603008

FORM 1
REGULATION 9

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952-1973

APPLICATION FOR A PATENT

We KUROSAKI REFRACTORIES CO., LTD.

of 1-1, Higashihama-machi, Yahatanishi-ku, Kitakyushu-shi, Fukuoka-ken, JAPAN

hereby apply for the grant of a Patent for an invention entitled:

HIGH-DURABILITY PLATE BRICK FOR SLIDING GATE NOZZLE APPARATUS

which is described in the accompanying complete specification. This Application is a Convention Application and is based on the Application(s) numbered: 62261336 for a Patent or similar protection made in Japan on 15 October 1987.

Our address for service is:

GRIFFITH HACK & CO.
71 YORK STREET
SYDNEY N.S.W. 2000
AUSTRALIA

DATED this 6th day of October, 1988.

KUROSAKI REFRACTORIES CO., LTD.
By their Patent Attorneys

GRIFFITH HACK & CO.

APPLICATION ACCEPTED AND AMENDMENTS ALLOWED 8 · 8 -90

TO: THE COMMISSIONER OF PATENTS
COMMONWEALTH OF AUSTRALIA

0837A:rk

B — APPLICATION BY ASSIGNEE OF INVENTOR

COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952

DECLARATION IN SUPPORT OF AN APPLICATION FOR A PATENT

(Name of applicant) In support of an application made by: Kurosaki Refractories Co., Ltd

(Title) for a patent for an invention entitled: High-Durability Plate Brick For Sliding Gate Nozzle Apparatus

(Full name and address of signatory) I, Yajiro FUKAGAWA

of 1-1 Higashihama-machi, Yahatanishi-ku, Kitakyushu-shi, Fukuoka-ken, JAPAN

do solemnly and sincerely declare as follows:

1. I am authorised by the above mentioned applicant for the patent to make this declaration on its behalf.

(Full name and address of inventor(s))

2. The name and address of each actual inventor of the invention is as follows: Tsutomu HARADA and Hiroshi SHIKANO

of c/- Kurosaki Refractories Co., Ltd., 1-1 Higashihama-machi, Yahatanishi-ku, Kitakyushu-shi, Fukuoka-ken, JAPAN and (same as above for second inventor)

(State whether by assignment or contract of employment) and the facts upon which the applicant is entitled to make this application are as follows: The Applicant is the assignee of the said invention from the actual inventors

(Delete paragraphs 3 and 4 for non-Convention application)

3. The basic application(s) as defined by Section 141 of the Act was (were) made as follows:
Country Japan on 15th October, 1987
in the name(s) Kurosaki Refractories Co., Ltd
and in ..... on .....
in the name(s) .....
and in ..... on .....
in the name(s) .....

(Place and date of signing)

4. The basic application(s) referred to in the preceding paragraph was(were) the first application(s) made in a Convention country in respect of the invention the subject of this application.

Declared at Fukuoka-ken Japan this 24th day of September 19 88

Signed: Yajiro Fukagawa Yajiro FUKAGAWA

Position: President

GRIFFITH HACK & CO

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(12) PATENT ABRIDGMENT (11) Document No. AU-B-23502/88
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(54) Title
HIGH-DURABILITY PLATE BRICK FOR SLIDING GATE NOZZLE APPARATUS

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(71) Applicant(s)
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(56) Prior Art Documents
US 4646950

(57) Claim

1. A method of producing a high-durability plate brick for a sliding gate nozzle apparatus comprising mixing a refractory aggregate composition containing a metal having a melting point of not higher than 1000°C, a thermosetting resin exhibiting a higher mechanical strength when heated to about 150°C to 250°C, and 10 to 90 weight % based on the amount of thermosetting resin of a silicon resin, the thermosetting resin and silicon resin being present in an amount of 2 to 15 weight % based on the amount of refractory aggregate composition, and heating the mixture to form said plate brick.

4. A method according to claim 1 or claim 2, comprising heating said mixture to a temperature of from 500°C to 1000°C in a non-oxidizing atmosphere.

5. A method according to any one of claims 1 to 4, wherein said silicon resin is silicone resin and said thermosetting resin is selected from the group consisting of phenol resin, furan resin, epoxy resin and mixtures thereof.

6. A method according to any one of claims 1 to 5,

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wherein said metal is present in an amount of 1 to 20 weight % based on the amount of refractory aggregate composition, has a maximum particle size of 0.5 mm, and is selected from the group consisting of Al, Mg, Zn, Sn, Ba, Pb and alloys thereof.

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PATENTS ACT 1952 Form 10

COMPLETE SPECIFICATION

FOR OFFICE USE

Short Title:

Int. Cl:

Application Number:
Lodged:

Complete Specification-Lodged:
Accepted:
Lapsed:
Published:

Priority:

amendments ... section 49 and is correct for printing

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: KUROSAKI REFRACTORIES CO., LTD.

Address of Applicant: 1-1, Higashihama-machi, Yahatanishi-ku, Kitakyushu-shi, Fukuoka-ken, JAPAN

Actual Inventor: Tsutomu Harada and Hiroshi Shikano

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Complete Specification for the invention entitled:

HIGH-DURABILITY PLATE BRICK FOR SLIDING GATE NOZZLE APPARATUS

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method of producing a high-durability plate brick for a sliding gate nozzle (hereinunder referred to as "SN") apparatus which is used for controlling a flow rate of a molten metal on casting. In a further aspect, the invention relates to a high-durability plate brick produced by the method.

Description of the Prior Art

An SN apparatus is generally composed of three parts, namely, an upper nozzle, a plate brick consisting of a fixed plate and a sliding plate, and a lower nozzle. Among these, the plate brick is a part which is required to have the specialized properties for the function of controlling the flow rate of a molten metal.

Since the plate brick is subject to physical and chemical attack such as violent thermal shock and wear caused by a stream of molten metal, spalling resistance and corrosion resistance are the most important properties required for working the plate brick. Further, in order to obtain stable high durability, oxidation resistance and mechanical strength are also important properties to have in addition to the above properties.

The present inventors previously disclosed in Japanese Patent Publication No. 60-29664 an improved SN plate in resistance against the deterioration of the mechanical strength in the middle temperature range (400°C to 700°C) and the spalling resistance and the corrosion resistance which is prepared by admixing 2 to 15 weight % of a thermosetting synthetic resin such as phenol resins, furan resins and epoxy resins with a refractory aggregate including 1 to 20 weight % of a powder of a low-melting metal having a particle size of not more than 0.5 mm, molding and heating the resultant mixture, to a temperature of not higher than 800°C.

Improvement in the mechanical strength of thus prepared SN plate brick was achieved by heating at temperature from about 150°C to 250°C.

There are, however, problems are still remaining

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unsolved, that improvement of mechanical strength at a temperature higher than 300°C that SN plate is practically subject to, can not be expected due to oxidation.

SUMMARY OF THE INVENTION

According to the present invention there is provided a method of producing a high-durability plate brick for a sliding gate nozzle apparatus comprising mixing a refractory aggregate composition containing a metal having a melting point of not higher than 1000°C, a thermosetting resin exhibiting a higher mechanical strength when heated to about 150°C to 250°C, and 10 to 90 weight % based on the amount of thermosetting resin of a silicon resin, the thermosetting resin and silicon resin being present in an amount of 2 to 15 weight % based on the amount of refractory aggregate composition, and heating the mixture to form said plate brick.

As a refractory aggregate which said resin mixture may be admixed with, in the present invention, any of one or more than two selected from a group consisting of silica, alumina, silica-alumina, magnesia, spinel, chromium ore, SiC, Si_3N_4, B_4C, BN and carbonaceous materials such as graphite and amorphous carbon is usable.

As the low-melting metal to be included in said refractory aggregate, at least one metal having a low melting point not higher than 1000°C and selected from the group consisting of Al, Mg, Zn, Sn, Ba and Pb and an alloy thereof is usable. The amount of said low-melting metal included in the refractory aggregate may be from 1 to 20 weight % and the particle size thereof may not exceed 0.5 mm preferably.

As examples of the thermosetting resin which easily exhibits a higher mechanical strength when heated to about 150°C to 250°C, a phenol resin, a furan resin and an epoxy resin. And a resin which can be set at room temperature by use of a catalyst should be as said thermosetting resin in this invention.

As a silicon resin, silicone resin is most preferable from a view point of oxidation resistance. The amount of silicon resin added to at least one resin

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of the above is 10 to 90 wt% to the thermosetting resin employed. If the amount is less than 10 wt%, it is difficult to maintain stable high oxidation resistance. On the other hand, if the amount is more than 90 wt%, it is difficult to maintain the stable mechanical strength. Said mixed resin may be prepared before adding to the refractory aggregate, or may be added separately to the refractory aggregate in a mixer. The amount of resin mixture to be added is dependent on the bulk specific gravity of the refractory aggregate to a certain extent, but is preferably 2 to 15 wt%. If it is less than 2 wt%, molding becomes impossible; if more than 15 wt%, it makes molding difficult.

On preparing the SN plate brick, the refractory aggregate included with said low-melting point metal powder added with said resin mixture is subject to heating at a temperature lower than 1,000 °C., usually a temperature from 100 to 300°C. But when the brick is required to have a higher strength, the molded mixture is heated to a temperature higher than 500 °C to 1,000°C in a non-oxidizing atmosphere in order to melt the low-melting metal or react it with some components of the aggregate. The temperature for heating is not to be higher than 1,000 °C. If it exceeds 1,000 °C, the spalling resistance becomes inferior.

A plate brick for an SN apparatus produced according to the present invention exerts no deleterious influence on the sliding property, corrosion resistance and spalling

resistance even when it is applied to a sliding plate, and enables the mechanical property and the oxidation resistance to be well balanced at a high level, thereby enhancing the durability becomes inferior.

The above and other objects, features and advantages of the present invention are made clear through the following description of the preferred embodiment thereof, taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 shows a change in the mechanical strength (index of compression strength) and the oxidation resistance of a brick exhibited when the mixing ratio of a silicon resin and a phenol resin are varied in the composition shown in Table 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Alumina and aluminium were used as respectively as the refractory aggregate and as the low-melting point metal As a thermosetting resin which easily exhibits a higher mechanical strength when heated to about 150 to 250°C, a phenol resin was selected. The phenol resin was mixed with a silicon resin in ratios of 75 : 25, 50 : 50 and 25 : 75, respectively, and the aggregate and the resin mixture were heated in a bottom rotating mixer. The resultant mixture was molded in the form of a friction press plate, which was thermoset at 250°C for 24 hours, thereby obtaining the plate for an SN apparatus. The compositions, the mixing ratios and the

properties of the respective plates are shown in Table 1.

For comparison, a plate which contains no silicon resin and a plate which contains no phenol resin were produced in the same method, and the properties thereof are also shown in Table 1.

Table 1

Ingredient	Sample No.				
	1 (Comp.)	2	3	4	5 (Comp.)
Alumina powder	91	91	91	91	91
Clay powder	2	2	2	2	2
Carbon powder	2	2	2	2	2
Al	5	5	5	5	5
Phenol resin	+5	+3.75	+2.5	+1.25	-
Silicon resin	-	+1.25	+2.5	+3.75	+5
Properties					
Bulk specific gravity	3.11	3.13	3.12	3.13	3.13
Apparent porosity (%)	10.6	10.0	9.9	8.9	7.8
Compression strength (kg/cm^{-2})	1200	1136	1091	996	812
BS Wear index* after oxidation (600°C × 2hr)	270	134	74	52	29

*The smaller the numeral, the better.

As is obvious from Table 1, the mechanical strength is balanced well with the oxidation resistance in the samples 2, 3 and 4 which are in accordance with the present invention in comparison with the samples 1 and 5 in the comparative example.

When sample 3 was subjected to a practical test in an SN apparatus of a 60-ton ladle, it showed a remarkable improvement in durability compared with

conventional bricks which had used only a phenol resin or a silicon resin. In addition, there was little deterioration of the sliding surface after use due to oxidation and deterioration of the construction due to physical wear. Thus, the test of sample 3 brought about very good results.

Furthermore, a the mechanical strength (index of compression strength) and the oxidation resistance were measured while varying the ratio of the silicon resin and the phenol resin in the composition shown in Table 1. The results are shown in Fig. 1.

The compression strength (index) of each sample is indicated by the mark - ● - on the assumption that the compression strength is 100 when the phenol resin contained is 100%.

The oxidation resistance index k was calculated from the following formula on the basis of the BS wear index of the surface of the brick measured after 2-hour oxidation treatment.

$$k = \frac{1}{\text{BS wear index}} \times 100$$

The oxidation resistance index of each sample was represented by the mark ... ■ ... on the assumption that the compression strength is 100 when the silicon resin contained is 100%.

While there has been described what is at present considered to be a preferred embodiment of the

invention, it will be understood that various modifications may be made thereto, and it is intended that the appended claims cover all such modifications as fall within the true spirit and scope of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of producing a high-durability plate brick for a sliding gate nozzle apparatus comprising mixing a refractory aggregate composition containing a metal having a melting point of not higher than 1000°C, a thermosetting resin exhibiting a higher mechanical strength when heated to about 150°C to 250°C, and 10 to 90 weight % based on the amount of thermosetting resin of a silicon resin, the thermosetting resin and silicon resin being present in an amount of 2 to 15 weight % based on the amount of refractory aggregate composition, and heating the mixture to form said plate brick.

2. A method according to claim 1, further comprising mixing said thermosetting resin and said silicon resion prior to mixing with said refractory aggregate composition.

3. A method according to claim 1 or claim 2, comprising heating said mixture to a temperature of from 100°C to 300°C.

4. A method according to claim 1 or claim 2, comprising heating said mixture to a temperature of from 500°C to 1000°C in a non-oxidizing atmosphere.

5. A method according to any one of claims 1 to 4, wherein said silicon resin is silicone resin and said thermosetting resin is selected from the group consisting of phenol resin, furan resin, epoxy resin and mixtures thereof.

6. A method according to any one of claims 1 to 5, wherein said metal is present in an amount of 1 to 20 weight % based on the amount of refractory aggregate composition, has a maximum particle size of 0.5 mm, and is selected from the group consisting of Al, Mg, Zn, Sn, Ba, Pb and alloys thereof.

7. A method of producing a high-durability plate brick for a sliding gate nozzle apparatus substantially as hereinbefore described with reference to samples 2, 3 and 4 of Table 1.

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8. A high-durability plate brick for a sliding gate nozzle apparatus produced according to the method of any preceding claim.

DATED this 30th day of April 1990
KUROSAKI REFRACTORIES CO., LTD.

By their Patent Attorneys
GRIFFITH HACK & CO.

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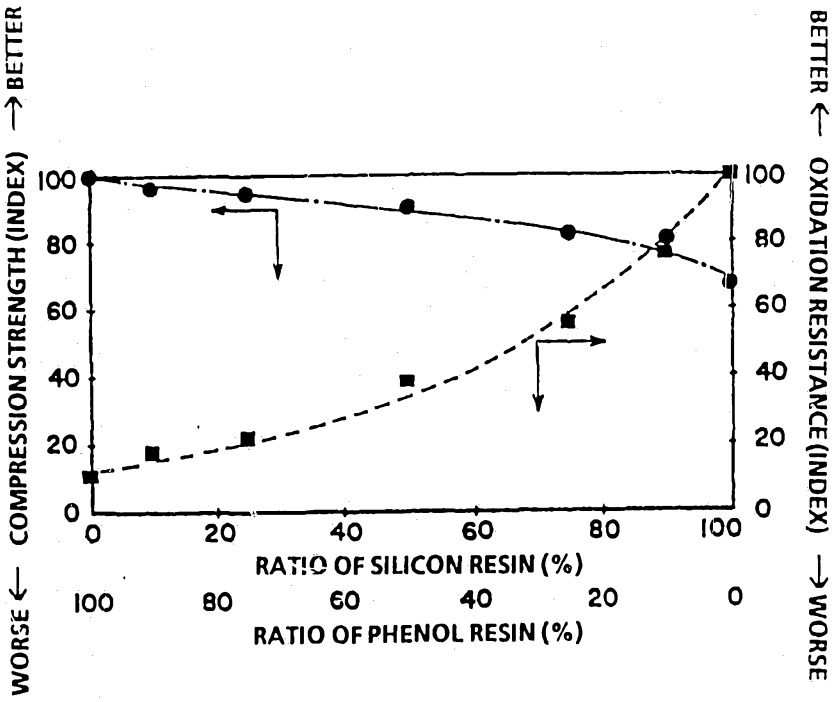
FIG. 1


WORSE ← COMPRESSION STRENGTH (INDEX) → BETTER
BETTER ← OXIDATION RESISTANCE (INDEX) → WORSE
100
80
60
40
20
0
0
20
40
60
80
100
RATIO OF SILICON RESIN (%)
100
80
60
40
20
0
RATIO OF PHENOL RESIN (%)