molten steel pool and a lower molten steel pool, respectively, both pools being separated by a direct current magnetic field zone provided within a mold or at a lower site thereof.

BACKGROUND OF THE INVENTION

The present inventors have heretofore proposed and practiced a process for producing a double-layered slab whose surface layer and internal layer are composed of steel compositions different from each other, wherein the strand pool for continuous casting is separated into an upper pool and a lower pool by applying various types of direct current magnetic fields, and two kinds of molten steels having compositions different from each other are poured into the two pools through separate immersion nozzles, whereby mixing of the two kinds of steels is minimized.

For example, the present inventors have proposed processes for producing slabs by using the following techniques: a technique of applying a magnetic flux zone having a uniform density in the slab width direction from one of the long sides thereof to the other as disclosed in KOKAI (Japanese Unexamined Patent Publication) No. 63-108947; a technique of applying a magnetic flux zone in the direction parallel to the drawing direction of the slab as disclosed in KOKAI (Japanese Unexamined Patent Publication) No. 63-100549; a technique wherein a direct current magnetic field is applied to a slab cross section vertical to the drawing direction in such a manner that a magnetic flux flows out from the center of the cross section to the periphery thereof, or on the contrary the magnetic flux is absorbed to the center thereof from the periphery thereof as disclosed in Japanese Unexamined Patent Publication (KOKAI) No. 4-309436.

However, in these processes, a double-layered slab is produced in principle by the following procedures: two kinds of molten steels are prepared by such an equipment having a function for adjusting the compositions of the steels as a converter, an electric furnace, a ladle and a vacuum degassing equipment; these steels are separately transported to a continuous casting machine, and poured into two tundishes, respectively; the two kinds of steels are fed into an upper molten steel pool and a lower molten steel pool within a mold, respectively, through two nozzles separately provided to the two tundishes; and a slab is drawn after the step of continuous casting.

The preparation of two kinds of molten steels separately as described above often brings about marked lowering of production efficiency in production mills which have been constructed to produce a single-layered continuously cast slab and variously improved. The efficiency lowering has become a fatal problem of the process, and a essential improvement has been required.

To solve the problem, the present inventors have already proposed a method for adjusting a molten steel composition in a molten steel pool by feeding a wire thereto in KOKAI (Japanese Unexamined Patent Publication) No. 63-108947. However, the resultant molten steel has not always had a uniform composition in this case.

To improve the problem, a technique has been proposed in KOKAI (Japanese Unexamined Patent Publication) No. 3-243245 wherein solutes added to molten steel from a wire is stirred and mixed by an electromagnetic stirrer to make the solute concentration uniform.

In general, when solutes are added to molten steel in the form of a wire without further processing or wire covered with a metal such as iron from the molten steel surface within a mold, and when the wire passes through a powder layer 16 or the molten portion of the powder layer 16 within the mold 1 without taking any measures, as shown in Fig. 7, a portion of the powder is expected to adhere to the wire 12A, to become molten powder 22, to be drawn into molten steel pools of molten steels 13A, 15, and to form defects within the slab. In addition, the reference numeral 21 designates a solidified layer of steel adhering around powder 20.

As shown in Fig. 8, a guide tube 23 made of a refractory material may be placed at the location of the molten steel surface from which the wire 12A enter the molten steel, and the wire 12A may be fed without being directly contacted with the powder layer 16. Practically, since the temperature of the molten steel around the guide tube 23 is lowered, the molten steel is solidified and adheres thereto, and as a result casting operation is sometimes hindered.

Furthermore, even if the problem of the powder layer 16 has been solved, there cannot be produced a double-layered slab homogeneous both in the peripheral direction and in the longitudinal direction thereof when the concentration of the wire component cannot be sufficiently homogenized after melting the wire

12A.

Though it is not impossible to make the component concentration homogeneous by electromagnetic stirring as disclosed in Japanese Unexamined Patent Publication (KOKAI) No. 3-243245 described above as means for overcoming the problem, there may arise a case that the component separation cannot be successfully performed when stirring is practiced at a site where the direct current magnetic field zone is affected.

On the other hand, a technique of feeding a treating agent in a wire-form within a teeming nozzle to a molten steel to be teemed into a mold is disclosed in Japanese Unexamined Patent Publication (KOKAI) No. 51-32432. For the purpose of adding a deoxidant, etc., to the constrained flow of molten metal flowing from a ladle to a mold and preventing retardation of the continuous casting operation caused by disadvantageous deposition of high melting-point oxides formed from the added treating agents, this technique is used in feeding the treating agents in a wire-form in the nozzle of the ladle by passing the agents through the central through-hole of the stopper rod.

Since the flow rate of the molten metal passing through the nozzle is great, the contact time of the materials constituting the nozzle and the following reaction products are short: a reaction product between a molten metal at the time of adding the wire and enriched solutes formed by the wire addition, and a reaction product between the materials constituting the nozzle and the enriched solutes formed thereby. It is therefore concluded that the deposition of these reaction products on the nozzle wall is not significant.

Since the molten metal flow flows out from the pouring end of the short nozzle and falls through the air onto the molten steel surface in the mold, the dissolution amount of the wire-form treating agent in the molten metal flow and the time for dissolving and mixing the treating agent are restricted. Accordingly, it is not possible to feed a large amount of the treating agent and to have a uniform dissolution concentration thereof.

DISCLOSURE OF THE INVENTION

The present invention has been achieved in view of the problems described above. An object of the present invention is to provide a process for casting a double-layered slab which makes the composition adjustment of molten metal such as molten steel used for the process simple, and which reduces the production cost thereof and improves the quality thereof.

A further object of the present invention is to provide a process for casting a double-layered slab which is capable of casting, continuously and without interruption, a slab having an outer layer and an internal layer each having a uniform composition distribution.

To achieve the objects as described above in the present invention, molten steel, for example, is first poured into a molten metal pool formed by a mold and a dummy bar from a short nozzle and a long nozzle provided at the lower site of a tundish, and a direct current magnetic field zone which acts on the entire slab width is imposed by a magnet provided at a lower site of the mold a predetermined distance apart from the meniscus in the casting direction to separate the molten steel into an upper and a lower portion, continuous casting strand pools thus being formed. Accordingly, the front end of the short nozzle and that of the long nozzle are immersed in the two pools, respectively.

Subsequently, an alloy wire for composition adjustment is fed within one or both of the immersion nozzles, sufficiently melted therewithin and mixed with the molten steel to adjust the molten steel to have a predetermined composition.

The resultant molten steels each having a uniformly adjusted composition are each poured into respective pools, rapidly cooled, and solidified to cast a double-layered slab having a surface layer and an internal layer each composed of the respective metals having uniform compositions.

It is necessary to carry out the following procedures in casting the double-layered slab of the present invention:

(1) a molten steel of a single composition is placed in the tundish;

(2) molten steel is separated into an upper pool and a lower pool within the mold by providing a direct current magnetic field zone to the mold;

(3) a long immersion nozzle and a short immersion nozzle are used for pouring molten steels into respective pools; and

(4) desired additive alloys for forming double-layer compositions are sufficiently melted and mixed within the respective immersion nozzles so that the molten steels within the respective immersion nozzles have respective uniform additive alloy concentrations;

and it is important to observe the following procedure to surely practice the present invention:

(5) an inert gas is injected into the immersion nozzle.

An inert gas such as Ar is blown into the molten metal flow within the nozzle from a wire insertion opening at the stopper top end or from the upper portion of the nozzle wall, and finely dispersed within the fluid, whereby there are inhibited the adhesion and deposition along the entire length of the immersion nozzle, of reaction products of dissolved substances and the molten metal within the nozzle and mutual reaction products of nozzle constituent materials and these materials. As a result, an increase in the internal flow resistance of the nozzle is prevented.

As in the process of the present invention wherein the nozzle is long, the lower portion of the nozzle is immersed in the molten metal, and in addition the direction of the flow path is changed at the nozzle front end, the flow resistance of the molten metal within the entire nozzle is increased, and pouring steel into the pools is liable to be hindered. Blowing an inert gas into the immersion nozzles exerts extremely significant effects on continuous casting operation over a long period of time.

In addition, to adjust smoothly the rate of molten metal flow into each of the pools in the present invention, two tundishes into which the same molten metal is poured may be arranged, and a short nozzle and a long nozzle may be provided to the respective tundishes.

In this case, different molten metals may naturally be poured into respective tundishes, and additive alloy wires are further fed into respective immersion nozzles connected to respective pools requiring composition adjustment.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an entire schematic view, which is partially sectional, showing one embodiment of the present invention.

Fig. 2 is a partially enlarged sectional view of Fig. 1.

Fig. 3 is a sectional schematic view showing a major portion in another embodiment of the present invention.

Fig. 4 is a sectional schematic view showing a major portion of another embodiment of the present invention.

Fig. 5 is a sectional schematic view showing a major portion of another embodiment of the present invention.

Fig. 6 is a sectional schematic view showing a major portion of another embodiment of the present invention.

Fig. 7 is a sectional schematic view showing a major portion of a conventional embodiment.

Fig. 8 is a sectional schematic view showing a major portion of another conventional embodiment.

Fig. 9 is a graph showing the concentration distribution of Ti on a slab section in the present invention.

Fig. 10 is a graph showing the concentration distribution of Ti on a slab section in a conventional embodiment.

Fig. 11 is a mold section showing locations where Ti concentrations are measured.

BEST MODE FOR PRACTICING THE PRESENT INVENTION

The present invention will be illustrated below in detail.

Fig. 1 schematically shows the entire equipment for practicing the present invention, wherein a magnet 2 is placed at a lower site of a mold 1. A direct current magnetic flux is applied in the direction vertical to the casting direction (A), namely, in the direction crossing the thickness of the mold, by the magnet to form a static magnetic field zone 2A, whereby an upper molten metal pool 1A and a lower molten metal pool 1B are formed within the mold. A tundish 3 in which, for example, a molten steel 13 is stored is arranged above the mold 1. To the bottom portion of the tundish are provided a short immersion nozzle 4 open to the upper pool 1A and a long immersion nozzle 5 open to the lower pool 1B.

Fig. 1 shows a situation where an additive alloy wire 12 is fed into the short nozzle 4 to adjust the composition of molten steel to be poured into the upper pool 1. The reference numeral 6 in Fig. 1 designates a tundish stopper for the short nozzle 4. It has a through-hole 6A for the alloy wire 12 as shown in Fig. 2 in detail, and opens and closes a tundish opening 3A. To the top of the stopper 6 is provided a sealing mechanism 8 consisting of an inert gas sealing chamber 8A, a labyrinth seal 8B, etc. The reference numerals 9, 10 and 11 designate a straightening machine for wire drawing, an alloy wire feeder and a coiler, respectively.

As shown in Fig. 2, the short nozzle 4 is formed at the tundish opening 3A in such a manner that the short nozzle 4 and the tundish bottom become an integral body. If necessary, a porous refractory material 17 connected to an inert gas injection hole 18 is provided.

In the equipment as described above, a molten steel pool is formed between the mold 1 and a dummy bar (not shown), and the stopper is opened to pour the molten steel 13 in the tundish 3 into the molten steel pool. When the molten steel in the pool has a predetermined depth, the static magnetic field zone 2A is generated to form the upper molten steel pool 1A and the lower molten steel pool 1B. The alloy wire 12 is then fed into the short nozzle 4. The alloy wire 12 is melted and mixed within the short nozzle 4 to have a predetermined concentration, and the resultant molten steel is poured into the upper molten steel pool 1A.

To form a molten steel 14 whose additive alloy concentration has been adjusted in the upper pool 1A, namely, to form a molten steel for the surface layer, relationships represented by the following formulas should be satisfied:

$$L_N < L + L_M \quad (1)$$

$$L_N > (Vxd)/2f \quad (2)$$

wherein f is an average melting rate of the alloy wire 12, d is a diameter of the wire, V is a feed rate of the wire, L_M is a distance from the front end of the stopper 6 which is in the state of closing the tundish opening to a meniscus 14B within the mold, L_N is a distance from the front end of the stopper 6 to an immersion nozzle pouring hole 4A, and L is a distance from the meniscus 16 to a central position 2B of the direct current magnetic field zone.

In addition, the length of the long nozzle 5 for teeming a molten steel 13A for the internal layer, namely, the distance from the front end of a stopper 7 to a nozzle pouring hole 5A should be longer than the distance L of the central position 2B of the static magnetic field zone.

When the molten steel 13 is teemed into the mold 1 as described above, the molten steel 14 for the surface layer in the upper pool is solidified to form a solidified shell 14A, and subsequently the molten steel 13A for the internal layer is also solidified to form a solidified shell 13B. Finally, from the mold is drawn a double-layered slab composed of the outer layer 14A and the internal layer 13B each having a uniform concentration distribution.

The inert gas, for example Ar, is blown into the teeming nozzle desirably at a rate of 0.1 to 15.0 liter/min. That is, stabilized casting becomes possible over a long period of time if the inert gas is blown in the range mentioned above.

Fig. 3 shows an embodiment using the equipment in Fig. 1, wherein the alloy wire 12 is fed into the long nozzle 5 through the stopper 7 to form a molten steel 15 for the internal layer containing the additive alloy at a uniform concentration, and a double-layered slab composed of a surface layer 13B and an internal layer 15A containing the added alloy is produced.

Fig. 4 shows an embodiment wherein an alloy wire 12 and an alloy wire 12A are fed into a short nozzle 4 and a long nozzle 5, respectively, through respective stoppers 6, 7 to form a molten steel 14 for the surface layer and a molten steel 15 for the internal layer each containing respective additive alloys at a uniform concentration, and a double-layered slab composed of a surface layer 14A and an internal layer 15A each containing the respective added alloys is produced.

Fig. 5 and Fig. 6 show embodiments wherein the tundish is separated into a tundish 3A for storing a molten steel 13a and a tundish 3B for storing a molten steel 13b, and a short nozzle 4 and a long nozzle 5 are provided to the tundish 3A and the tundish 3B, respectively. Fig. 5 shows an embodiment of forming a molten steel 15 for the internal layer by feeding an alloy wire 12 to the molten steel 13b. Fig. 6 shows an embodiment of forming a molten steel 14 for the surface layer and a molten steel 15 for the internal layer by feeding an alloy wire 12 and an alloy wire 12A into the molten steel 13a and the molten steel 13b, respectively. The alloy wire may naturally be fed only into the molten steel 13a.

When each of the molten steel layers is provided with a tundish separately from the other tundish as described above, the amounts of molten steels fed into the respective molten metal pools can be more effectively adjusted. Moreover, in the case of pouring molten metals different from each other being poured into respective molten metal layers, this procedure is convenient.

In addition, in the embodiments of Fig. 5 and Fig. 6, an inert gas may also be blown into the molten steel from the opening for alloy wire feeding at the top end of the stopper or from the nozzle wall in the same manner as in the embodiment of Fig. 1, and finely dispersed thereinto. As a result, the deposition amount of adhering material on the internal wall of the nozzle is decreased, and there can be stably produced a double-layered slab having a uniform concentration distribution in the slab peripheral direction and the slab casting direction.

EXAMPLES

Example 1

As shown in Fig. 1, a molten steel having an internal layer composition as listed in Table 1 and stored in a tundish was poured into a molten steel pool formed by a continuous casting-machine copper mold 1200 mm in long side and 250 mm in short side and a dummy bar to have a predetermined depth. A direct current magnetic field having a uniform magnetic flux density of 5000 G in the width direction of the slab was applied at a site 0.63 m (distance L) apart from a meniscus 14B within the mold in the downward direction to form a direct current magnetic field zone 2A (central position of the direct current magnetic field being referred to as 2B). The molten steel pool was thus separated into an upper portion and a lower portion in the casting direction.

To form a surface layer having a thickness D of 25 mm, the drawing rate (casting rate) Vc of the slab was determined to be 0.4 m/min from the following formula:

D = 0.020 x (L/Vc) 1/2 (3)

To carry out such casting, the flow rates of each of the molten steels were controlled by adjusting the opening degree of each of the stoppers in such a degree that the flow rate of the molten steel for the surface layer and that of the molten steel for the internal layer became 3.36 kg/sec and 11.04 kg/sec, respectively. The molten steel for the surface layer was passed through a short immersion nozzle 4 while an alloy wire containing 70% of Al was being fed into the nozzle at a rate of 1.44 g/sec. As a result, the Al content of the slab thus obtained became 0.032% by weight as shown in Table 1.

Moreover, Ag gas was fed into the short nozzle at a rate of 0.5 liter/min during feeding the Al wire.

The double-layered slab could be stably cast for 120 minutes. The Al concentration of the surface layer was uniform both in the slab peripheral direction and slab longitudinal direction, and no powder inclusion was recognized.

Table 1

(wt.%)

	C	Mn	Si	P	S	Al
Surface layer constituent	0.001	0.11	0.01	0.007	0.009	0.032
Internal layer constituent	0.001	0.11	0.01	0.007	0.009	0.002

Example 2

A direct current magnetic field was applied at the lower site of a continuous casting copper mold for casting a slab having a long side of 1500 mm and a short side of 200 mm, whereby the molten steel pool within the continuous casting strand was separated into an upper pool and a lower pool in the casting direction. The slab which was solidified was drawn while the same molten ultra low carbon steel was being fed into each of the pools through respective nozzles different from each other in length. The molten steel to be fed into the pools was stored in two tundishes, and a wire (Ti content of 70%) in which Ti alloy was sealed was fed at a rate of 38.9 g/sec into a nozzle for pouring the molten steel into the lower pool corresponding to the internal layer through a stopper 7 having a through-hole and a sealing mechanism as shown in Fig. 5.

The central position 2B of the direct current magnetic field is 60 cm apart from a meniscus 13C in the downward direction. The magnetic flux was applied in the thickness direction of the slab, and the magnetic flux density at the central position was 5500 G. The slab was cast at a rate of 1 m/min while the opening degree of the stoppers 6, 7 were controlled in such a manner that the molten steel for the surface layer and that for the internal layer were teemed into the mold at a rate of 7.75 kg/sec and 27.25 kg/sec, respectively. When the molten steel was solidified at the rates as mentioned above within the mold of the continuous casting machine, the boundary between the upper and the lower pool was located at the central position of the direct current magnetic field zone, and the surface layer thickness reached 20 mm.

Ar was fed into the molten steel at a rate of 1 liter/min together with the wire from the front end of the stopper for the nozzle into which the wire was fed. Casting was stably carried out for 120 minutes, and all the molten steel was completely cast.

The Ti concentration distribution in the slab peripheral direction of the internal layer of the slab thus cast was 0.1% as shown in Fig. 9, which agreed with the concentration estimated from the casting conditions as mentioned above. Moreover, the Ti concentration distribution was constant in the longitudinal direction.

In addition, Fig. 11 shows the locations at which the Ti concentration distribution in a slab section was measured.

Example 3

Casting a slab was carried out under the same conditions as in Example 2 except that Ar was not fed. As a result, the feed rate of the molten steel from the nozzle for the internal layer through which the Ti wire was fed was lowered about 55 minutes after starting to cast, and the maintenance of the feed rate of 27.25 kg/sec became difficult. As a result, mixing the upper pool and the lower pool took place. The Ti concentration of the slab internal layer varied from 0.03 to 0.21% after the mixing took place, though the internal layer had a uniform Ti concentration of 0.1% for about 55 minutes from starting to cast the slab. The casting was interrupted 80 minutes after starting to cast because feeding the molten steel for the internal layer became impossible. After casting, reaction products of the nozzle refractory material and Ti were observed to adhere to and deposit on the nozzle wall surface when the interior of the nozzle was examined.

Comparative Example 1

Casting a slab was carried out under the same conditions as in Example 2 except that the wire was fed into the pool for the internal layer from the powder layer within the mold without passing the wire through the stopper as shown in Fig. 7. The wire was covered with iron and adjusted in such a manner that it started to be melted within the pool for the internal layer.

Though casting a slab was stably carried out and completed, a marked variation of the Ti concentration in the internal layer was observed in the slab peripheral direction as shown in Fig. 10 when the slab was examined subsequent to casting.

Moreover, there was detected within the slab a large amount of powder which seemed to have been entrapped by the meniscus during feeding the wire.

The locations at which the Ti concentration was measured were as shown in Fig. 11, and the wire was added at a location designated by the reference numeral 24.

POSSIBILITY OF UTILIZATION IN THE INDUSTRY

As described above in detail, in continuous casting a double-layered slab, the present invention provides a process wherein a molten steel having a base composition is prepared without preparing two kinds of molten steels having compositions different from each other, a wire or two wires are fed from the stopper or stoppers of a tundish or two tundishes during teeming a molten steel for the internal or surface layer, or both molten steels for the respective internal and the surface layer into a mold, the wire(s) is (are) melted and uniformly mixed within a nozzle or two nozzles, and the resultant molten steel(s) is (are) poured into a predetermined molten pool or two molten pools. As a result, molten steels having desired compositions can be readily prepared. In addition, since no powder inclusion is observed and casting can be stably carried out over a long period of time, the production cost of the double-layered slab can be reduced, and the quality thereof can be improved.

The explanation of the reference numerals are as follows:

1:	a mold,
2:	a magnet
2A:	a static magnetic field zone,
3:	a tundish,
4:	a short immersion nozzle,
5:	a long immersion nozzle,
6, 7:	tundish stoppers,

8: a sealing mechanism,
12: an alloy wire,
13: a molten steel,
13A: a molten steel for the internal layer,
14: a molten steel for the surface layer, and
18: an inert gas injection hole.

Claims

1. A process for producing a double-layered slab comprising a surface layer and an internal layer by feeding molten metal into an upper molten metal pool and a lower molten metal pool which are separated by a direct current magnetic field zone provided within a continuous casting mold or at a lower site thereof,
wherein a short immersion nozzle and a long immersion nozzle are provided to a tundish for continuous casting arranged above the mold, a molten metal is fed into the upper molten metal pool through the short immersion nozzle, a molten metal is fed into the lower molten metal pool through the long immersion nozzle, a through-hole is provided to the central portion of either of the two tundish stoppers detachably provided to the two respective molten metal-pouring holes of the tundish, an alloy wire is inserted in the through-hole to be melted therewithin whereby a molten metal having a desired composition is prepared in one of the molten metal pools, and a molten metal is fed into the other molten metal pool from the other molten metal-pouring hole of the tundish through the immersion nozzle.

2. The process according to claim 1, wherein a through-hole is provided in the central portion of both tundish stoppers, two different kinds of alloy wires to be added are inserted in the respective through-holes, and melted within the respective immersion nozzles, whereby molten metals of desired compositions are prepared in the respective molten metal pools.

3. The process according to claim 1 or claim 2, wherein an inert gas is fed into the immersion nozzle(s) in which the alloy wire(s) is (are) inserted.

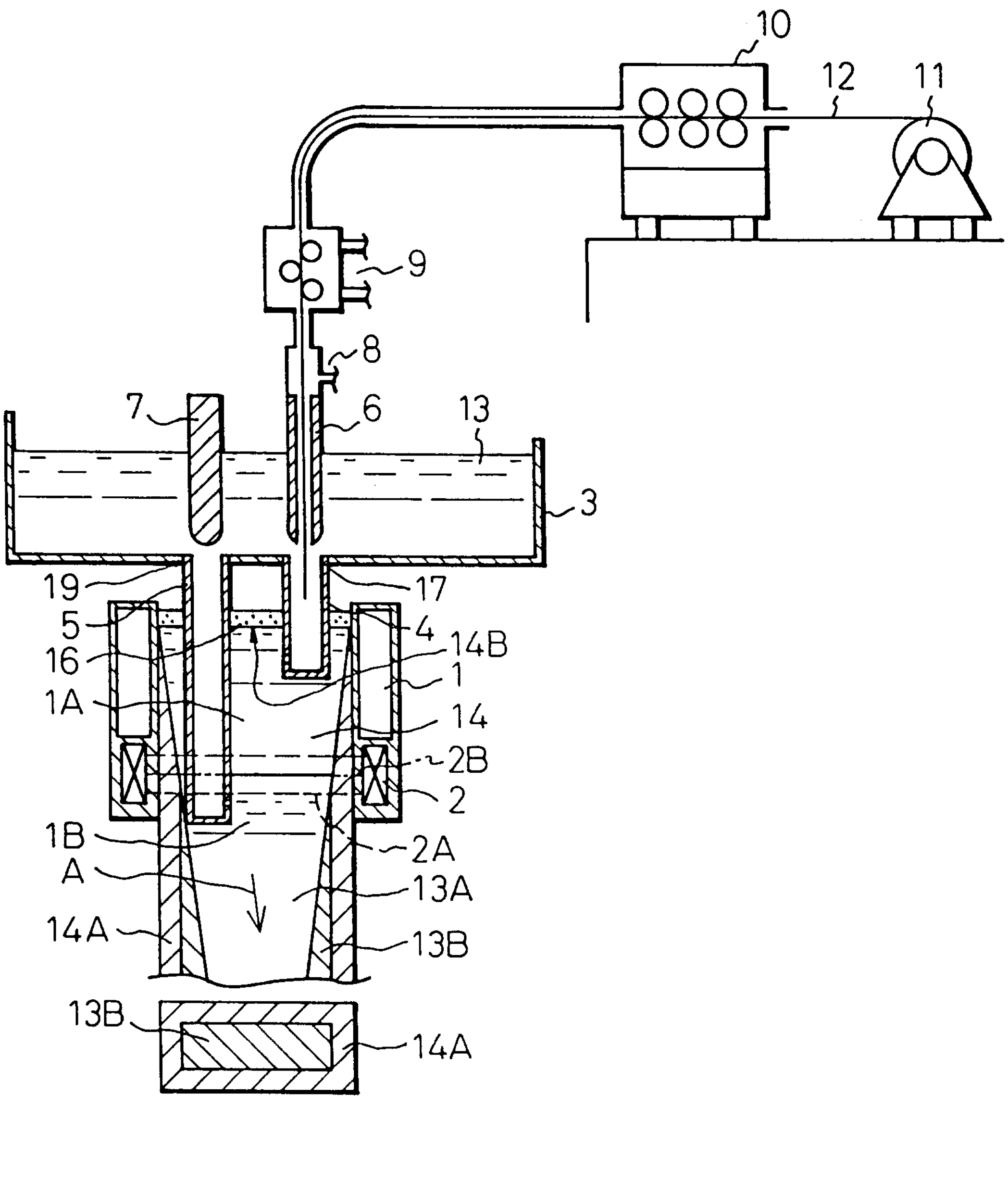
4. A process for producing a double-layered slab comprising a surface layer and an internal layer by feeding molten metal into an upper molten metal pool and a lower molten metal pool which are separated by a direct current magnetic field zone provided within a continuous casting mold or at a lower site thereof,
wherein two molten metals of the same kind are separately poured into two respective tundishes for continuous casting arranged above the mold, the molten metal in either one of the two tundishes is fed into the upper molten metal pool through a short immersion nozzle, the other molten metal in the other tundish is fed into the lower molten metal pool through a long immersion nozzle, a through-hole is provided at the central portion of either of the two tundish stoppers detachably provided to two respective molten metal-pouring holes of the two respective tundishes for continuous casting, an alloy wire is inserted in the through-hole to be melted therewithin whereby a molten metal having a desired composition is prepared in one of the molten metal pools, and the other molten metal is fed into the other molten metal pool from the molten metal-pouring hole of the other tundish through the immersion nozzle.

5. The process according to claim 4, wherein molten metals having compositions different from each other are separately poured into the two respective tundishes for continuous casting.

6. The process according to claim 4, wherein molten metals having compositions different from each other are separately poured into the respective two tundishes, a through-hole is provided to the central portion of each of the two tundish stoppers provided to the respective tundishes for continuous casting, and two different kinds of alloy wires to be added are inserted in the respective through-holes and melted within the respective immersion nozzles, whereby molten metals having desired compositions are prepared in the respective molten metal pools.

7. The process according to claim 4, claim 5 or claim 6, wherein an inert gas is fed into the immersion nozzle(s) in which the alloy wire(s) is (are) inserted.

Fig.1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1B
2A
A
13A
14A
13B
13B
14A

Fig.2

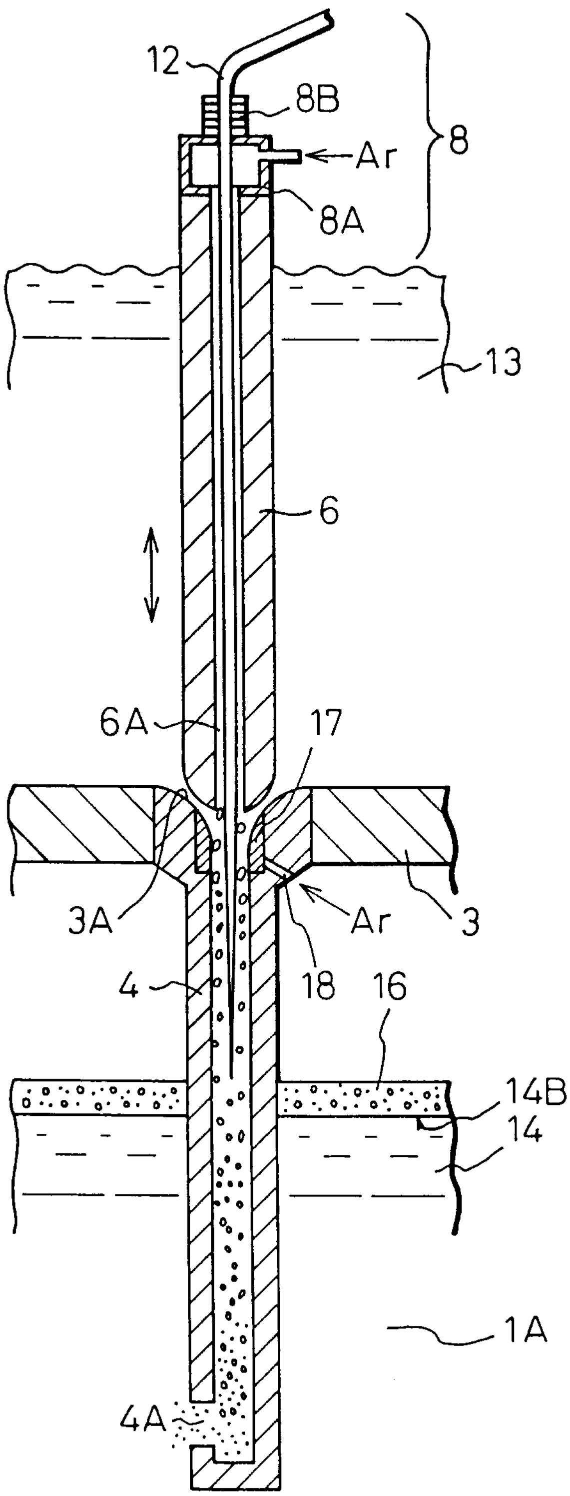
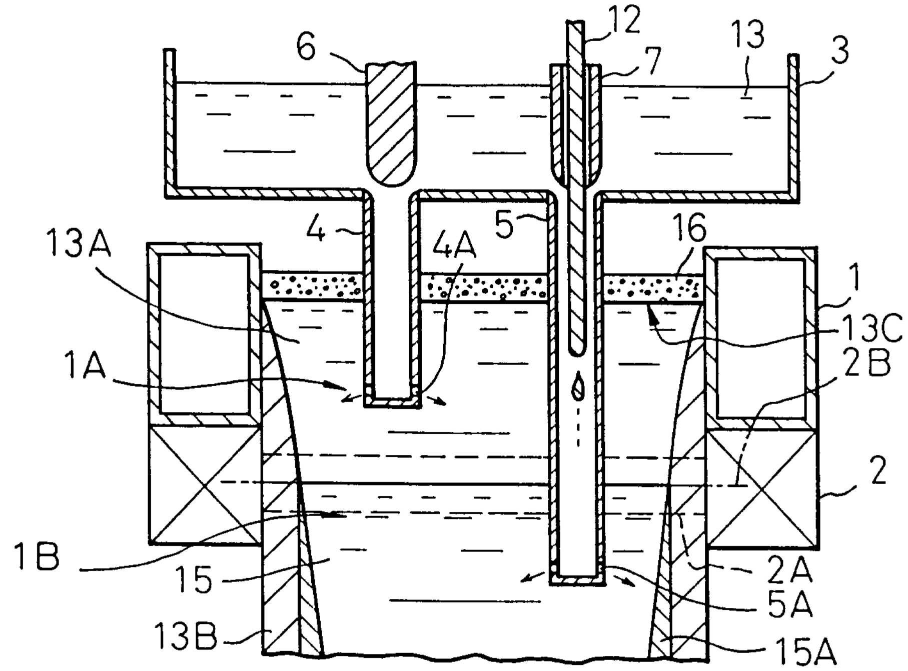


Fig.3



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13
3
7
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5
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4A
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2B
2
1B
2A
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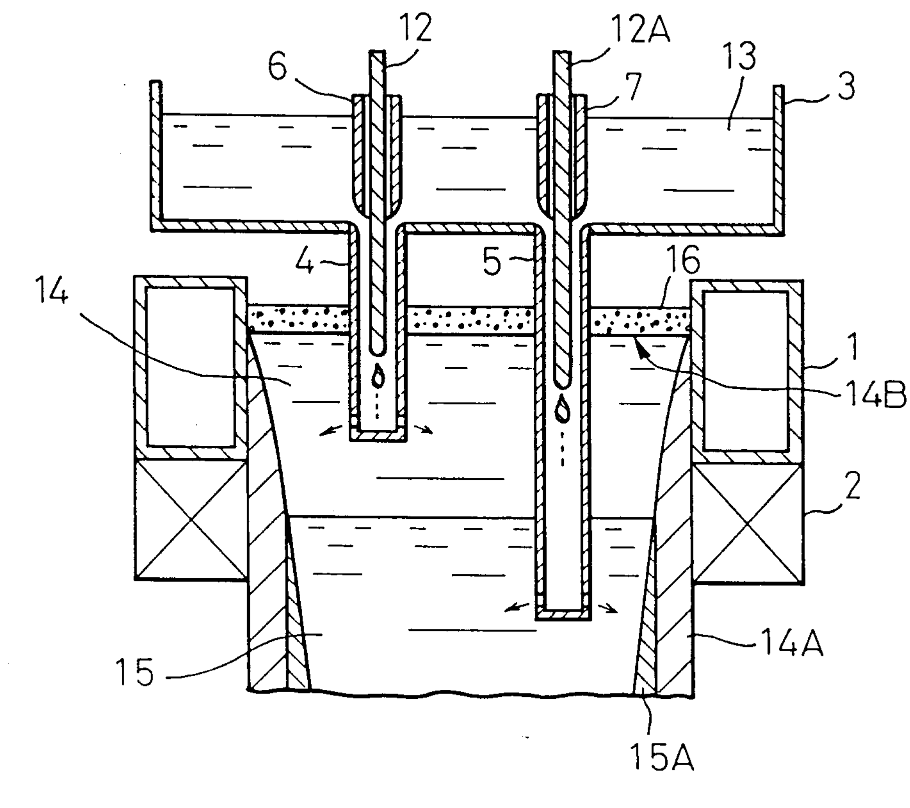
5A
13B
15A

Fig.4



12
12A
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13
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5
16
14
1
14B
2
14A
15
15A

Fig. 5

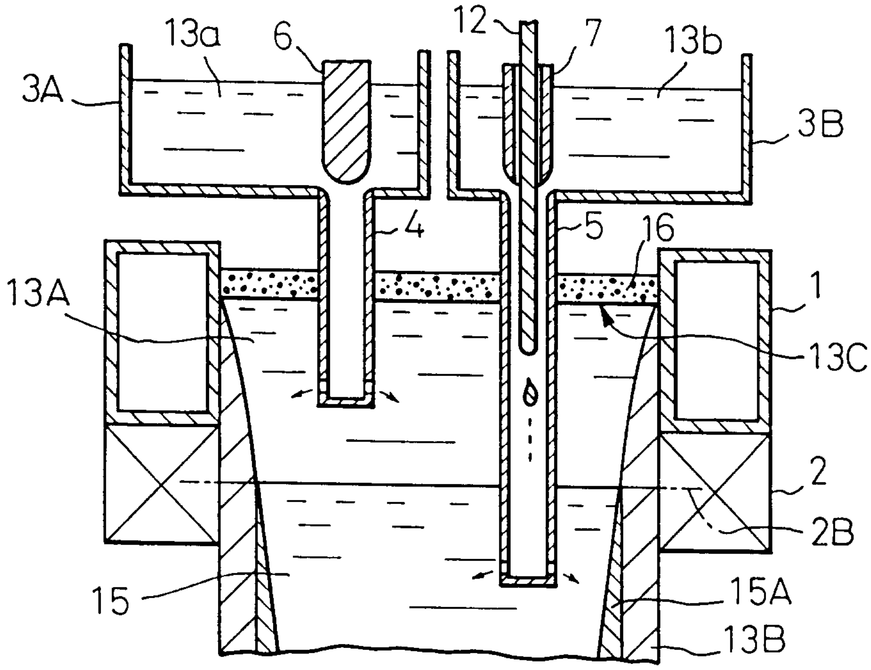

12
13a
6
7
13b
3A
3B
4
5
16
13A
1
13C
2
2B
15
15A
13B

Fig. 6

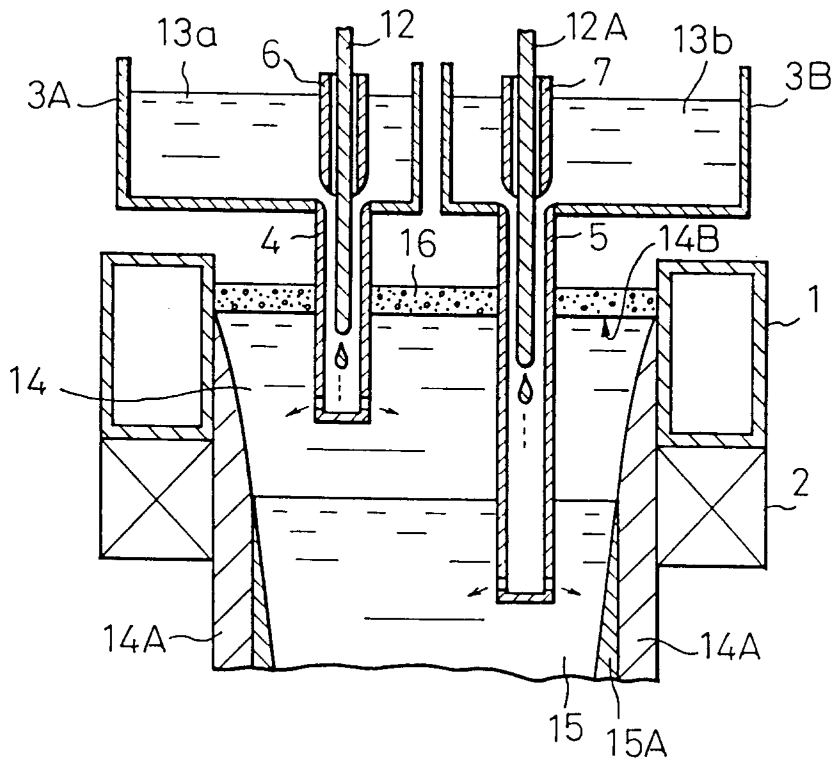

13a
12
12A
13b
6
7
3A
3B
4
16
5
14B
1
14
2
14A
14A
15
15A

Fig.7

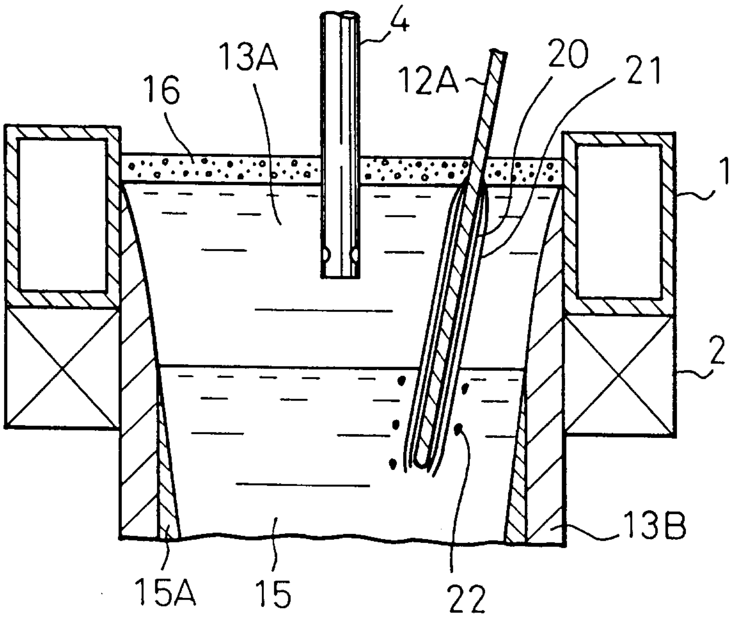


Fig.8

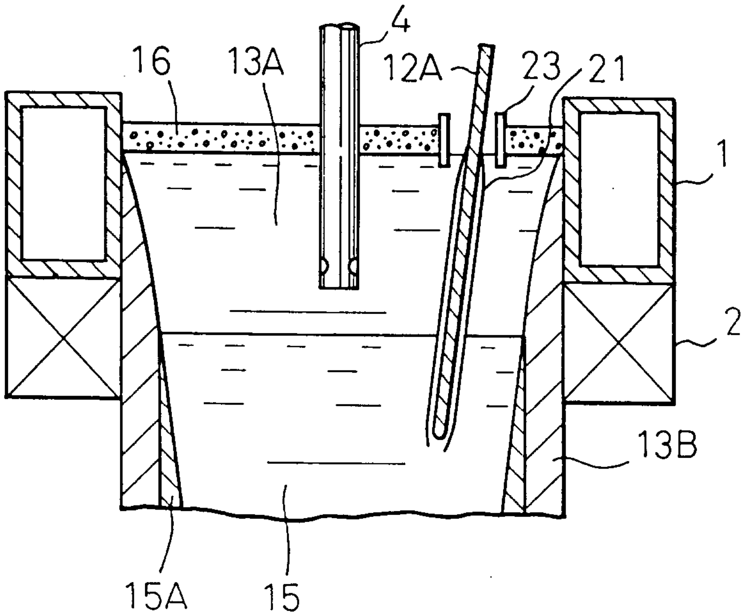


Fig.9

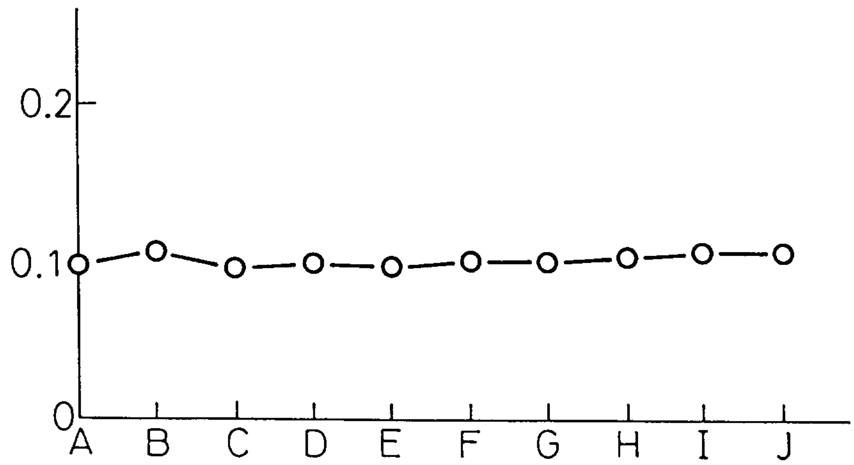


Fig.10

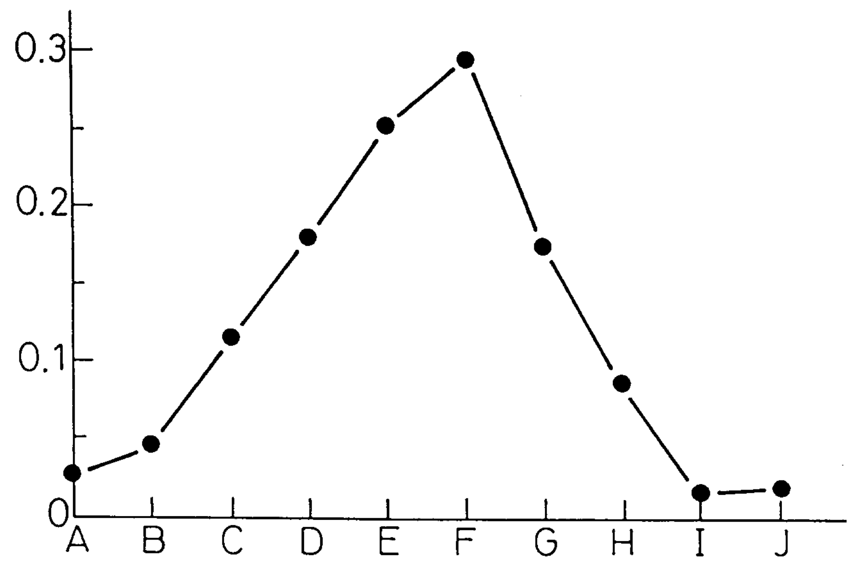
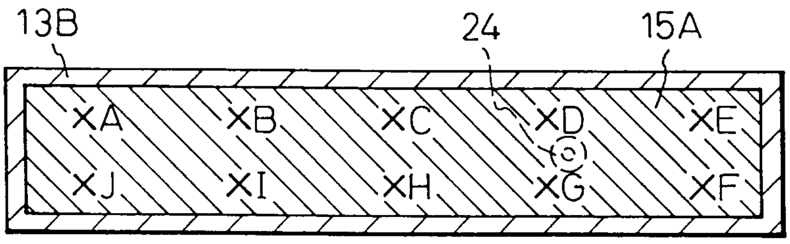


Fig.11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP93/00530

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl^5 B22D11/00, 11/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl^5 B22D11/00-11/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926 - 1993
Kokai Jitsuyo Shinan Koho	1971 - 1993

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, B2, 3-20295 (Nippon Steel Corp.), March 19, 1991 (19. 03. 91), & EP, B1, 265235 & US, A, 4828015 & DE, CO, 3767278	1-7
A	JP, A, 4-75750 (Nippon Steel Corp.), March 10, 1992 (10. 03. 92), (Family: none)	1-7
A	JP, A, 63-212052 (Nippon Steel Corp.), September 5, 1988 (05. 09. 88), (Family: none)	1-7
A	JP, B2, 59-46698 (Sumitomo Metal Industries, Ltd.), November 14, 1984 (14. 11. 84), (Family: none)	1-7

[X] Further documents are listed in the continuation of Box C.   [ ] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
June 10, 1993 (10. 06. 93)	June 29, 1993 (29. 06. 93)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.