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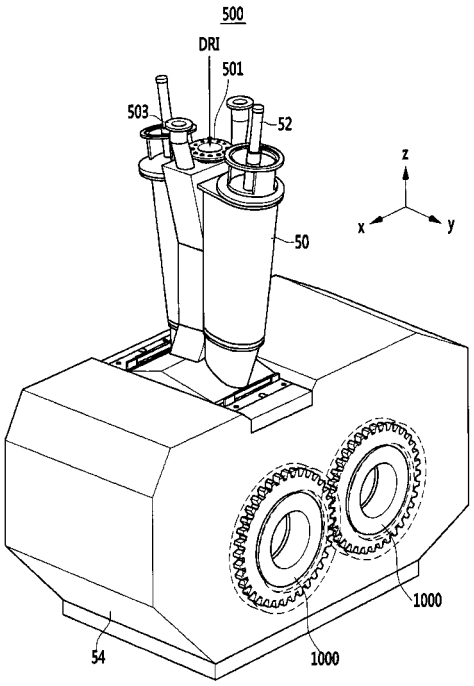
(54) APPARATUS FOR MANUFACTURING COMPACTED IRON, AND APPARATUS FOR MANUFACTURING MOLTEN IRON COMPRISING THE APPARATUS

(57) The present invention relates to an apparatus for manufacturing compacted iron and an apparatus for manufacturing molten iron comprising the same. The apparatus for manufacturing compacted iron comprises: i) a roll core comprising a shaft; and ii) a roll tyre surrounding a circumference of the roll core and having a recess on a surface thereof applied such that compacted irons are manufactured by compressing powder to the compacted irons. A cooling passage through which a cooling fluid applied to cool the roll tyre flows is formed on border surfaces of the roll tyre and the roll core contacting each other, and at least one sealing groove located in parallel to the cooling passage and spaced apart from the cooling passage and applied to seal the border surfaces is formed on the border surfaces.

FIG. 1



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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2009-0087826 filed in the Korean Intellectual Property Office on September 17, 2009, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

(a) Field of the Invention

[0002] The present invention relates to an apparatus for manufacturing compacted iron and an apparatus for manufacturing molten iron comprising the same, , and more particularly, to an apparatus for manufacturing compacted iron which can firmly seal a cooling fluid circulating in a roll tyre and an apparatus for manufacturing molten iron comprising the same.

(b) Description of the Related Art

[0003] In a smelting reduction process, lump coal and compacted reduced iron are used and charged into a melter-gasifier to manufacture molten iron. Thus, compacted reduced irons, i.e. compacted irons are manufactured by reducing fine ores and are charged to a melter-gasifier.

[0004] The compacted irons are manufactured by compacting direct reduced irons (DRIs). The continuous compacted irons are manufactured by introducing the direct reduced irons into a gap between a pair of rolls and driving the pair of rolls to compress the direct reduced iron. Here, each of the rolls includes a roll core and a ring-shaped roll tyre coupled to the periphery thereof.

[0005] The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in an effort to provide an apparatus for manufacturing compacted iron which can firmly seal a cooling fluid circulating in a roll tyre. Further, the present invention has been made in an effort to provide an apparatus for manufacturing molten iron comprising the above-mentioned apparatus for manufacturing compacted iron.

[0007] An exemplary embodiment of the present invention provides an apparatus for manufacturing compacted iron, comprising: i) a roll core comprising a shaft; and ii) a roll tyre surrounding a circumference of the roll core and having a recess on a surface thereof applied such that compacted irons are manufactured by compressing powder to the compacted irons. A cooling passage through which a cooling fluid applied to cool the roll tyre flows is formed on border surfaces where the roll tyre and the roll core contact each other, and at least one sealing groove located in parallel to the cooling passage and spaced apart from the cooling passage and applied to seal the border surfaces is formed on the border surfaces.

[0008] The at least one sealing groove may comprise a pair of sealing grooves, and the cooling passage may be located between the pair of sealing grooves. A sealing material may be filled in the sealing groove. The sealing material may comprise a rubber. The sealing material may further comprise graphite. The melting point of the sealing material may be 600°C to 800°C. The sealing groove may be formed along a surface of the roll core in a circumferential direction of the roll core. The sealing groove may comprise: i) a central part recessed toward the roll tyre; and ii) a pair of steps formed on opposite sides of the central part and convexly formed toward the roll tyre. A ratio of the radius of curvature of the central part to the radius of curvature of one step of the pair of steps may be 4 to 10. Directions in which the pair of steps face may be inclined toward an imaginary plane including the center of the central part in directions crossing a direction along which the shaft extends. The roll core may comprise: i) at least one first sealing passage extending in a direction crossing a direction along which the shaft extends and connected to the sealing groove; and ii) at least one second sealing passage extending in a direction parallel to the direction along which the shaft extends and connected to the first sealing passage, one end of the at least one second sealing passage being formed on a side surface of the roll core. The sealing material for filling the sealing groove may be applied to be compulsorily fed through the first sealing passage and the second sealing passage. The at least one second sealing passage may comprise a plurality of second sealing passages and the plurality of second sealing passages may be spaced apart from each other at a substantially regular interval.

[0009] The apparatus for manufacturing compacted iron according to an exemplary embodiment of the present invention may further comprise: a cap coupled to the end of the second sealing passage to seal the end of the second sealing passage. A threaded groove may be formed at the end of the second sealing passage and the cap may be coupled to the threaded groove.

[0010] Another exemplary embodiment of the present invention provides an apparatus for manufacturing molten iron, comprising: i) an apparatus for manufacturing compacted iron; and ii) a melter-gasifier for receiving compacted irons from the apparatus for manufacturing compacted iron to manufacture molten iron.

[0011] The apparatus for manufacturing compacted iron comprising: i) a roll core comprising a shaft; and ii) a roll tyre surrounding a circumference of the roll core

and having a recess on a surface thereof applied such that compacted irons are manufactured by compressing powder to the compacted irons. A cooling passage through which a cooling fluid applied to cool the roll tyre flows is formed on border surfaces where the roll tyre and the roll core contact each other, and at least one sealing groove located in parallel to the cooling passage and spaced apart from the cooling passage and applied to seal the border surfaces is formed on the border surfaces.

[0012] According to the exemplary embodiments of the present invention, it is possible to prevent a roll tyre rotating in a high temperature from being pushed out and a cooling fluid from being discharged to the outside of the roll tyre. As a result, a lifespan of the roll tyre can be increased. Further, since the roll tyre can be efficiently cooled by the sealed cooling fluid, compacted irons can be stably manufactured continuously. Accordingly, compacted irons and molten iron can be efficiently manufactured.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a schematic perspective view of an apparatus for manufacturing compacted iron according to an exemplary embodiment of the present invention.

FIG. 2 is a schematic perspective view of a roll included in the apparatus for manufacturing compacted iron of FIG. 1.

FIG. 3 is a schematic cross-sectional view of the roll of FIG. 2 taken along direction III-III.

FIG. 4 is a view schematically showing a process of sealing portion IV of FIG. 3.

FIG. 5 is a schematic enlarged cross-sectional view of a sealing groove.

FIG. 6 is a schematic view of an apparatus for manufacturing molten iron comprising the apparatus for manufacturing compacted iron of FIG. 1.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0014] FIG. 1 is a schematic perspective view of an apparatus for manufacturing compacted iron 500 according to the first embodiment of the present invention. The structure of the apparatus for manufacturing compacted iron 500 of FIG. 1 is shown simply to exemplify the present invention, and the present invention is not limited thereto. Thus, the structure of the apparatus for manufacturing compacted iron 500 may be variously modified.

[0015] As shown in FIG. 1, the apparatus for manufacturing compacted iron 500 comprises an charging hopper 50, a pair of screw feeders 52, and a pair of rolls 1000. The pair of rolls 1000 is fixed within a casing 54. In addition, the apparatus for manufacturing compacted iron 500 may further comprise other parts.

[0016] As shown in FIG. 1, powder, e.g. direct reduced irons **(DRIs)** are charged into the charging hopper 50 through a supply port 501 of the charging hopper 50 along the -z-axis direction. Although FIG. 1 illustrates that direct reduced irons are used as powder, any materials other than the direct reduced irons may be used as powder.

[0017] Direct reduced irons may be manufactured by charging and fluidizing fine ores into a fluidized bed reduction furnace into which reducing gas is supplied and reducing the fine ores. The powder manufactured through the process is introduced between the pair of rolls 1000 by using the pair of screw feeders 52 installed within the charging hopper 50. The pair of rolls 1000 compress the powder while rotating in opposite directions to manufacture compacted irons.

[0018] As shown in FIG. 1, the gas generated by the powder is exhausted to the outside through exhaust ports 503 installed in the charging hopper 50. As gas is removed from the powder, the powder can be compressed well without leaving air gaps. Hereinafter, the structure of a roll 1000 included in the apparatus for manufacturing compacted iron 500 of FIG. 1 will be described in more detail with reference to FIG. 2.

[0019] FIG. 2 schematically illustrates the roll 1000 included in the apparatus for manufacturing compacted iron 500 of FIG. 1. The structure of the roll 1000 of FIG. 2 is shown simply to exemplify the present invention, and the present invention is not limited thereto. Thus, the shape of the roll 100 may be variously modified.

[0020] As shown in FIG. 2, the roll 1000 comprises a roll tyre 20 and a roll core 30. The roll tyre 20 surrounds a circumference of the roll core 30. A plurality of recesses 201 on a surface of the roll tyre 20 are formed to extend along the y-axis direction. Thus, corrugated compacted irons can be continuously manufactured by rotating the roll 100 and compressing powder into the compacted irons with the plurality of recesses 201. As the roll tyre 20 compresses the powder while contacting the powder with a high temperature, the roll tyre 20 may be thermally deformed or damaged. Thus, periodically the roll tyre 20 is heated and is removed from the roll core 30, the roll tyre is repaired to be reused or is exchanged with a new product.

[0021] As shown in FIG. 2, the roll core 30 comprises a shaft 301 extending in the y-axis direction. A cooling passage 3011 is formed in the shaft 301 along the y-axis direction. Cooling fluid flowing through the cooling passage 3011 cools the heated roll tyre 20 and roll core 30. Here, cooling fluid refers to any material including water, capable of cooling the high temperature roll tyre 20 and roll core 30. Thus, any medium other than water may be used as cooling fluid.

[0022] When the roll 1000 rotates at a high speed, the roll tyre 20 is slid by a rotating force, thereby causing a scratch or a gap on border surfaces where the roll tyre 20 and the roll core 30 contact each other. As a result, the cooling fluid which cools the roll tyre 20 while flowing along the cooling passage 3011 (see FIG. 3) formed on

the border surface thereof can be leaked to the outside.

[0023] Thus, in the exemplary embodiment of the present invention, the border surfaces where the roll tyre 20 and the roll core 30 contact each other are sealed by using sealing grooves 10 (see FIG. 3), etc. As a result, a cooling fluid can be interrupted from being leaked to the outside.

[0024] As shown in FIG. 2, caps 12 are attached to one side surface of the roll core 30. The caps 12 are spaced apart from each other about the shaft 301 by a regular interval to be attached to a side surface of the roll core 30. For example, although one cap 12 is not shown in FIG. 2, a total of four caps 13 including the shown three caps 12 are spaced apart from each other by a regular interval to be attached to the side surface of the roll core 30. Although not shown in FIG. 2, the caps 12 are attached to another side surface of the roll core 30. The caps 12 seal second sealing passages 19 (see FIG. 3) extending in the y-axis direction in the roll core 30. The caps 12 prevent foreign substances from penetrating the roll core 30. As the caps 12 are spaced apart from each other by a regular interval, the second sealing passages 19 (see FIG. 3) are also spaced apart from each other by a substantially regular interval to be formed in the roll core 30. Hereinafter, the structure of the roll 1000 for sealing a cooling fluid will be described in more detail with reference to FIG. 3.

[0025] FIG. 3 shows a schematic cross-sectional structure of the roll 1000 of FIG. 2 taken along direction III-III. The structure of the roll 1000 of FIG. 3 is shown simply to exemplify the present invention, and the present invention is not limited thereto. Thus, the structure of the roll 1000 may be modified to another form.

[0026] As shown in FIG. 3, the cooling passage 3011 through which the cooling fluid circulates is formed in the roll 1000. The cooling fluid supplied along the cooling passage 3011 (indicated by a dotted line) formed at the center of the shaft 301 contacts the roll tyre 30 while spirally rotating along the cooling passage 3011 formed on the border surfaces. Thus, compacted irons can be continuously manufactured as the cooling fluid cools the roll tyre 30 while preventing thermal deformation of the roll tyre 30. Although the cooling passage 3011 is formed in the roll tyre 20 in FIG. 3, a cooling passage may be formed in the roll core 30.

[0027] As shown in FIG. 3, a pair of sealing grooves 10 are located along the y-axis direction to be spaced apart from the cooling passage 3011 formed on the border surface 25 side by side with the cooling passage 3011. Although four sealing grooves 10 are formed in FIG. 3, the sealing grooves 10 vertically facing each other are the same as each other. The sealing grooves 10 vertically facing each other are continuously connected while forming ring-shapes along the border surface 25. That is, the sealing grooves 10 are formed in a circumferential direction of the roll core 30, i.e. a direction parallel to the z-axis, along the border surface, in more detail, along surfaces 303 of the roll core 30. Although the sealing grooves 10 are formed on the surfaces 303 of the roll core 30 in FIG. 3, the sealing grooves 10 may be formed on surfaces of the roll tyre 20.

[0028] The cooling passage 3011 formed on the border surface 25 is located between the pair of sealing grooves 10. Thus, when an aperture is generated between the roll tyre 20 and the roll core 30 by the rotations of the roll tyre 20 and the roll core 30 so that when the cooling fluid can be leaked to the outside along the border surface 25, a sealing material 60 (see FIG. 4) is filled in the pair of sealing grooves 10 to prevent the cooling fluid from being leaked to the outside. That is, the border surface 25 can be sealed by using the pair of sealing grooves 10.

[0029] As shown in FIG. 3, the roll core 30 has a first sealing passage 17 and a second sealing passage 19. The first sealing passage 17 extends in a direction crossing a direction along which the shaft 301 extends, i.e. in the z-axis direction and is connected to the sealing groove 10. Further, the second sealing passage 19 extends in a direction parallel to a direction along which the shaft 301 extends, i.e. in the y-axis direction and is connected to the first sealing passage 17. Hereinafter, a process of sealing a cooling fluid will be described in more detail with reference to FIG. 4.

[0030] FIG. 4 schematically shows a process of sealing a cooling fluid at portion IV of FIG. 3. The sealing process of FIG. 4 is shown simply to exemplify the present invention, and the present invention is not limited thereto.

[0031] As shown in FIG. 4, as the roll tyre 20 and the roll core 30 rotate, a gap between the roll tyre 20 and the roll core 30 may widen, causing a cooling fluid L from being leaked from the cooling passage 3011 (see FIG. 3). In this case, as indicated by an arrow, the sealing material 60 heated to a specific temperature range is compulsorily fed in a bent arrow direction through the first sealing passage 17 and the second sealing passage 19 with the cap 12 being opened. When the sealing material 60 is compulsorily fed by using only one first sealing passage 17 and one second sealing passage 19, the sealing material 60 is filled in the remaining three first sealing passages (not shown) and the remaining three second sealing passages (not shown) communicated with the sealing groove 10 after being filled in the sealing groove 10. Thus, the cap 12 can be closed after it is confirmed that the three first sealing passages (not shown) and the three second sealing passages (not shown) are completely filled with the sealing material 60.

[0032] The sealing material 60 may be heated to 70°C to 80°C to have a viscosity before used. As a result, the sealing material 60 may be filled in the sealing grooves 10. As the four first sealing passages 17 and the four second sealing passages 19 are formed in the roll core 30 to be communicated with the sealing grooves 10, the sealing material 60 can be efficiently filled in the sealing grooves 10 through the four first sealing passages 17 and the four second sealing passages 19. Meanwhile, the roll tyre 20 and the roll core 30 may be rotated after the sealing material 60 is filled in the sealing grooves 10.

[0033] Meanwhile, the cap 12 is coupled to one end 191 of the second sealing passage 19 to seal the end 191 of the second sealing passage 19. The end 191 is formed on a side surface of the roll core 30. The sealing material 60 is so highly viscous that if the liquefied filling material 60 is filled in the roll core 30 through the end 191, the filling material 60 is not leaked from the end 191 but is easily solidified within the roll core 30. A threaded groove 1911 is formed at the end 191 and a thread 121 is formed in the cap 12. Thus, the cap 12 is firmly coupled to the end 191 through coupling of the threaded groove 1911 and the thread 121. As a result, the filling material 60 is not easily leaked to the outside.

[0034] The sealing material 60 comprises a rubber. The rubber comprises a natural rubber or a synthetic rubber. Since a rubber is used for the sealing material 60, the border surfaces 25 of the roll tyre 20 and the roll core 30 can be efficiently sealed. Further, the rubber can be used in a high temperature environment of approximately 150°C to 200°C and thus is suitable for the sealing material 60. In addition, the rubber is elastic and thus can efficiently cope with vibrations due to rotations of the roll tyre 20 and the roll core 30.

[0035] The sealing material 60 may further include graphite. Graphite is contained in the sealing material 60 to increase the melting point of the sealing material 60. In addition, the sealing material 60 may further comprise suitable materials. The melting point of the sealing material 60 may be 600°C to 800°C. When the melting point of the sealing material is too low, the sealing material 60 may be melted, which makes it difficult to seal the border surfaces 25. Meanwhile, when the melting point of the sealing material 60 is too high, the sealing material 60 is hardened to be too hard that the elasticity thereof is reduced. Hereinafter, the shape of the sealing groove 10 will be described in more detail with reference to FIG. 5.

[0036] FIG. 5 schematically shows an enlarged cross-sectional structure of the sealing groove 10. The roll tyre 20 will be omitted in FIG. 5 for convenience of description. Further, FIG. 5 shows a sealing groove 10 which is not connected to the first sealing passage 17 (see FIG. 4).

[0037] As shown in FIG. 5, the sealing groove 10 comprises a central part 101 and a pair of steps 103. The central part 101 is recessed toward the roll tyre 20 (see FIG. 4). Further, the pair of steps 103 are formed on opposite sides of the central part 101. The pair of steps 103 are convexly formed toward the roll tyre 20 (see FIG. 4). Thus, the sealing groove 10 can stably accommodate the sealing material 60 (see FIG. 4, the same hereinbelow) at the central part 101 and can prevent the sealing material 60 from overflowing to the outside of the sealing groove 10 due to the pair of steps 103.

[0038] Here, the ratio of the radius of curvature 101r r of the central part to the radius of curvature 103r of the steps 103 may be 4 to 10. When the ratio is less than 4, the size of the central part 101 is too small that the sealing groove 10 may not accommodate an adequate amount of the sealing material 60 necessary for sealing. In addition, when the ratio is more than 10, since the size of the steps 103 is too small that the sealing material 60 accommodated in the sealing groove 10 may easily overflow to the outside. Thus, it is preferable to maintain the ratio of the radius of curvature 101r r of the central part 101 to the radius of curvature 103r of the steps 103 in the above-mentioned range.

[0039] Meanwhile, as shown in FIG. 5, an imaginary plane 101p comprising a center 101c of the central part 101 may be considered. The imaginary plane 101p is formed along the center 101c of the central part 101. Thus, the imaginary plane 101p is formed in parallel to the zx plane of FIG. 2. That is, the imaginary plane 101p extends in a direction crossing a direction in which the shaft 301 (see FIG. 2) extends. Here, the directions (indicated by dotted lines) in which the pair of steps 103 face are inclined toward the imaginary plane 101 p. Thus, since the pair of steps 103 are inclinedly formed, the sealing material 60 can be stably accommodated in the sealing groove 10.

[0040] FIG. 6 schematically shows an apparatus for manufacturing molten iron 9000 comprsing the apparatus for manufacturing compacted iron 500 of FIG. 1.

[0041] As shown in FIG. 6, the apparatus for manufacturing molten iron 9000 comprises an apparatus for manufacturing compatecd iron 500 and a melter-gasifier 60. Here, the melter-gasifier 60 receives lump coals or coal briquettes and compacted irons to manufacture molten iron. In addition, the apparatus for manufacturing molten iron 9000 may further comprise a powder storage bin 200, a crusher 400, and a storage vessel 600. The powder storage bin 200 stores powder. Further, the crusher 400 receives compacted irons from the apparatus for manufacturing compacted iron 500 to crush the compacted irons. The storage vessel 60 temporarily stores the crushed compacted irons and then supplies the stored compacted irons to the melter-gasifier 700. The detailed structure of the melter-gasifer 60 can be easily understood by those skilled in the art to which the present invention pertains, and a detailed description thereof will be omitted.

[0042] As shown in FIG. 6, the lump coals or coal briquettes supplied to the melter-gasifier 60 serve as a heat source for smelting the compacted irons while being heated by oxygen. Thus, the compacted irons are smelted to manufacture molten iron.

[0043] Although the present invention has been described in the above description, it will be easily understood by those skilled in the art to which the present invention pertains that various changes and modification can be made without departing from the concepts and ranges of the following claims.

[0044] While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the

spirit and scope of the appended claims.

Claims

1. An apparatus for manufacturing compacted iron, comprising:

   a roll core comprising a shaft; and
   a roll tyre surrounding a circumference of the roll core and having a recess on a surface thereof applied such that compacted irons are manufactured by compressing powder to the compacted irons,
   wherein a cooling passage through which a cooling fluid applied to cool the roll tyre flows is formed on border surfaces where the roll tyre and the roll core contact each other, and
   at least one sealing groove located in parallel to the cooling passage to be spaced apart from the cooling passage and applied to seal the border surfaces is formed on the border surfaces.

2. The apparatus for manufacturing compacted iron of claim 1, wherein the at least one sealing groove comprises a pair of sealing grooves, and the cooling passage is located between the pair of sealing grooves.

3. The apparatus for manufacturing compacted iron of claim 2, wherein a sealing material is filled in the sealing groove.

4. The apparatus for manufacturing compacted iron of claim 3, wherein the sealing material comprises a rubber.

5. The apparatus for manufacturing compacted iron of claim 4, wherein the sealing material further comprises graphite.

6. The apparatus for manufacturing compacted iron of claim 4, wherein the melting point of the sealing material is 600°C to 800°C.

7. The apparatus for manufacturing compacted iron of claim 2, wherein the sealing groove is formed along a surface of the roll core in a circumferential direction of the roll core.

8. The apparatus for manufacturing compacted iron of claim 7, wherein
   the sealing groove comprises:

   a central part recessed toward the roll tyre; and
   a pair of steps formed on opposite sides of the central part and convexly formed toward the roll tyre.

9. The apparatus for manufacturing compacted iron of claim 8, wherein a ratio of the radius of curvature of the central part to the radius of curvature of one step of the pair of steps is 4 to 10.

10. The apparatus for manufacturing compacted iron of claim 8, wherein directions in which the pair of steps face are inclined toward an imaginary plane including the center of the central part in directions crossing a direction along which the shaft extends.

11. The apparatus for manufacturing compacted iron of claim 7, wherein
    the roll core comprises:

    at least one first sealing passage extending in a direction crossing a direction along which the shaft extends and connected to the sealing groove; and
    at least one second sealing passage extending in a direction parallel to the direction along which the shaft extends and connected to the first sealing passage, one end of the at least one second sealing passage being formed on a side surface of the roll core.

12. The apparatus for manufacturing compacted iron of claim 11, wherein the sealing material for filling the sealing groove is applied to be compulsorily fed through the first sealing passage and the second sealing passage.

13. The apparatus for manufacturing compacted iron of claim 11, wherein the at least one second sealing passage includes a plurality of second sealing passages and the plurality of second sealing passages are spaced apart from each other by a regular interval.

14. The apparatus for manufacturing compacted iron of claim 11, further comprising:

    a cap coupled to the end of the second sealing passage to seal the end of the second sealing passage.

15. The apparatus for manufacturing compacted iron of claim 14, wherein a threaded groove is formed at the end of the second sealing passage and the cap is coupled to the threaded groove.

16. An apparatus for manufacturing molten iron, comprising:

    an apparatus for manufacturing compacted iron; and
    a melter-gasifer for receiving compacted irons from the apparatus for manufacturing compact-

ed iron to manufacture molten iron,
wherein the apparatus for manufacturing compacted iron comprises:

a roll core comprising a shaft; and
a roll tyre surrounding a circumference of the roll core and having a recess on a surface thereof applied such that compacted irons are manufactured by compressing powder to the compacted irons, and
wherein a cooling passage through which a cooling fluid applied to cool the roll tyre flows is formed on border surfaces where the roll tyre and the roll core contact each other, and at least one sealing groove located in parallel to the cooling passage and spaced apart from the cooling passage and applied to seal the border surfaces is formed on the border surfaces.

FIG. 1

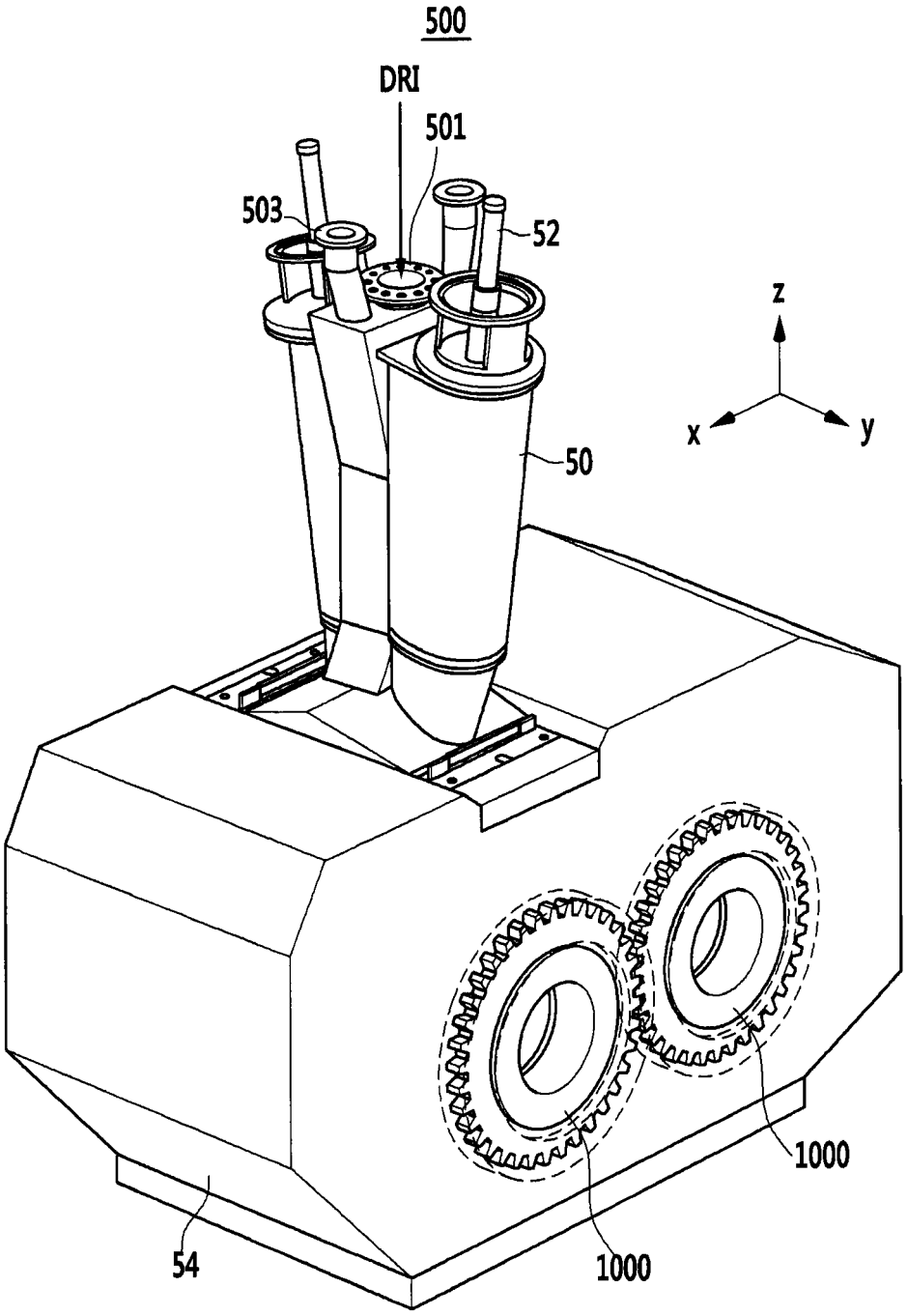


FIG. 2

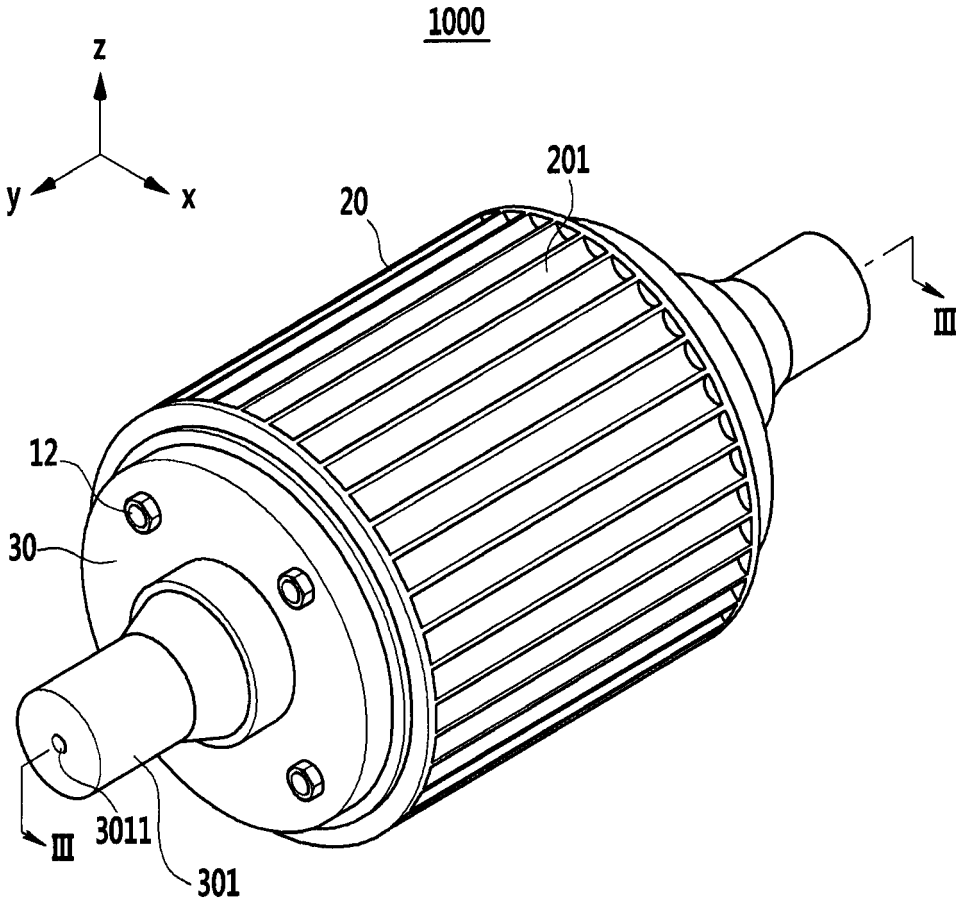


FIG.3

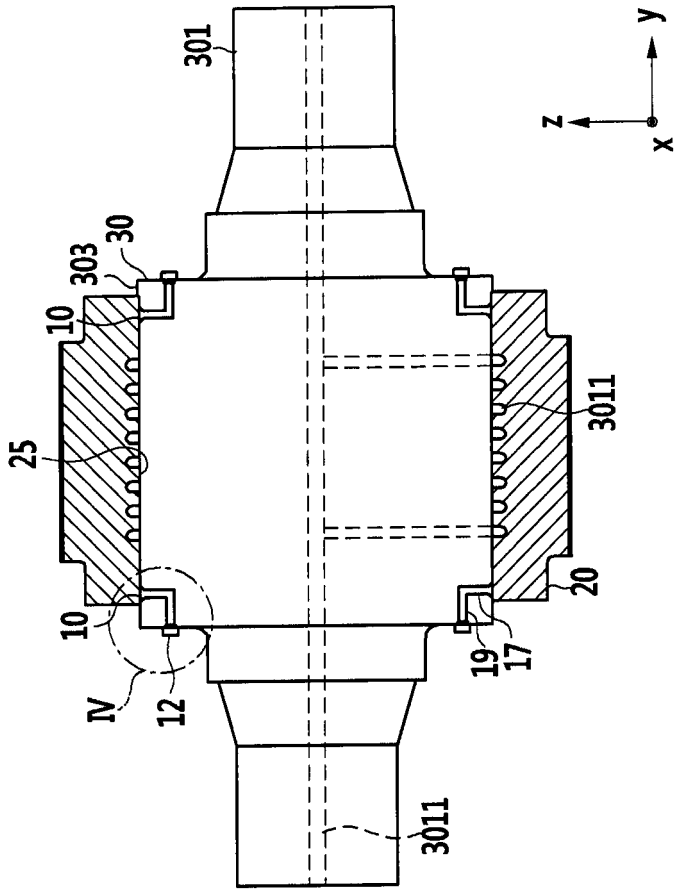


FIG.4

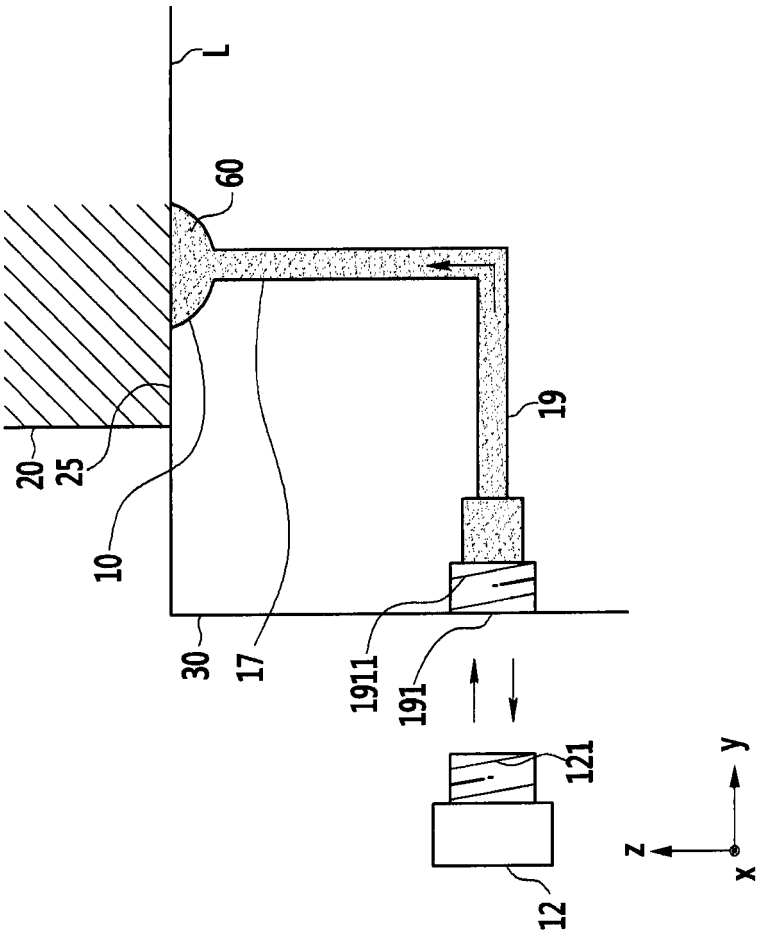


FIG.5

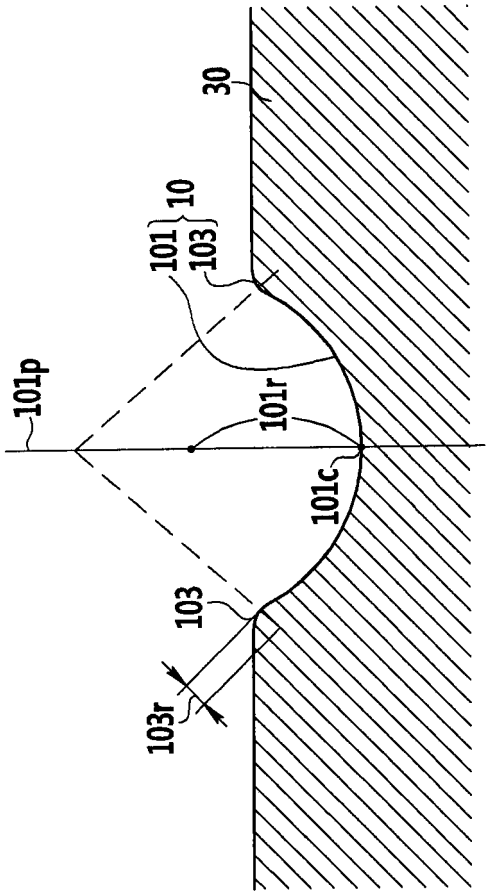
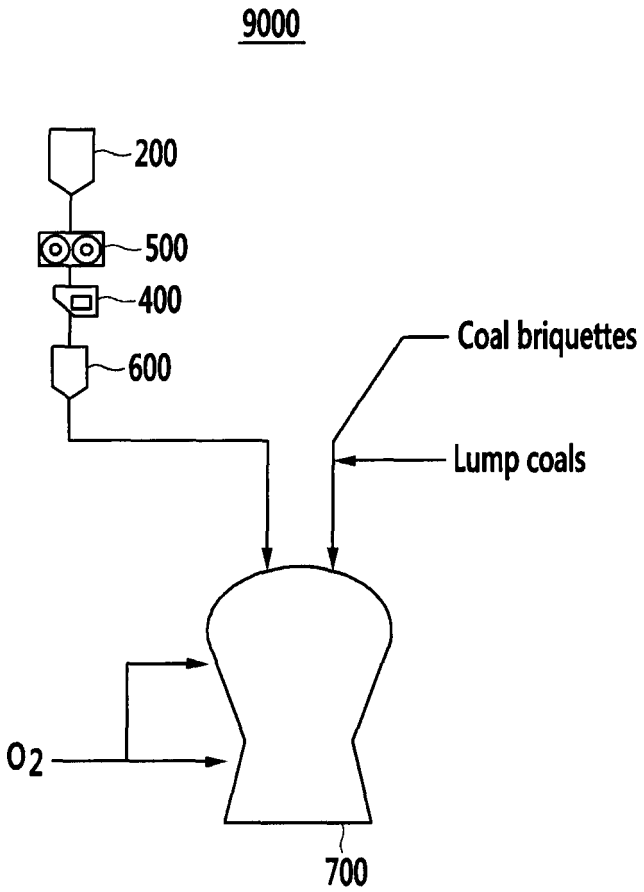


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2010/004098

A. CLASSIFICATION OF SUBJECT MATTER

C22B 1/16(2006.01)i

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)

C22B 1/16; C22B 1/248; C21B 13/00; C21B 11/00; B22D 11/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

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

eKOMPASS (KIPO internal) & Keywords: roll, cooling, sealing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-0784150 B1 (POSCO) 10 December 2007	1-16
A	KR 10-2006-0061485 A (POSCO) 08 June 2006	1-16
A	KR 10-2002-0063850 A (VOEST-ALPINE INDUSTRIEANLAGENBAU GMBH) 05 August 2002	1-16
A	JP 59-133334 A (MITSUBISHI HEAVY IND LTD) 31 July 1984	1-16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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