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(54) Filter for molten metal and casting apparatus

(57) A filter (20) for removing a foreign matter from a stream of molten metal has a central portion (20a) and a peripheral portion, wherein the molten metal flow rate in the central portion is higher than in the peripheral portion. A casting apparatus comprises a furnace (3) and a mould (10). The filter (20) can be fitted in a passage (6) connecting the furnace and the mould.

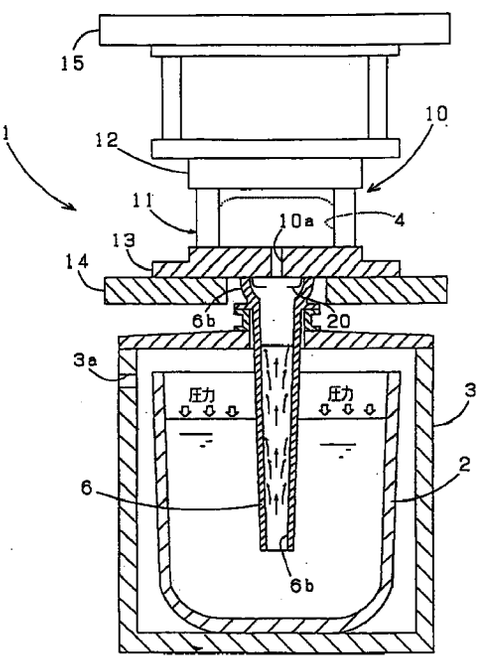

FIGURE 1

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Description

This invention relates to a filter for removing foreign matter from a stream of molten metal. Moreover, the invention relates to a casting apparatus including such a filter.

In the conventional casting, it has been known that the mechanical strength of a product becomes lower than the theoretical strength of the material itself when foreign matters in the molten metal are mixed into a mold cavity together with the molten metal in the manufacturing process of a casting product, and an idea is proposed that a filter is provided in a duct to prevent mixture of foreign matters into the product. For example, Japanese Unexamined Patent Publication Hei 2-241656 proposes that in a duct forming a flow passage are provided two filters with different thickness, pore diameter, and porosity, on the upper and lower sides.

However, in eliminating foreign matters by using filters described above, it is necessary to employ filters with a fine mesh or a minute diameter to remove minute foreign matters, which results in an easy clogging of filters and prevents a long-term use, causing frequent filter replacement with the result of reduced manufacturing efficiency.

In order to solve such problems, in Japanese Unexamined Patent Publication Hei 7-28904 is proposed an idea that at the inlet of a duct forming a flow passage is provided a filter assembly with coarse filters set closely on both sides of a fine filter, said coarse filter first eliminating relatively large foreign matters, thereby preventing clogging of the fine filter caused by larger foreign matters and effecting a longer life of the filter assembly.

However, arrangement of the filter assembly with coarse filters set closely on both sides of a fine filter, results in a complicated production procedure of the filter assembly itself as well as a higher product cost.

Even if the filter assembly is arranged such that a coarse filter first eliminates large foreign matters, it is disposed such a manner as to block the duct, so that the filter itself acts as a resistance to the molten metal flowing in the duct. Especially, when the central portion of the filter assembly is clogged with foreign matters, the resistance to the molten metal flow becomes very great, so that a need might happen for the replacement of the filter assembly even when the filter is not clogged as a whole.

Further, when the filter assembly is provided at the inlet of the duct as described above, the duct must be removed from the furnace at the time of filter replacement, posing another problem of complicated filter change.

In order to solve the foregoing problems, the object of this invention is to provide a filter for removing foreign matter from a stream of molten metal and a casting apparatus incorporating said filter capable of reducing the influence of the filter clogging on the molten metal to a minimum and of eliminating foreign matters efficiently for a long time.

The foregoing object is achieved by a filter having a central portion and a peripheral portion, wherein the molten metal flow rate in the central portion is higher than in the peripheral portion.

Furthermore, the above object is achieved by a casting apparatus comprising a furnace for holding molten metal, a mould for receiving the molten metal, the mould being connected to the furnace through a duct, said molten metal being poured into the mould through said duct by using a pressure difference between the inside of the furnace and the inside of the mould, and a filter fitted inside said duct for eliminating impurities from the molten metal flowing to the mould wherein the molten metal passage rate in the central portion is set higher than in the peripheral portion therearound.

Further preferred embodiments are contained in the respective subclaims.

An embodiment of a filter and a casting apparatus according to this invention will be described below by way of example with reference to the accompanying drawings:

Fig. 1 is a schematic vertical sectional view of a low pressure casting apparatus incorporating a filter for casting apparatuses according to this invention;
Fig. 2 is a view of the low pressure casting apparatus of Fig. 1, with the mold and the duct being separated;
Fig. 3 is an enlarged view of the mounting section of the filter to the casting apparatus of Fig. 1;
Fig. 4(a) is a top view of the filter, and Fig. 4(b) is a sectional view taken along line A-A of Fig. 4(a);
Fig. 5 is a diagram showing the measurement of the deposition of foreign matters (so-called slag) to the quantity of filtered molten metal for the filter 20.

In figure 1, numeral 1 shows a low pressure casting apparatus. The low pressure casting apparatus 1 is arranged such that it is composed of a furnace 3 containing a crucible 2, a mold 10 formed with a mold cavity 4 for a cast product, and a duct 6 the lower end of which is immersed close to the bottom of the crucible 2 and the upper end of which is connected to pouring gates 10a of the mold 10, and that the molten metal rises in the duct 6 against its gravity to be poured from the pouring gates 10a into the mold cavity 4 when compressed air or inert gas is introduced into the furnace 3 so as to apply pressure to the molten metal in the crucible 2.

The mold 10 is composed of a mold body 11 formed with a mold cavity 4 and made up of four split dies dividable through backward and forward and rightward and leftward sliding movement, and an upper mold 12 and a lower mold 12 defining the upper and lower ends of the mold cavity 4; and is held at a given pressure by upper and lower mold die bases 15, 14. As for the pouring gate 10a, though only one gate is shown in Fig. 1, the lower mold 13 is formed with a plurality of pouring gates,

the duct 6 having an enlarged diameter in the shape of a funnel at its top 6a so as to cover all the pouring gates 10a.

The mold 10, as shown in Fig. 2, is arranged in such a manner as to be separated from the duct 6 together with the upper and lower mold die bases 15, 14.

As shown in Fig. 3 in detail, a filter 20 is held between the lower end of the mold 10 or more specifically the bottom of the lower mold 13 and the top of the duct 6.

Figs. 4(a), (b) are a top view of the filter 20 and a sectional view taken along line A-A.

The filter 20, as shown in Figs. 4, is made of a wire net in the shape of a flat hull bottom, formed at its top end with a flanged section 21 extending radially outwardly, the flanged section having four fitting tongues 22 extending outwardly at the front and rear, and the sides, respectively.

In the central portion of the bottom of the wire net constituting an filter surface of the filter 20, is formed an opening 20a whose sectional area is at least larger than the total sectional areas of the pouring gates 10a of the mold 10.

The filter 20 described above, as shown in Fig. 3, is placed on the duct 6 so as to be engaged at its flanged section with the top end of the duct, fixed at the tongues 22 to the duct 6 with appropriate fixing members such as bolts, and then held between the mold 10 and the duct 6, with the mold 10 mounted to the top of the duct 6.

Functions of the low pressure casting apparatus with a filter depicted above will be described below.

When a pressure is applied to the furnace 3 after the mold 10 is set to the duct, molten metal in the crucible 2 rises in the duct 6 against its gravity, as shown in Fig. 1. The molten metal flow goes up at an appropriately adjusted velocity through pressure applied to the furnace 3 depending on the shape of the mold cavity 4 of the mold 10 or the material of the molten metal. However, since the flow velocity is basically zero on the wall surface 6b of the duct 6, it is highest at the duct center and decreases as the flow approaches the wall surface 6b radially outwardly from the duct center. Therefore, the molten metal flows in the duct while spreading radially outwardly as shown by arrows in Fig. 1, being released at the enlarged diameter section 6a formed at the top of the duct 6, and further spreads outwardly. This molten metal flow in the duct 6 causes foreign matters in the molten metal to be pushed aside toward the wall surface 6b of the duct 6 while rising upwardly in the duct 6, so that the foreign matters are eliminated from the central portion of the molten metal flow.

In this way, while the central portion of the molten metal containing no foreign matters is poured from pouring gates 10a into the mold cavity 4 after passing through the opening of the filter 20, the outer portion of the molten metal containing foreign matters passes through the wire net section of the filter 20, and is poured into the mold cavity 4 after being filtered of the foreign matters

Fig. 5 is a diagram showing the measurement of the deposition of foreign matters (so-called slag) to the quantity of filtered molten metal (unit weight×number of shots). The diagram shows that the deposition of foreign matters increases in proportion to the quantity of the filtered molten metal, and accordingly the filter 20 has adequate durability in collecting foreign matters.

As described above, the filter is arranged such that an opening 20a is provided in the central portion and a wire net section is located only in the outer portion where foreign matters accumulate, allowing the resistance of the clogged foreign matters to the molten metal flow to be reduced to a smallest possible level, which prevents poor run of the molten metal due to decreased flow velocity caused by filter clogging. Further, this allows changes in the filter resistance over time to the molten metal to be restricted, to a minimum, so that difficulties such as development of burrs caused by changes in flow velocity can be controlled to a lowest level even for a long-term use in the same casting condition, which effects stability in the quality of products.

In the embodiment described above, the filter 20 is arranged such that it is provided with a flanged section 21 which can be held between the duct 6 and the lower mold 13. Therefore, as shown in Fig. 2, the filter can be removed easily if the mold 10 is simply raised upwardly, thereby effecting easy replacement of the filter.

In addition, the filter 20 is formed in the shape of a flat hull bottom, so that the area of the peripheral filter section can be enlarged.

Further, an opening 20a is formed in the central portion which has no influence on the filtering effect of the filter 20, so that the filter 20 will not change its original form for a long-term use because of its small resistance to the molten metal flow.

The filter 20 may be formed of various materials depending on the casting conditions such as material and temperature of the molten metal. For example, it can be formed of, but not limited to, a SUS 304-plated wire net with a surface oxidized in an atmosphere at 500°C, preferably a zinc-plated wire net oxidized in an atmosphere at 500 °C,or a ceramic-coated wire net etc.

The filter 20 may be made of materials other than the wire net, for example, but not limited to, meshed materials such as expanded metal and punching metal, or ceramic filters.

The molten metal passage rate of the filter 20 at the peripheral portion, that is, mesh size for the wire net, hole diameter for the punching metal, or porosity for the ceramic filter may also be determined as required depending on the casting conditions such as material and temperature of the molten metal.

Further, the filter 20 is of a flat hull bottom shape in this embodiment, but may be formed into any appropriate shape as long as it has an opening in the central

portion, for example, the shape of a flat plate.

The size of the opening of the filter 20 is preferably over 35% of the minimum sectional area of the flow passage of the duct, but not limited to that, and may be determined at will within a range over which passage of the foreign matters is prevented.

Moreover, the filter 20 is disposed between the duct 6 and the mold 10 (lower mold 13) in this embodiment, but may be disposed at any appropriate position if placed within the duct 6, preferably above the original level of the molten metal in the crucible 2, in which case, foreign matters can be eliminated reliably even when they are initially deposited on the inside wall of the duct.

Still further, a low pressure casting apparatus has been described as a way of example in this embodiment, but the type of the casting apparatus is not limited to that, and any type of casting apparatus with a duct through which molten metal is supplied to the mold cavity, can be employed, for example, but not limited to, casting apparatuses operated by the differential pressure casting method or the Cosworth method with a duct of an electromagnetic pump type.

Yet further, the filter and the casting apparatus are separated from each other, but arrangement is not limited to this embodiment, and if no filter replacement is necessary or the clogged foreign matters can be removed from the filter by washing, the filter may be incorporated into the casting apparatus, for example, into the duct or the mold.

Furthermore, the filter 20 is formed with an opening in its central portion, but as long as the molten metal passage rate of the filter 20 at the central portion which has no influence on the filtering effect, is set higher than that at the peripheral portion therearound, the central portion of the filter may be formed as, for example, but not limited to, a coarse wire net having no influence on the filtering effect. This netted arrangement will effects higher rigidity of the filter itself.

Further, a duct 6 with enlarged upper end diameter has been described as a way of example in this embodiment, but the shape of the duct 6 is not limited to that, and this invention can be also applied to a straight pipe duct.

As described above, the filter is fitted inside a duct, for eliminating impurities from molten metal flowing into a mold, in a casting apparatus having a furnace holding molten metal and the mold receiving the molten metal connected thereto through the duct forming a flow passage of the molten metal, said molten metal being poured into the mold through said duct by using pressure difference between the insides of said furnace and said mold, wherein the molten metal passage rate in the central portion is set higher than that in the peripheral portion therearound. Therefore, the resistance of the filter to the molten metal flow in the duct can be reduced to a smallest possible level, and changes in the filter resistance over time to the molten metal flow due to clogging can also be restricted to a minimum, so that the filter can be used for a long time without decreased filtering efficiency.

Further, the casting apparatus has a furnace holding molten metal and a mold receiving the molten metal connected thereto through a duct. The molten metal is poured into the mold through said duct by using pressure difference between the insides of said furnace and said mold. Inside said duct there is provided a filter whose molten metal passage rate is higher in the central portion than in the peripheral portion therearound, and impurities are eliminated from the molten metal flowing from the furnace into the mold by said filter. Therefore, the resistance of the filter to the molten metal flow in the duct can be reduced to a smallest possible level, and changes in the filter resistance over time to the molten metal flow due to clogging can also be restricted to a minimum, so that the filter can be used for a long time without decreased filtering efficiency, which allows the frequency of filter replacement to be reduced to a minimum, thereby effecting increased manufacturing efficiency.

Claims

1. A filter for removing a foreign matter from a stream of molten metal, said filter (20) having a central portion and a peripheral portion, wherein the molten metal flow rate in the central portion is higher than in the peripheral portion.

2. Filter according to claim 1, **characterized in that** the central portion is an opening (20a).

3. Filter according to claim 1 or 2, **characterized in that** the filter has a bottom in the shape of a flat hull bottom and that an opening is formed in the centre of said bottom.

4. Filter according to one of the claims 1 to 3, **characterized in that** the filter (20) is provided with a flanged portion (22) which is adapted to engange with the top of a duct.

5. Casting apparatus comprising:

   a furnace (3) for holding molten metal,
   a mould (10) for receiving the molten metal, the mould (10) being connected to the furnace (3) through a duct (6),
   said molten metal being poured into the mould (10) through said duct (6) by using a pressure difference between the inside of the furnace (3) and the inside of the mould (10), and
   a filter (20) fitted inside said duct for eliminating impurities from the molten metal flowing to the mould wherein the molten metal passage rate in the central portion is set higher than in the peripheral portion therearound.

6. Casting apparatus according to claim 5, **characterized in that** the area of the central portion with a higher molten metal passage rate is larger than the total sectional areas of pouring gates (10a) of the mould (10).

7. Casting apparatus according to claim 5 or 6, **characterized in that** the central portion with a higher molten metal passage rate is an opening (20a).

8. Casting apparatus according to one of claims 5 to 7, **characterized in that** the filter (20) has a bottom in the shape of a flat hull bottom and is formed with an opening in the centre of said bottom.

9. Casting apparatus according to one of claims 5 to 8, **characterized in that** the filter (20) is provided with a flanged portion (22) engageable with the top of the duct (6), said filter being retained with said flanged portion (22) held between the top of the duct (6) and the bottom of the mould (10).

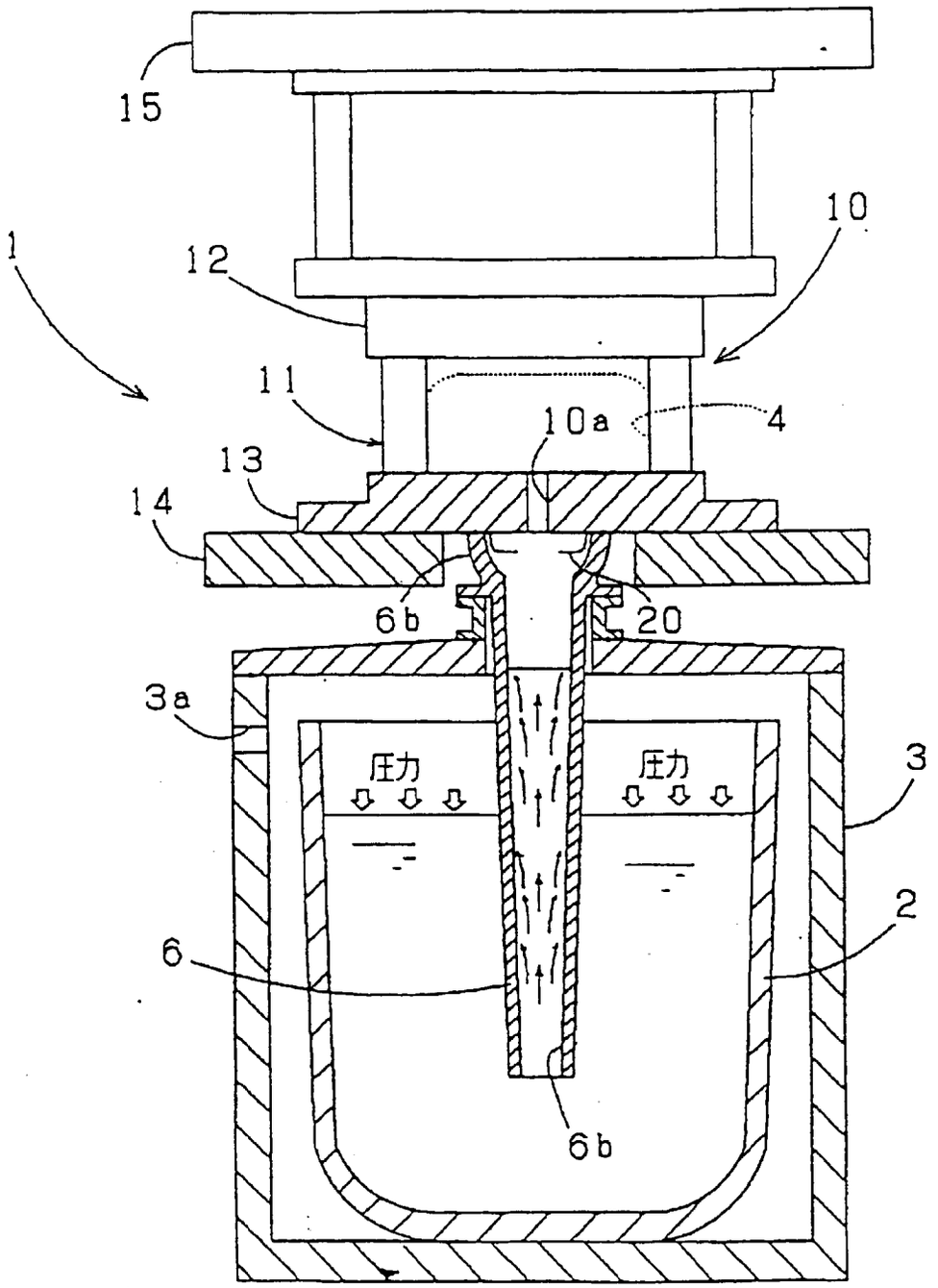

FIGURE 1

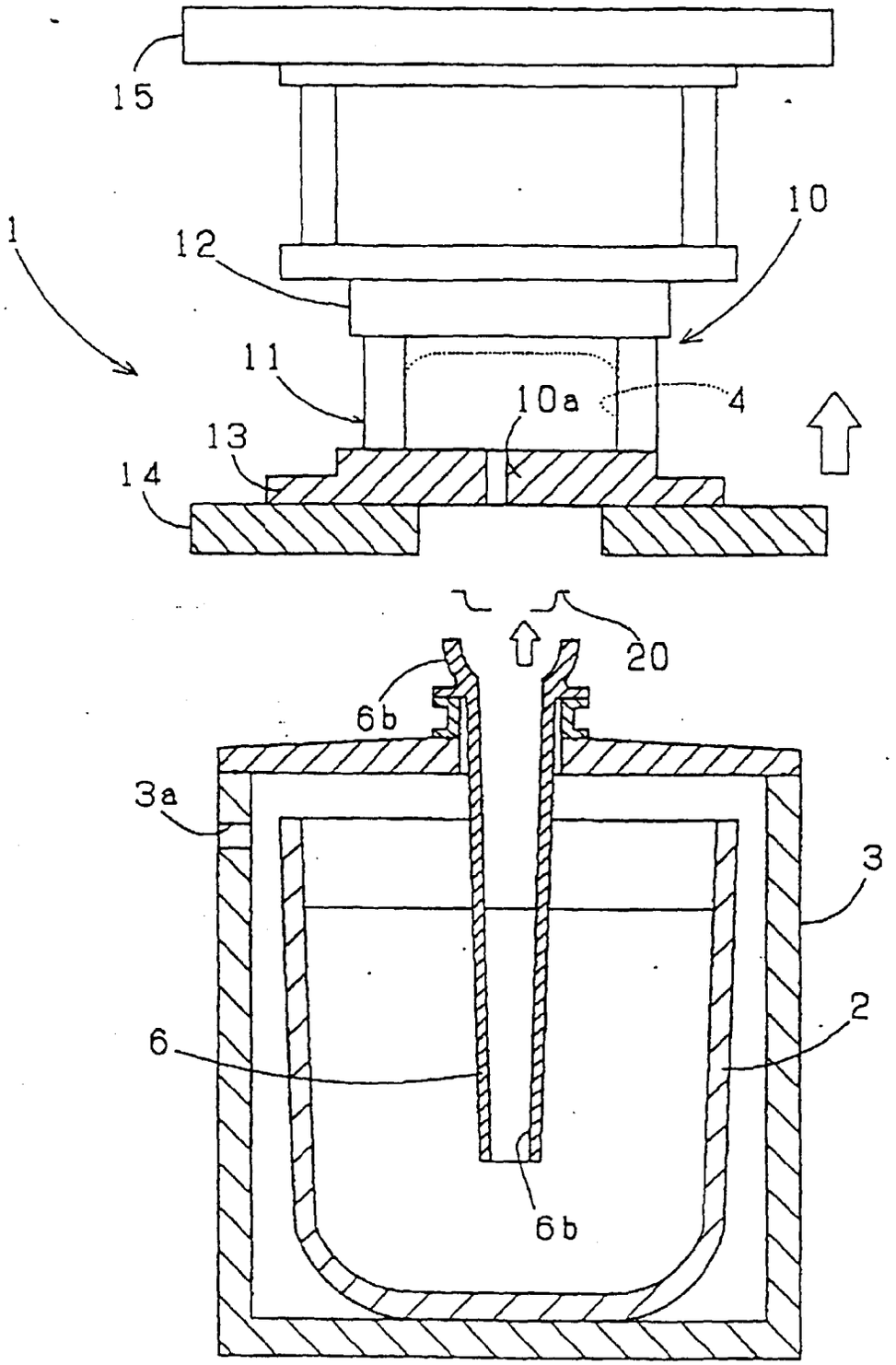

FIGURE 2

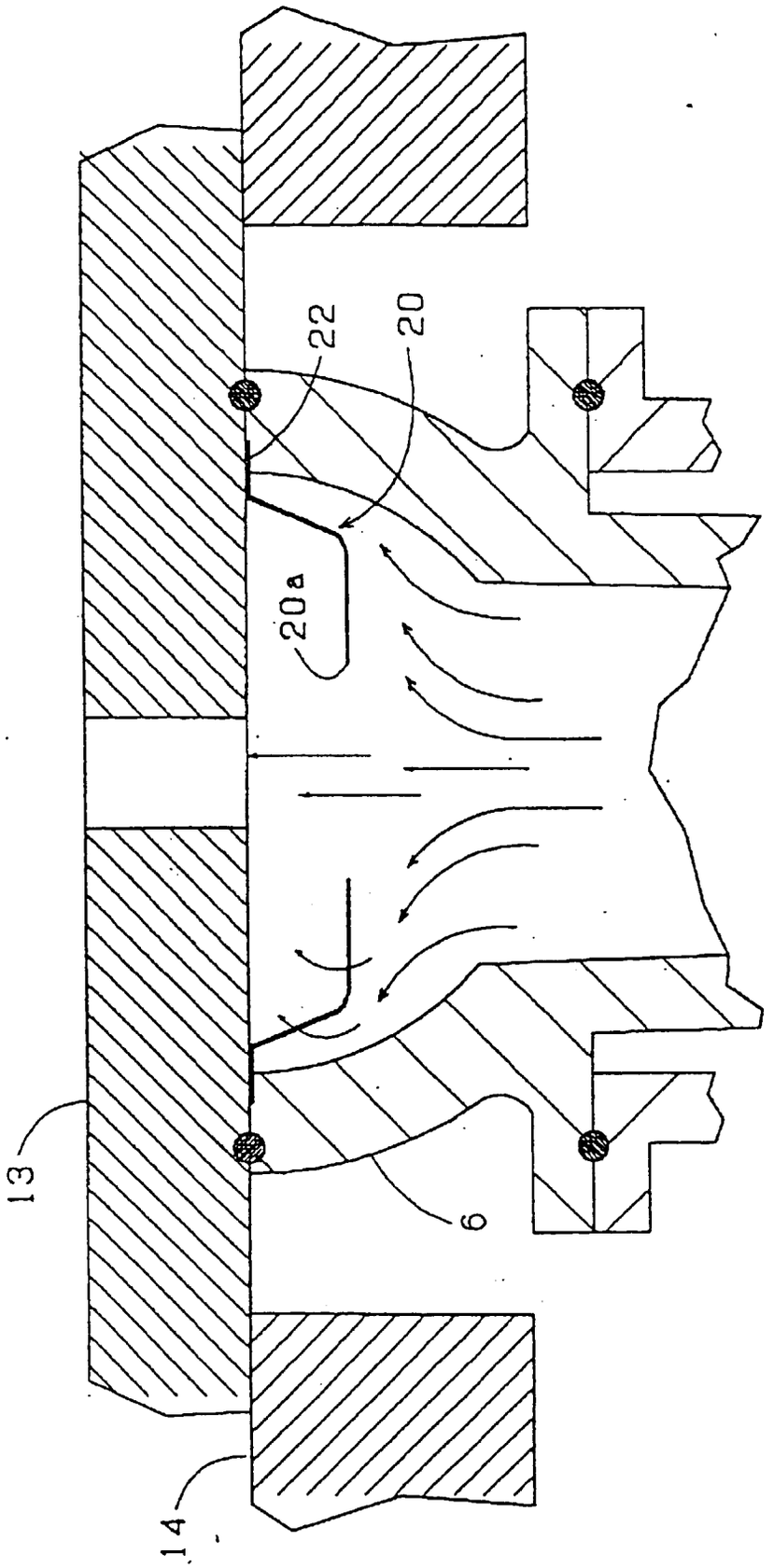

FIGURE 3

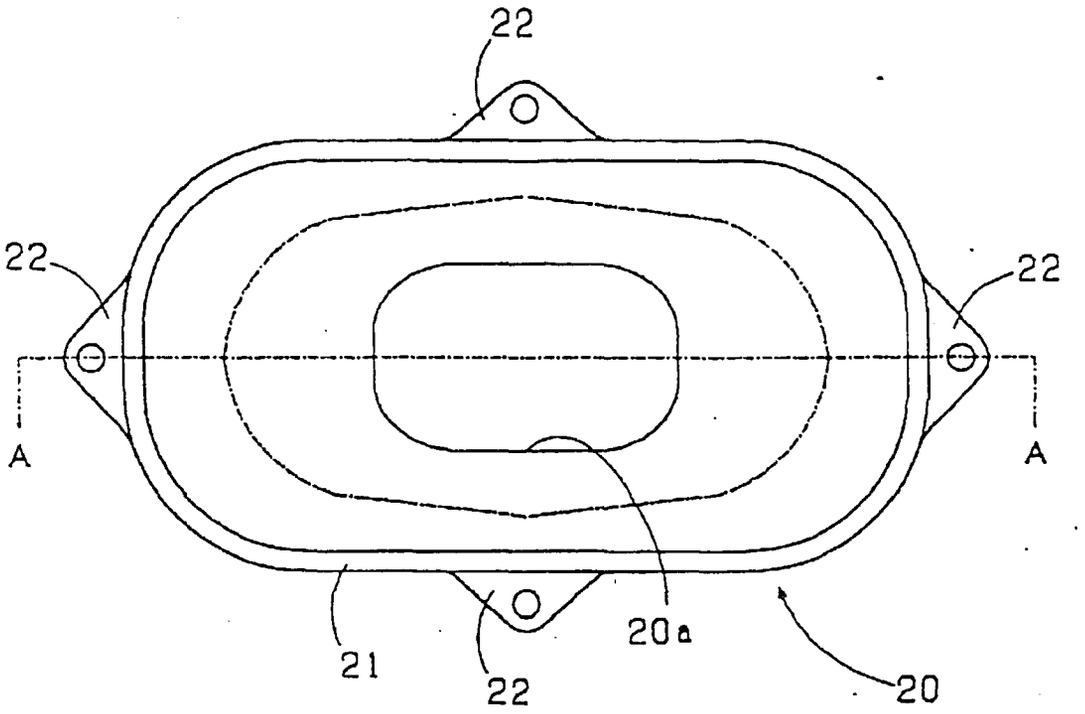

FIGURE 4(a)

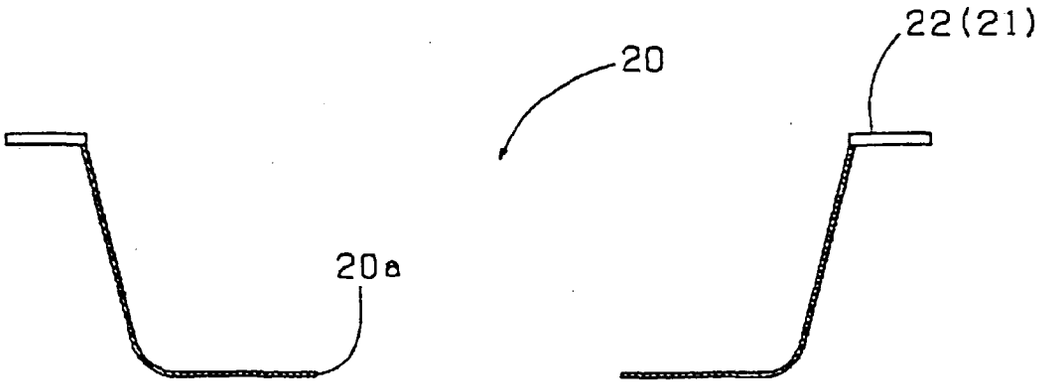

FIGURE 4(b)

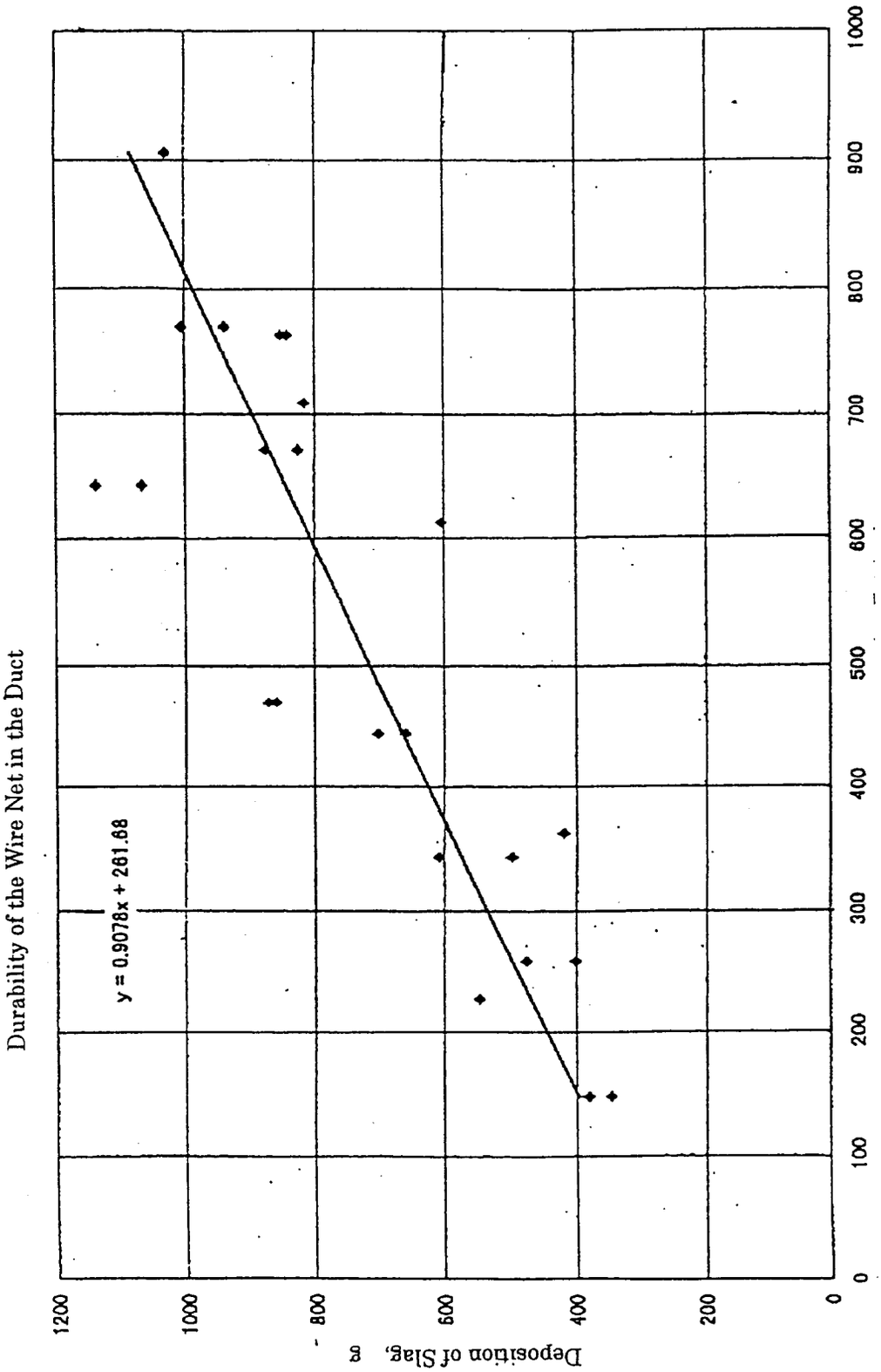
Durability of the Wire Net in the Duct
Deposition of Slag, g
y = 0.9078x + 261.68
0
100
200
300
400
500
600
700
800
900
1000
200
400
600
800
1000
1200
Quantity of the Filtered Molten Metal
(Unit Weight × Number of Shots), kg/duct

FIGURE 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 1932

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A,D	PATENT ABSTRACTS OF JAPAN vol. 014, no. 567 (M-1059), 17 December 1990 & JP 02 241656 A (HITACHI METALS LTD), 26 September 1990, * abstract *	1,5	B22D43/00 B22D18/04
A,D	PATENT ABSTRACTS OF JAPAN vol. 096, no. 002, 29 February 1996 & JP 07 284904 A (HITACHI METALS LTD), 31 October 1995, * abstract *	1,5	
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 028 (M-557), 27 January 1987 & JP 61 199566 A (DAIHATSU MOTOR CO LTD), 4 September 1986, * abstract *	1,5	
A	DE 18 67 524 U (ALCAN ALUMINIUMWERKE G.M.B.H.) * claim 1; figures 1-3 *	1,5	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B22D
A	DE 22 63 539 A (THE CARBORUNDUM CO.) 5 July 1973 * claim 1; figures 1-4 *	1,5	
A	DE 32 44 079 A (BBC AKTIENGESELLSCHAFT BROWN, BOVERI & CIE.) 14 June 1984 * claim 1; figures 1,2 *	1,5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	26 May 1998	Sutor, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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