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LOW-PRESSURE CASTING APPARATUS

Abstract

A low-pressure casting apparatus includes a lower mold disposed on a holding furnace, an upper mold configured to be raised and lowered relative to the lower mold, and a plurality of side molds disposed above the lower mold. A cavity is formed between the lower mold, the upper mold and the side molds. The lower mold includes a lower cast main part forming an inner bottom surface of the cavity, and a lower mold base part holding the lower cast main part. The lower cast main part has a sprue bushing that opens into the cavity. At least one of the side molds is advanceable and retractable relative to a mold center. The lower mold base part has guide pillars that restrict advanced positions of the side molds. The horizontal adjustment gap is provided between the lower cast main part and the lower mold base part.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a U.S. national stage application of International Application No. PCT/JP2022/019520, filed on May 2, 2022.

BACKGROUND
Technical Field
[0002] The present invention relates to an improvement to a low-pressure casting apparatus.
Background Technology
[0003] An example of a prior-art low-pressure casting apparatus is described in Japanese Laid-Open Patent Application No. 2007-319891 (hereinafter referred to as Patent Citation 1). The low-pressure casting apparatus described in Patent Citation 1 comprises a lower mold disposed above a holding furnace, an upper mold that can be raised and lowered relative to the lower mold, and a plurality of horizontal molds that can be advanced and retracted above the lower mold with respect to a mold center. In the low-pressure casting apparatus, a cavity is formed between the lower mold, the lowered upper mold, and the advanced horizontal molds. The lower mold has a sprue that communicates with a stalk.
[0004] After the molds have been closed in the low-pressure casting apparatus, the inside of the holding furnace is pressurized, whereby molten metal in the holding furnace is passed through the stalk and the sprue and filled into the cavity. The low-pressure casting apparatus solidifies the molten metal in the cavity by cooling, and then opens the molds to release a cast article.
SUMMARY
[0005] Generally, in a low-pressure casting apparatus comprising a lower mold, an upper mold, and a horizontal mold, guide pillars that restrict an advanced position of the horizontal mold are disposed on the lower mold, and the temperature of the lower mold, which has a sprue, correspondingly increases. Therefore, in a prior-art low-pressure casting apparatus, the lower mold is prone to thermal expansion in the horizontal direction, and when thermal expansion occurs, positions of the guide pillars are displaced toward the outside of the molds, causing the advanced position of the horizontal mold to shift forward. As a result, in a prior-art low-pressure casting apparatus, there is a risk that a clearance-exceeding gap will be formed, particularly between the upper mold and the horizontal mold, and overcoming such drawbacks has been a problem.
[0006] The present invention was devised with focus on the problems with the prior art described above, it being an object of the invention to provide a low-pressure casting apparatus in which excessive gaps between casts caused by thermal expansion of the lower mold can be prevented, and improvements in mold-closing accuracy can be realized.
[0007] A low-pressure casting apparatus according to the present invention comprises a lower mold disposed over a holding furnace, an upper mold that can be raised and lowered relative to the lower mold, and a plurality of side molds disposed over the lower mold, a cavity being formed between the lower mold, the upper mold, and the side molds. The lower mold includes a lower cast main part that forms an inner bottom surface of the cavity, and a lower mold base part that holds the lower cast main part. The lower cast main part has sprue bushes that open into the cavity. At least one of the side molds can advance and retract relative to a mold center, and the lower mold base part has guide pillars that restrict advanced positions of the advanceable and retractable side molds. The low-pressure casting apparatus is characterized in that a horizontal adjustment gap is provided between the lower cast main part and the lower mold base part.
[0008] When casting is performed in the low-pressure casting apparatus comprising the configuration described above, the lower cast main part, which has the sprue bushes, correspondingly increases in temperature, and the lower cast main part thermally expands mainly in a horizontal direction. As a countermeasure, the lower mold of the low-pressure casting apparatus

is divided into the lower cast main part and the lower mold base part and the adjustment gap is provided therebetween; therefore, the thermal expansion of the lower cast main part is absorbed by the adjustment gap, and thermal deformation of the lower mold base part is minimized. As a result, in the low-pressure casting apparatus, displacement of the guide pillars in the lower mold base part is prevented and the proper advanced positions of the advanceable and retractable side molds are ensured, and there will not be excessive gaps larger than clearance between the side molds and the upper mold.

[0009] Due to employing the configuration described above, the low-pressure casting apparatus according to the present invention can prevent excessive gaps between casts caused by thermal expansion of the lower mold, and can realize improvement in mold-closing accuracy.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Referring now to the attached drawings which form a part of this original disclosure, selected embodiments are illustrated.

[0011] FIG. **1** is a plan view of a lower cast in an open state in a first embodiment of a low-pressure casting apparatus according to the present invention;

[0012] FIG. **2** is a vertical cross-sectional view of a mold-open state;

[0013] FIG. **3** is a plan view, continuing from FIG. **1**, of a lower cast in a mold-closed state;

[0014] FIG. **4** is a vertical cross-sectional view, continuing from FIG. **2**, of a mold-closed state;

[0015] FIG. **5** is a vertical cross-sectional view of a mold-open state in a second embodiment of the low-pressure casting apparatus according to the present invention;

[0016] FIG. **6** is a plan view of a lower cast in a mold-open state;

[0017] FIG. **7** is a vertical cross-sectional view, continuing from FIG. **5**, of a mold-closed state;

[0018] FIG. **8** is a vertical cross-sectional view of a mold-closed state in a third embodiment of the low-pressure casting apparatus according to the present invention; and

[0019] FIG. **9** is an explanatory circuit diagram of a suction mechanism of the low-pressure casting apparatus shown in FIG. **8**.

DETAILED DESCRIPTION OF EMBODIMENTS

First Embodiment

[0020] A low-pressure casting apparatus shown in FIGS. **1** and **2** comprises a lower mold **1** disposed on a holding furnace **50**, an upper mold **2** that can be raised and lowered relative to the lower mold **1**, and a plurality (four in the illustrated example) of side molds **3** to **6** disposed on the lower mold **1**. In the low-pressure casting apparatus, a cavity **7**, which is a casting space, is formed between the lower mold **1**, the upper mold **2**, and the plurality of side molds **3** to **6**, as shown in FIGS. **3** and **4**. FIGS. **2** and **4** show only side molds **3** and **5**, which are disposed on the left and right in the drawings.

[0021] The holding furnace **50**, although not shown in detail, is a well-known type that stores molten metal and comprises a stalk which is a passage filled with the molten metal, an internal pressurizing mechanism, and the like.

[0022] The lower mold **1** comprises a lower cast main part **1**A that forms an inner bottom surface of the cavity **7**, and a lower mold base part (die base) **1**B that holds the lower cast main part **1**A. The lower cast main part **1**A in the illustrated example describes a square shape in a plan view, and four sprue bushes **8** are arranged vertically and horizontally in the center. Lower parts of each of the sprue bushes **8** communicate with the stalk of the holding furnace **50**, and upper parts open into the cavity **7**.

[0023] In the lower mold **1** in the illustrated example, an outer periphery of the lower cast main part **1**A has a downward-oriented step, the lower mold base part **1**B has an upward-oriented step on

an inner periphery of a portion accommodating the lower cast main part **1**A, and the steps engage with one another. This allows the lower cast main part **1**A and the lower mold base part **1**B to be combined such that upper surfaces thereof are continuous in the same plane, and a horizontal adjustment gap S is provided therebetween.

[0024] The upper mold **2** integrally has an upper cast main part **2**A that forms an inner upper surface of the cavity **7** and an upper mold base part **2**B, the upper mold **2** can be raised and lowered by a drive mechanism (not shown), and the upper mold **2** comprises a mold release plate **9** provided with a plurality of mold release pins **9**A passing vertically through the upper cast main part **2**A. The mold release plate **9** can be raised and lowered by another drive mechanism separate from the drive mechanism of the upper mold.

[0025] At least one of the side molds **3** to **6** of the low-pressure casting apparatus according to the present invention can be advanced and retracted relative to a mold center. The side molds **3** to **6** of the illustrated example have side cast main parts **3**A-**6**A that form an inner side surface of the cavity **7** and plates **3**B to **6**B disposed on back surfaces of the side cast main parts **3**A to **6**A. The side molds **3** to **6** are disposed on the four sides of the cavity **7**, and can all be advanced and retracted relative to the mold center by a drive mechanism (not shown). The side molds **3** to **6** are disposed in positions corresponding to the sides of the square-shaped lower cast main part **1**A.

[0026] By contrast, the lower mold base part **1**B of the lower mold **1** has guide pillars **10** that restrict the advanced positions of the advanceable and retractable side molds **3** to **6**, the guide pillars **10** being located at positions between adjacent side molds **3** to **6**, outward of the four corners of the square-shaped lower cast main part **1**A. When the side molds **3** to **6** have been advanced toward the mold center from the state shown in FIG. **1**, the guide pillars **10** restrict the advanced positions of the side molds **3** to **6** due to contact being made therewith by the plates **3**B to **6**B of the side molds **3** to **6** as shown in FIG. **3**.

[0027] In the low-pressure casting apparatus having the configuration described above, by advancing the side molds **3** to **6** and lowering the upper mold **2** from the mold-open state shown in FIGS. **1** and **2**, the mold-closed state shown in FIGS. **3** and **4** is achieved and the cavity **7** is formed. The low-pressure casting apparatus then fills the cavity **7** with the molten metal in the holding furnace **50** through the stalk and the sprue bushes **8** by increasing pressure in the holding furnace **50** and reducing pressure in the cavity **7** as appropriate. After the molten metal has solidified, the molds are opened as shown in FIGS. **1** and **2**, the mold release plate **9** is lowered relative to the upper mold **2**, and the mold release pins **9**A are caused to protrude from the upper mold **2** to release a cast article.

[0028] In the low-pressure casting apparatus during the casting described above, the lower cast main part **1**A, which has the sprue bushes **8**, correspondingly increases in temperature, and the lower cast main part **1**A thermally expands in the horizontal direction. As a countermeasure, in the low-pressure casting apparatus, the lower mold **1** is divided into the lower cast main part **1**A and the lower mold base part **1**B and the adjustment gap S is provided therebetween; therefore, the thermal expansion of the lower cast main part **1**A can be absorbed by the adjustment gap S and thermal deformation of the lower mold base part **1**B is minimized.

[0029] As a result, in the low-pressure casting apparatus, displacement of the guide pillars **10** in the lower mold base part **1**B is prevented, proper advanced positions of the advanceable and retractable side molds **3** to **6** can be ensured due to the guide pillars **10**, and there will be no gaps larger than the clearance between the lower mold **1** and the side molds **3** to **6** or between the side molds **3** to **6** and the upper mold **2**.

[0030] Thus, in the low-pressure casting apparatus, excessive gaps between casts due to thermal expansion of the lower mold **1** can be prevented, and an improvement in mold-closing accuracy can be realized. As a result, in the low-pressure casting apparatus, an improvement in dimensional accuracy of the cast articles can be realized along with the improvement in mold-closing accuracy, and it is possible to reduce the quantity of puncture defects particularly in casting using aluminum

as a material.
[0031] FIGS. **5** to **9** illustrate second and third embodiments of the low-pressure casting apparatus according to the present invention. In the following embodiments, the same components as those in the first embodiment are denoted by the same symbols, and detailed descriptions thereof are omitted.
Second Embodiment
[0032] The low-pressure casting apparatus shown in FIGS. **5** and **6** comprises a plurality (two in the illustrated example) of combinations of a lower mold **1**, an upper mold **2**, and a plurality of side molds **3** to **6**. In this case, the lower mold **1** has two lower cast main parts **1**A, but the lower mold base part **1**B is shared. The upper mold **2** is divided into an upper cast main part **2**A and an upper mold base part **2**B that form an internal upper surface of a cavity **7**, and the upper mold base part **2**B holds the upper cast main part **2**A such that the upper cast main part **2**A can move back and forth in the direction in which the side molds **3** to **6** are aligned.
[0033] The upper cast main part **2**A of the illustrated example can move back and forth in the direction in which the side molds **3** and **5** are aligned, which is the left-right direction in the drawings. The upper cast main part **2**A is connected to the upper mold base part **2**B by an elastic body or a slidable structure of recesses and protrusions, such as grooves and ridges. In this case, the range in which the upper cast main part **2**A moves back and forth should be a range that allows for mold-closing. In the upper cast main part **2**A and the upper mold base part **2**B, insertion holes for the mold release pins **9**A are formed into long holes in cross section in order to allow relative movement with the mold release pins **9**A.
[0034] Furthermore, the low-pressure casting apparatus comprises a center base **11** on which at least one of the side molds is positioned. The center base **11** is a structure extending from between two upper mold base parts **2**B, **2**B to a lower mold **1**, and the center base **11** positions two side molds **3** and **5** of which the back surfaces face each other, i.e., a right side mold **5** in the right-side group in FIG. **5** and a left side mold **3** in the left-side group in FIG. **5**.
[0035] The center base **11** may be configured to be capable of being raised and lowered via a drive mechanism (not shown), and by causing a recess **11**A provided at a lower end of the center base to engage with a protrusion **1**C of the lower mold base part **1**B, the center base **11** is positioned in the horizontal direction.
[0036] In the low-pressure casting apparatus, the center base **11** and the side molds **5** and **3** positioned by the center base **11** are separated from each other so that an adjustment shim **12** can be interposed therebetween. In other words, the opposing surfaces of the center base **11** and the side molds **3** and **5** are flat, and an adjustment shim **12** in the form of a flat plate can be interposed between the opposing surfaces.
[0037] The center base **11** can also constitute a center mold that includes the side molds **3** and **5**. In this case, as with the lower mold **1** and the upper mold **2** described above, the side molds **3** and **5** are equivalent to side cast main parts (**3**A and **5**A) that form the inner side surfaces of the cavity **7**, and the center base **11** is equivalent to a center mold base part. This results in a structure in which the center mold is divided into side cast main parts (**3** and **5**) and center mold base part (**11**), and an adjustment shim **12** can be interposed therebetween.
[0038] In the low-pressure casting apparatus comprising the above configuration, as in the first embodiment, due to the adjustment gaps S provided between the lower cast main parts **1**A and **1**A and the lower mold base part **1**B in the lower mold **1**, thermal expansion of the lower cast main parts **1**A and **1**A can be absorbed to minimize thermal expansion of the lower mold base part **1**B, and shifting of the positions of the guide pillars **10** and the advanced positions of the advanceable and retractable side molds **3**, **4** and **6** can be prevented to satisfactorily maintain mold-closing accuracy.
[0039] In the low-pressure casting apparatus described above, the upper molds **2** are divided into upper cast main parts **2**A and upper mold base parts **2**B, the upper mold base parts **2**B are pushed

against the center base **11**, and the upper cast main parts **2**A can move back and forth relative to the upper mold base parts **2**B.

[0040] This allows the upper cast main parts **2**A of the low-pressure casting apparatus to move in opposite directions (the directions of the arrows) relative to the center base **11** during mold closing as shown in FIG. **7**; therefore, the upper cast main parts **2**A can be corrected to the proper mold-closing positions and further improvement in mold-closing accuracy can be realized.

[0041] Furthermore, by using the center base **11** and the adjustment shim **12** for positioning the two side molds **3** and **5** in the low-pressure casting apparatus described above, the positions of the side molds **3** and **5** can be adjusted, the other side molds and the upper cast main parts **2**A can be closed with the fixed side molds **3** and **5** as a reference, and further improvement in mold-closing accuracy can therefore be realized.

[0042] Furthermore, in the low-pressure casting apparatus described above, the use of the center base **11** eliminates the need for drive mechanisms to position the side molds **3** and **5**, and the entire apparatus can therefore be made smaller than when a plurality of casting apparatuses are simply arranged side by side.

Third Embodiment

[0043] The low-pressure casting apparatus shown in FIG. **8** has the same basic configuration as that of the second embodiment (FIGS. **5** to **7**). Exhaust passages P for discharging air in the cavity **7** are located between the lower mold **1** and the side molds **3** and **5**, and a suction mechanism **60** is provided to suction air out of the cavity **7** through the exhaust passages P.

[0044] Well-known chill vents may be used for the exhaust passages P. The suction mechanism **60**, as shown in FIG. **9**, has two exhaust pipes **61**A and **61**B, each connected to a respective exhaust passage P of the low-pressure casting apparatus. The exhaust pipes **61**A and **61**B are connected to a suction source **62** constituted of a vacuum pump or a vacuum tank, pressure adjustment valves V**1**, V**2** and exhaust valves V**3** are provided partway along the exhaust pipes, and the suction source **62** and the valves V**1**-V**3** are controlled on the basis of values measured by pressure gauges M**1**, M**2** for the cavities **7** and **7**.

[0045] As described in the first and second embodiments, the low-pressure casting apparatus comprising the above configuration has favorable mold-closing accuracy, and it is therefore possible to differentiate between the exhaust passages P and the general clearance between molds. As a result, the low-pressure casting apparatus has no unnecessary gaps between molds, so the air in the cavity **7** can be intentionally suctioned out and discharged to a favorable degree using the exhaust passages P, and a degree of vacuum in the cavity **7** can be increased without enclosing the entire casting apparatus in a large housing. The low-pressure casting apparatus also enables low-pressure casting using a multi-cavity mold, and can favorably produce thin-walled castings.

[0046] The configuration of the low-pressure casting apparatus according to the present invention is not limited to only the embodiments above; changes can be made as appropriate within a range that does not deviate from the scope of the invention, and the present invention can naturally also be applied to castings or the like using a core.

Claims

1. A low-pressure casting apparatus comprising: a lower mold disposed on a holding furnace; an upper mold configured to be raised and lowered relative to the lower mold; and a plurality of side molds disposed above the lower mold, a cavity being formed between the lower mold, the upper mold, and the side molds, the lower mold including a lower cast main part forming an inner bottom surface of the cavity, and a lower mold base part holding the lower cast main part, the lower cast main part having a sprue bushing that opens into the cavity, at least one of the side molds being advanceable and retractable relative to a mold center, the lower mold base part having guide pillars that restrict advanced positions of the advanceable and retractable side molds, and a horizontal

adjustment gap being provided between the lower cast main part and the lower mold base part.

2. The low-pressure casting apparatus according to claim 1, further comprising a plurality of combinations of the lower mold, the upper mold, and the plurality of side molds, the upper mold including an upper cast main part that forms an inner upper surface of the cavity, and an upper mold base part that holds the upper cast main part such that the upper cast main part is configured to move back and forth in a direction in which the side molds are aligned.

3. The low-pressure casting apparatus according to claim 2, further comprising a center base that positions at least one of the side molds, the center base and the side mold positioned by the center base being separated from each other such that an adjustment shim can be interposed therebetween.

4. The low-pressure casting apparatus according claim 1, wherein exhaust passages for discharging air in the cavity are located between the upper mold and the side molds, and a suction mechanism is provided to suction air out of the cavity through the exhaust passages.

5. The low-pressure casting apparatus according to claim 1, wherein the lower cast main part has a downward-oriented step on an outer periphery thereof, the lower mold base part has an upward-oriented step on an inner periphery of a portion accommodating the lower case main part, and the steps of the lower cast main part and the lower mold base part engage with one another.