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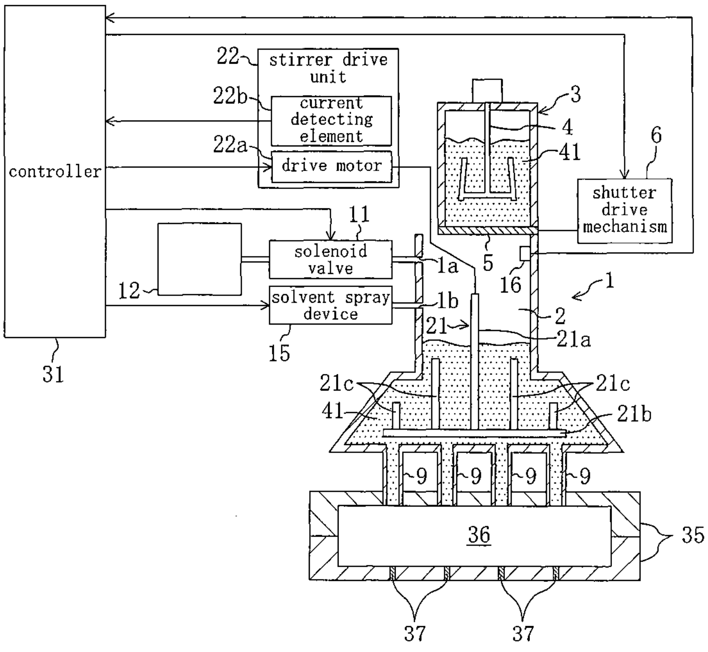
(54) Casting mold making method and casting mold making system

(57) In blowing gas-curing casting sand **41,** which is accommodated in a receiver **2** of a blow head **1,** into a cavity **36** in molding dies **35** and thereby packing it into the cavity **36,** prior to the blowing and packing of the casting sand **41** into the cavity **36,** the casting sand **41** in the receiver **2** is stirred by a stirrer **21** until the stirring resistance of the stirrer **21** enters a predetermined range (a range corresponding to an optimum bulk density range of casting sand within which casting sand **41** can efficiently blow out through blow nozzles **9**).

FIG. 1



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Description

BACKGROUND OF THE INVENTION

(a) Field of the Invention

[0001] This invention relates to the technical field of a casting mold making method and system in which gas-curing casting sand is blown and packed into a cavity created by molding dies.

(b) Description of the Related Art

[0002] In a well-known casting mold making method, such as disclosed in Published Japanese Patent Application No. H03-47647, gas-curing casting sand containing a binder (a phenol resin and a polyisocyanate compound) and a solvent (such as toluene) is previously accommodated in a blow head, the casting sand is blown and packed through the blow nozzles into a cavity in molding dies by feeding pressurized gas into the blow head and a curing gas (such as triethylamine gas) is then introduced into the cavity to cure the casting sand packed in the cavity, thereby making a casting mold.

[0003] In another known casting mold making method, such as disclosed in Published Japanese Patent Application No. 2001-225148, casting sand in a blow head (a hopper) is suspended and fluidized by air, lumps of the casting sand are broken up by passing them through a cutter and the casting sand is then blown and packed into the cavity by pressurized air.

[0004] Gas-curing casting sand as described above has a sticky particle surface owing to the binder. Therefore, the bulk density of gas-curing casting sand in the blow head greatly varies. This makes it difficult to ensure a constantly good packability of casting sand into the cavity.

[0005] To cope with this, it can be considered, as disclosed in the above Published Japanese Patent Application No. 2001-225148, to suspend and fluidize casting sand by air, break up casting sand lumps through the cutter and then blow and pack the casting sand into the cavity.

[0006] However, if the latter method is applied to gas-curing casting sand, the following problems may occur. When air is blown to casting sand in order to suspend and fluidize it, the solvent adhering to the surfaces of the sand particles together with the binder is blown off by the air to increase the concentration of the binder on the sand particle surface and thereby accelerate the curing reaction of the casting sand. Thus, the casting sand is cured prior to its packing into the cavity of the molding dies, thereby degrading the quality of a casting mold to be formed. Furthermore, when lumps of the casting sand are passed through the cutter in order to break them up, the solvent coated on the sand particles is highly likely to be reduced.

SUMMARY OF THE INVENTION

[0007] The present invention has been made in view of the foregoing points and, therefore, its object is to blow and pack gas-curing casting sand into a cavity created by molding dies while ensuring good, constant packability without curing the casting sand prior to the packing into the cavity.

[0008] To attain the above object, in the present invention, casting sand in a blow head is stirred with a stirrer prior to its blowing and packing into the cavity until the stirring resistance of the stirrer enters within a predetermined range.

[0009] Specifically, a method for making a casting mold of the present invention comprises: a blowing and packing step of feeding pressurized gas into a receiver that is provided in a blow head and accommodates gas-curing casting sand, thereby blowing the casting sand in the receiver into a cavity in molding dies through a blow nozzle that is provided in the blow head and communicates with the receiver and packing the casting sand into the cavity; a curing step of, after the blowing and packing step, introducing curing gas into the cavity to cure the casting sand packed in the cavity; and a stirring step of, before the blowing and packing step, stirring the casting sand in the receiver with a stirrer until the stirring resistance of the stirrer enters within a predetermined range.

[0010] Thus, prior to the blowing and packing of casting sand into the cavity, the casting sand in the receiver is stirred and unstiffened. If the bulk density of casting sand thus stirred is too high, the casting sand clogs the blow nozzle and thereby becomes difficult to get out of the blow nozzle. On the contrary, if the casting sand is excessively unstiffened to reach an excessively small bulk density, only the pressurized gas quickly blows out through the blow nozzle and, also in this case, the casting sand becomes difficult to get out of the blow nozzle. In other words, there exists an optimum bulk density range within which casting sand can efficiently blow out through the blow nozzle. On the other hand, if casting sand in the receiver is not stirred, its bulk density is generally higher than the optimum bulk density range. In addition, as the number of blowing and packing steps carried out increases, the bulk density of casting sand becomes higher and higher owing to pressures applied from pressurized gas. To avoid this, prior to the blowing and packing step, casting sand in the receiver is stirred by the stirrer to bring the bulk density of casting sand into the optimum bulk density range. Specifically, the stirring resistance of the stirrer is in correspondence with the bulk density of casting sand so that as the bulk density increases, the stirring resistance becomes higher. Therefore, if a range of stirring resistances corresponding to the optimum bulk density range is set to the predetermined range and casting sand is stirred until the stirring resistance enters within the predetermined range, the optimum bulk density range is reached. Thus, in the blowing and packing step, casting sand is constantly well packed into the cavity. Furthermore, in the stirring step, casting sand is simply stirred without using air or a cutter and the solvent coated on the sand particles is not reduced. This is rather preferable because the binder, the solvent and sand are further uniformly mixed.

[0011] In the above casting mold making method, preferably, the stirring step, the blowing and packing step and the curing step are sequentially repeated and the predetermined range is set in each stirring step. More preferably, the predetermined range is set based on the amount of casting sand in the receiver in each stirring step.

[0012] Thus, the predetermine range can be appropriately set based on the amount of casting sand in the receiver in each stirring step. Specifically, when the blowing and packing step is carried out once, the amount of casting sand in the receiver is reduced by the amount of casting sand packed into the cavity. If in this case no casting sand is supplementally fed into the receiver, the amount of casting sand in the receiver in the next stirring step differs from that in the previous stirring step. If the amount of casting sand changes thus, the relation between the bulk density of casting sand and the stirring resistance of the stirrer also changes. However, since in the present invention the range of stirring resistances corresponding to the optimum bulk density range can be set to the predetermined range, this provides good, constant packability in every stirring step.

[0013] Furthermore, in the above casting mold making method, preferably, the casting sand contains a binder and a solvent and the method further comprises a solvent feed step of, before or during the stirring step, supplementally feeding the solvent into the receiver.

[0014] Thus, particularly in repeating the stirring step, the blowing and packing step and the curing step, the solvent coated on the sand particles can be prevented from being reduced. Specifically, in the blowing and packing step, pressurized air is fed into the receiver in order to blow and pack casting sand into the cavity, whereby the solvent on the sand particles is blown away and reduced to a certain extent by the pressurized gas. However, since in the present invention the amount of solvent reduced can be supplementally fed, this prevents the quality of a produced casting mold from being degraded. Even if the solvent is supplementally fed thus, the binder, the solvent and sand can be stirred uniformly by stirring in the stirring step, which avoids that the solvent becomes locally excessive in the receiver.

[0015] A casting mold making system of the present invention includes a blow head having a receiver for accommodating gas-curing casting sand and a blow nozzle communicating with the receiver and a pressurized gas feed system for feeding pressurized gas into the receiver of the blow head and is configured to feed pressurized gas into the receiver through the pressurized gas feed system and thereby blow the casting sand in the receiver through the blow nozzle into the cavity and pack the casting sand into the cavity. The casting mold making system further comprises: a stirrer for stirring the casting sand in the receiver; a stirrer drive unit for driving the stirrer; a stirring resistance detection device for detecting the stirring resistance of the stirrer; and an operation controller for controlling the operation of the stirrer drive unit, the operation controller being configured to, prior to the feeding of pressurized gas into the receiver through the pressurized gas feed system, operate the stirrer drive unit until the stirring resistance detected by the stirring resistance detection device enters within a predetermined range.

[0016] Preferably, the above casting mold making system further comprises a casting sand amount detection device for detecting the amount of casting sand in the receiver, wherein the operation controller is configured to set the predetermined range based on the amount of casting sand detected by the casting sand amount detection device.

[0017] Furthermore, in the above casting mold making system, preferably, the casting sand contains a binder and a solvent, the casting mold making system further comprises a solvent spray device for supplementally feeding, under the control of the operation controller, the solvent into the receiver by spraying, and the operation controller is configured to, before or during the operation of the stirrer drive unit, operate the solvent spray device to supplementally feed the solvent into the receiver.

[0018] According to the above configurations of the casting mold making system, the above casting mold making method can be easily implemented and the same operations and effects as according to the above casting mold making method can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Figure **1** is a schematic block diagram showing a casting mold making system according to an embodiment of the present invention.

Figure **2** is a graph showing the relation between the bulk density of casting sand in a receiver and the kinetic energy of casting sand blown out through blow nozzles.

Figure **3** is a graph showing the relation between the bulk density of casting sand in the receiver and the stirring resistance of a stirrer.

Figure **4** is a flowchart showing a processing procedure of a controller.

DETAILED DESCRIPTION OF THE INVENTION

[0020] An embodiment of the present invention will be described below with reference to the drawings.

[0021] Figure **1** schematically shows a casting mold making system according to an embodiment of the present invention. The casting mold making system is a cold box casting mold making system including a blow head **1** with a receiver **2** for accommodating gas-curing casting sand **41**. The casting sand **41** contains a binder composed of a phenol resin and a polyisocyanate compound and a solvent so that the surfaces of sand particles are coated with the binder and the solvent. Examples of the phenol resin in the binder include phenol resins having at least one benzyl ether group in its molecule, novolak resins and their derivative resins. Examples of the polyisocyanate compound include diphenylmethane diisocyanate, hexamethylene diisocyanate and 4,4'-dicyclohexylmethane diisocyanate. The solvent is an organic solvent including aliphatic hydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons, halogenated hydrocarbons, ketones, esters, ethers and alcohols, or their mixtures.

[0022] The casting sand **41** is fed from a kneading unit **3** disposed above the receiver **2** to the receiver **2**. Specifically, the binder, the solvent and sand are charged into the kneading unit **3** and uniformly kneaded by a kneader **4** driven into rotation in the kneading unit **3**, thereby providing casting sand **41** in which sand particles are coated with the binder and the solvent as described above. A shutter **5**, opened and closed by a shutter drive mechanism **6**, is disposed between the receiver **2** and the kneading unit **3**. The operation of the shutter drive mechanism **6** is controlled by a controller **31**. When the shutter **5** is opened by the shutter drive mechanism **6**, the casting sand **41** falls down from the kneading unit **3** by its own weight and is fed to the receiver **2**.

[0023] The bottom of the blow head **1** is provided with a plurality of blow nozzles **9**, communicated with the receiver **2**, for blowing out casting sand **41** in the receiver **2** therethrough. The blow nozzles **9** are presented to a cavity **36** created by a plurality of molding dies **35** set up below the casting mold making system. Casting sand **41** blown out through the blow nozzles **9** is packed into the cavity **36** to have a shape of a casting mold to be made by the casting mold making system. Casting molds made by the casting mold making system include casting molds for cylinder blocks or cylinder heads and cores for water jackets of the cylinder heads.

[0024] An upper portion of any one of the side walls defining the receiver **2** in the blow head **1** is formed with an air feed port **1a** through which pressurized air serving as pressurized gas is fed into the receiver **2.** The air feed port **1a** is connected to an air tank **12** through a solenoid valve **11** whose actuation is controlled by the controller **31**. The air tank **12** is supplied with air in the factory while the air to the air tank **12** is kept at a constant pressure (about 0.2 MPa to about 1 MPa) by a regulator (not shown). The air supplied is stored as the pressurized air in the air tank **12**. When the solenoid valve **11** is actuated, the pressurized air in the air tank **12** is fed into the receiver **2**, whereby casting sand **41** in the receiver **2** is blown through the blow nozzles **9** into the cavity **36** in the molding dies **35** and packed into the cavity **36**. Thus, the solenoid valve **11**, the air tank **12** and the controller **31** constitute pressurized gas feed system for feeding pressurized gas into the receiver **2**. The pressurized air, blown into the cavity **36** together with the casting sand **41**, is vented out of the cavity **36** through air vents **37** attached to the bottom of the molding die **35**.

[0025] An upper portion of any one of the side walls defining the receiver **2** is formed with a solvent feed port **1b** through which the solvent is supplementally fed into the receiver **2.** The solvent feed port **1b** is connected to a solvent spray device **15** for supplementally feeding the solvent into the receiver **2** by spraying it. The operation of the solvent spray device **15** is controlled by the controller **31** and operates prior to the actuation of a drive motor **22a** of the after-mentioned stirrer drive unit **22** to supplementally feed a given amount of solvent into the receiver **2** by spraying. Specifically, the last time when casting sand **41** was blown and packed into the cavity **36**, the solvent on the sand particles has been blown away and reduced to a certain extent by pressurized air. Therefore, the solvent is supplementally fed into the receiver **2** by substantially the same amount as the amount of solvent reduced.

[0026] An upper part of the interior of the receiver **2** of the blow head **1** is provided with a casting sand amount sensor **16** serving as a casting sand amount detection device for detecting the amount of casting sand **41** in the receiver **2**. In this embodiment, the casting sand amount sensor **16** is configured to emit infrared rays downward, receive infrared rays reflected from the top surface of the casting sand **41** and detect the amount of casting sand **41** in the receiver **2** based on the intensity of the reflected infrared rays. However, any appropriate sensors having other configurations can also be employed. Data on the amount of casting sand **41** in the receiver **2** detected by the casting sand amount sensor **16** is input to the controller **31**.

[0027] Furthermore, a lower part of the interior of the receiver **2** of the blow head **1** is provided with a stirrer **21** for stirring casting sand **41** in the receiver **2**. The stirrer **21** is an element for unstiffening casting sand **41** to bring it to an optimum bulk density as described later. The stirrer **21** is composed of a rotary shaft **21a** vertically extending and rotatably supported, a base plate **21b** fixed to the lower end of the rotary shaft **21a** and extending horizontally, and a plurality of stirring bars **21c** disposed on the base plate **21b**. The upper end of the rotary shaft **21a** is connected to the stirrer drive unit **22**. The stirrer drive unit **22**, whose detailed configuration is not described here, includes a drive motor **22a**, a connecting member made, for example, of flexible wire and connecting the rotary shaft of the drive motor **22a** to the rotary shaft **21a**, and a drive circuit for driving the drive motor **22a**. The drive circuit includes a current detecting element **22b** for detecting the value of current flowing into the drive motor **22a**.

[0028] The operation of the drive motor **22a** of the stirrer drive unit **22** is controlled by the controller **31**. Specifically, the controller **31** constitutes an operation controller for controlling the operation of the drive motor **22a**

of the stirrer drive unit **22**. During operation of the drive motor **22a**, data on the value of current detected by the current detecting element **22b** is input to the controller **31**.

[0029] The controller **31** is configured to, prior to the blowing and packing of casting sand **41** in the receiver **2** into the cavity **36**, operate the drive motor **22a** until the stirring resistance of the stirrer **21** enters within a predetermined range. In this embodiment, the stirring resistance of the stirrer **21** is detected by the current detecting element **22b**. Specifically, the value of current of the drive motor **22a** is in correspondence with the motor torque required to rotate the stirrer **21**, i.e., the stirring resistance of the stirrer **21**, so that as the stirring resistance of the stirrer **21** increases, the value of current of the drive motor **22a** increases. Therefore, a predetermined range of current values is previously set corresponding to the predetermined range of stirring resistances and the drive motor **22a** is operated until the value of current detected by the current detecting element **22b** enters within the predetermined range of current values. Thus, the current detecting element **22b** constitutes a stirring resistance detection device for detecting the stirring resistance of the stirrer **21**.

[0030] The predetermined range of stirring resistances, i.e., the predetermined range of current values, is set at a range within which casting sand **41** in the receiver **2** can efficiently blow out through the blow nozzles **9**. In this respect, the relation between the bulk density of casting sand **41** in the receiver **2** and the kinetic energy thereof blown out through the blow nozzles **9** was examined by changing the bulk density of casting sand **41** in the receiver **2** while keeping the amount thereof constant. The kinetic energy was determined from the mass of the casting sand **41** in the receiver **2** and the velocity of it blown out through the blow nozzles **9**. The examination results are shown in Figure **2**. Figure **2** indicates that there exists a bulk density range within which the kinetic energy reaches the maximum value or near the maximum value, in other words, an optimum bulk density range within which casting sand **41** efficiently blows out through the blow nozzles **9**. The reason for this is as follows. If the bulk density of casting sand **41** is excessively high, casting sand **41** clogs the blow nozzles **9** and thereby becomes difficult to get out of the blow nozzles **9**. On the other hand, if casting sand **41** is excessively unstiffened to reach an excessive low bulk density, only pressurized air quickly blows out through the blow nozzles **9** and, also in this case, casting sand **41** becomes difficult to get out of the blow nozzles **9**.

[0031] Furthermore, the relation between the bulk density of casting sand **41** and the stirring resistance of the stirrer **21** (the motor torque of the drive motor) was also examined. The examination results are shown in Figure **3**. Figure **3** indicates that the stirring resistance of the stirrer **21** is in correspondence with the bulk density of casting sand **41** so that as the bulk density increases, the stirring resistance also increases. Therefore, the blowing of casting sand **41** into the cavity **36** will do well if a range of stirring resistances corresponding to the optimum bulk density range is set at the above-described predetermined range of stirring resistances. A range of current values corresponding to the predetermined range of stirring resistance can be set at the above-described predetermined range of current values.

[0032] The optimum bulk density range varies depending upon the amount of casting sand **41** in the receiver **2**. Therefore, the amount of casting sand **41** in the receiver **2** is detected by the casting sand amount sensor **16**. Specifically, an examination is previously made of the relation between the amount of casting sand **41** and the optimum bulk density range (i.e., the predetermined range of current values), the examination results are mapped in a table and the table is stored in the controller **31**. When receiving data on the amount of casting sand **41** from the casting sand amount sensor **16** during operation of the casting mold making system, the controller **31** sets, based on the table, a predetermined range of current values corresponding to the detected amount of casting sand **41**.

[0033] When the amount of casting sand **41** detected by the casting sand amount sensor **16** reaches below a predetermined amount, i.e., when the remaining amount of casting sand **41** gets too low to provide enough to pack casting sand **41** into the cavity **36**, the controller **31** actuates the shutter drive mechanism **6** to feed casting sand **41** from the kneading unit **3** into the receiver **2**.

[0034] Next, a processing procedure of the controller **31** is described with reference to the flowchart of Figure **4**.

[0035] In the first step S1, the solvent spray device **15** is operated to supplementally feed the given amount of solvent into the receiver **2** by spraying it. In the next step S2, a predetermined range of current values is set. Specifically, the predetermined range of current values is set based on the amount of casting sand **41** in the receiver **2** detected by the casting sand amount sensor **16** and the table.

[0036] Subsequently, the drive motor **22a** of the stirrer drive unit **22** is operated in step S3 and it is then determined in step S4 whether the value of current detected by the current detecting element **22b** is within the predetermined range of current values.

[0037] If the determination in step S4 is NO, the procedure goes back to step S3. If the determination in step S4 is YES, the procedure goes to step S5 to stop the drive motor **22a** and then goes to step S6 to actuate the solenoid valve **11** and thereby feed pressurized air in the air tank **12** into the receiver **2**.

[0038] In the next step S7, it is determined whether the amount of casting sand **41** detected by the casting sand amount sensor **16** is smaller than the predetermined amount. In the determination in step S7 is NO, the procedure ends. If the determination in step S7 is YES, the procedure goes to step S8 to actuate the shutter drive mechanism 6 and then ends.

[0039] Next, a description is given of a method for making a casting mold using the above casting mold making system.

[0040] First, the molding dies **35** are set up in the casting mold making system and the casting mold making system is activated by switch operation or in other manners. Thus, the given amount of solvent is supplementally fed into the receiver **2** (a solvent feed step). Then, the base plate **21b** of the stirrer **21** rotates about the rotary shaft **21a**, whereby the plurality of stirring bars **21c** on the base plate **21b** stir the casting sand **41** in the receiver **2** to unstiffen it (a stirring step). During the stirring, the binder, the solvent (including supplementally fed solvent) and sand in the receiver **2** are uniformly mixed. At the beginning of operation of the stirrer **21**, the bulk density of casting sand **41** in the receiver **2** is usually higher than the optimum bulk density range. However, with increasing duration of stirring of the stirrer **21**, the bulk density gradually decreases and then reaches the optimum bulk density range. When the optimum bulk density range is reached, the value of current detected by the current detecting element **22b** enters within the predetermined range of current values and the operation of the stirrer **21** is stopped.

[0041] Subsequently, pressurized air in the air tank **12** is fed into the receiver **2**, whereby casting sand **41** in the receiver **2** is blown through the blow nozzles **9** into the cavity **36** in the molding dies **35** and packed into it (a blowing and packing step). Since the bulk density of casting sand **41** has been set, prior to the blowing and packing step, at the optimum bulk density range within which casting sand **41** can efficiently blow out through the blow nozzles **9**, the casting sand **41** is well packed into the cavity **36** in the blowing and packing step.

[0042] After the blowing and packing step, in this embodiment, the molding dies **35** are moved to an unshown curing gas introduction device disposed separately from the blow head **1** in order to introduce curing gas into the cavity **36** in the molding dies **35**, and placed in the curing gas introduction device. Then, curing gas (such as triethylamine gas) is introduced into the cavity **36** to cure the casting sand **41** packed in the cavity **36** (a curing step), thereby completing the making of a high-quality casting mold.

[0043] Then, the molding dies **35** may be set up again in the casting mold making system in order to make another casting mold. In this case, when the casting mold making system is activated again, the solvent feed step, the stirring step and the blowing and packing step are similarly sequentially carried out. The solvent on the sand particles, however, has been blown away and reduced to a certain extent by pressurized air in the previous blowing and packing step. Therefore, in this solvent feed step, the solvent is supplementally fed by substantially the same amount as the amount of solvent reduced.

[0044] Then, in the next stirring step, the binder, the solvent (including supplementally fed solvent) and sand in the receiver **2** are further uniformly mixed. Furthermore, the amount of casting sand **41** generally becomes smaller than that in the previous stirring step (but becomes larger when casting sand **41** is fed from the kneading unit **3** into the receiver **2**). Therefore, in such cases, the optimum bulk density range (the predetermined range of current values) corresponding to the amount of casting sand **41** is set again. In this manner, in each stirring step, the optimum bulk density range (the predetermined range of current values) is set based on the amount of casting sand **41** in the receiver **2**. In each stirring step, the bulk density of casting sand **41** in the receiver **2** at the beginning of the stirring step is higher than the optimum bulk density range owing to the pressure applied from pressurized air in the previous blowing and packing step but the bulk density thereof at the end of the stirring step enters within the optimum bulk density range corresponding to the amount of casting sand **41**. Thus, in the next blowing and packing step, the casting sand **41** can be well packed into the cavity **36**. After the blowing and packing step, similarly, the curing step is carried out. If the above steps are repeated in this manner, a large number of casting molds can be made.

[0045] When the amount of casting sand **41** in the receiver **2** becomes smaller than the predetermined amount after the blowing and packing step, the shutter drive mechanism **6** is actuated to put the shutter **5** to an open position, whereby casting sand **41** is fed from the kneading unit **3** into the receiver **2**.

[0046] As described above, in this embodiment, casting sand **41** is stirred by the stirrer **21** prior to the blowing and packing of casting sand **41** into the cavity **36**, whereby the bulk density of casting sand **41** enters within the optimum bulk density range within which casting sand **41** can efficiently blow out through the blow nozzles **9**. Therefore, casting sand **41** can be constantly well packed into the cavity **36**.

[0047] Furthermore, since in the stirring step casting sand **41** is simply stirred without using air or a cutter, the solvent on the sand particles is not reduced in the stirring step. Although the solvent on the sand particles is reduced to a certain extent in the previous blowing and packing step, the amount of solvent thus reduced is supplementally fed by operating the solvent spray device **15**. This prevents the quality of a produced casting mold from being degraded.

[0048] Although in the above embodiment the stirring resistance of the stirrer **21** is detected by the current detecting element **22b** for detecting the value of current flowing into the drive motor **22a** of the stirrer drive unit **22**, the manner of detecting the stirring resistance of the stirrer **21** is not limited to this. For example, the stirrer **21** may be provided with a torque sensor and its stirring resistance may be detected by the torque sensor.

[0049] Although in the above embodiment the amount of casting sand **41** is detected by the casting sand amount sensor **16** in each stirring step, the casting sand amount sensor **16** may not be used, for example, in the case of making a large number of casting molds of the same configuration. Specifically, in this case, the amount of casting sand **41** reduced in a single blowing and packing step is substantially constant. On the basis of this fact, if after every given times of the blowing and packing step a given amount of casting sand **41** (i.e., the given times multiplied by the amount of casting sand reduced in a single blowing and packing step) is fed from the kneading unit **3** into the receiver **2**, the respective amounts of casting sand **41** in the respective stirring steps in the given times can be determined. Therefore, if the controller **31** stores the respective optimum bulk density ranges (the respective predetermined ranges of current values) corresponding to the respective amounts of casting sand **41** in the respective stirring steps, a large number of casting molds of the same configuration can be made without using the casting sand amount sensor **16**.

[0050] Furthermore, although in the above embodiment the solvent is supplementally fed into the receiver **2** prior to the stirring step, the solvent may be supplementally fed during the stirring step. Just after casting sand **41** is fed from the kneading unit **3** into the receiver **2** by the actuation of the shutter drive mechanism **6**, the solvent may not be fed or the amount of solvent fed may be small. Alternatively, the solvent feed step antecedent to each stirring step may not be eliminated. This should not be a serious problem because the amount of solvent reduced in each blowing and packing step is very small.

Claims

1. A method for making a casting mold, comprising:

a blowing and packing step of feeding pressurized gas into a receiver (2) that is provided in a blow head (1) and accommodates gas-curing casting sand (41), thereby blowing the casting sand in the receiver into a cavity (36) in molding dies (35) through a blow nozzle (9) that is provided in the blow head and communicates with the receiver and packing the casting sand into the cavity;
a curing step of, after the blowing and packing step, introducing curing gas into the cavity to cure the casting sand packed in the cavity; and
a stirring step of, before the blowing and packing step, stirring the casting sand in the receiver with a stirrer (21) until the stirring resistance of the stirrer enters within a predetermined range.

2. The method of claim 1, wherein
the stirring step, the blowing and packing step and the curing step are sequentially repeated, and
the predetermined range is set in each stirring step.

3. The method of claim 2, wherein the predetermined range is set based on the amount of casting sand in the receiver in each stirring step.

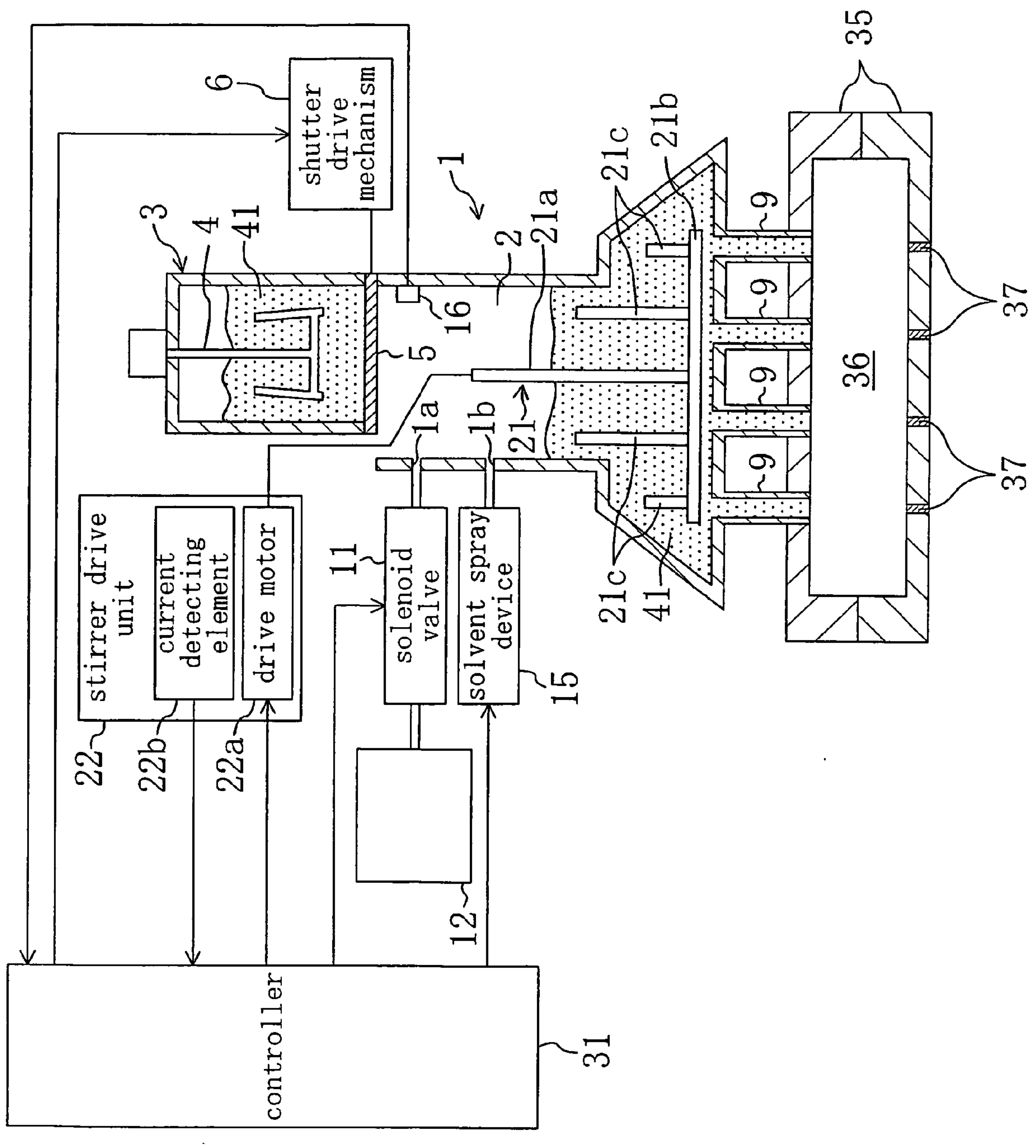
4. The method of any of claims 1 to 3, wherein
the casting sand contains a binder and a solvent, and the method further comprises a solvent feed step of, before or during the stirring step, supplementally feeding the solvent into the receiver.

5. A casting mold making system including a blow head (1) having a receiver (2) for accommodating gas-curing casting sand (41) and a blow nozzle (9) communicating with the receiver and a pressurized gas feed system (11, 12, 31) for feeding pressurized gas into the receiver of the blow head and configured to feed pressurized gas into the receiver through the pressurized gas feed system and thereby blow the casting sand in the receiver through the blow nozzle into a cavity (36) in molding dies (35) and pack the casting sand into the cavity, the casting mold making system further comprising:

a stirrer (21) for stirring the casting sand in the receiver;
a stirrer drive unit (22) for driving the stirrer;
a stirring resistance detection device (22b) for detecting the stirring resistance of the stirrer; and
an operation controller (31) for controlling the operation of the stirrer drive unit, the operation controller being configured to, prior to the feeding of pressurized gas into the receiver through the pressurized gas feed system, operate the stirrer drive unit until the stirring resistance detected by the stirring resistance detection device enters within a predetermined range.

6. The casting mold making system of claim 5, further comprising
a casting sand amount detection device (16) for detecting the amount of casting sand in the receiver,
wherein the operation controller is configured to set the predetermined range based on the amount of casting sand detected by the casting sand amount detection device.

7. The casting mold making system of claim 5 or 6, wherein
the casting sand contains a binder and a solvent,
the casting mold making system further comprises a solvent spray device (15) for supplementally feeding, under the control of the operation controller, the solvent into the receiver by spraying, and
the operation controller is configured to, before or during the operation of the stirrer drive unit, operate the solvent spray device to supplementally feed the solvent into the receiver.



shutter drive mechanism
stirrer drive unit
current detecting element
drive motor
solenoid valve
solvent spray device
controller
1
1a
1b
2
3
4
5
6
9
11
12
15
16
21
21a
21b
21c
22
22a
22b
31
35
36
37
41

FIG. 1

FIG. 2

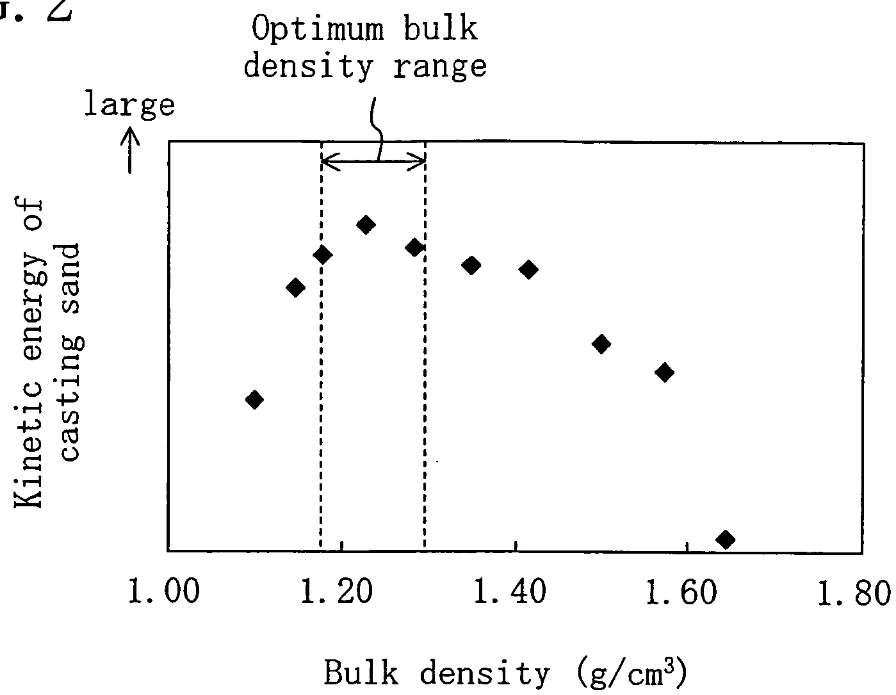

Optimum bulk
density range
large
Kinetic energy of
casting sand
1.00
1.20
1.40
1.60
1.80
Bulk density (g/cm³)

FIG. 3

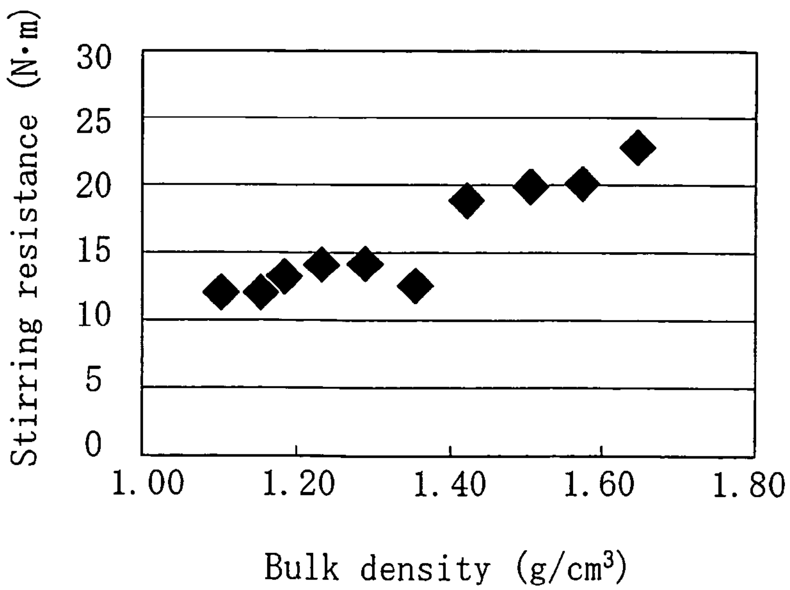
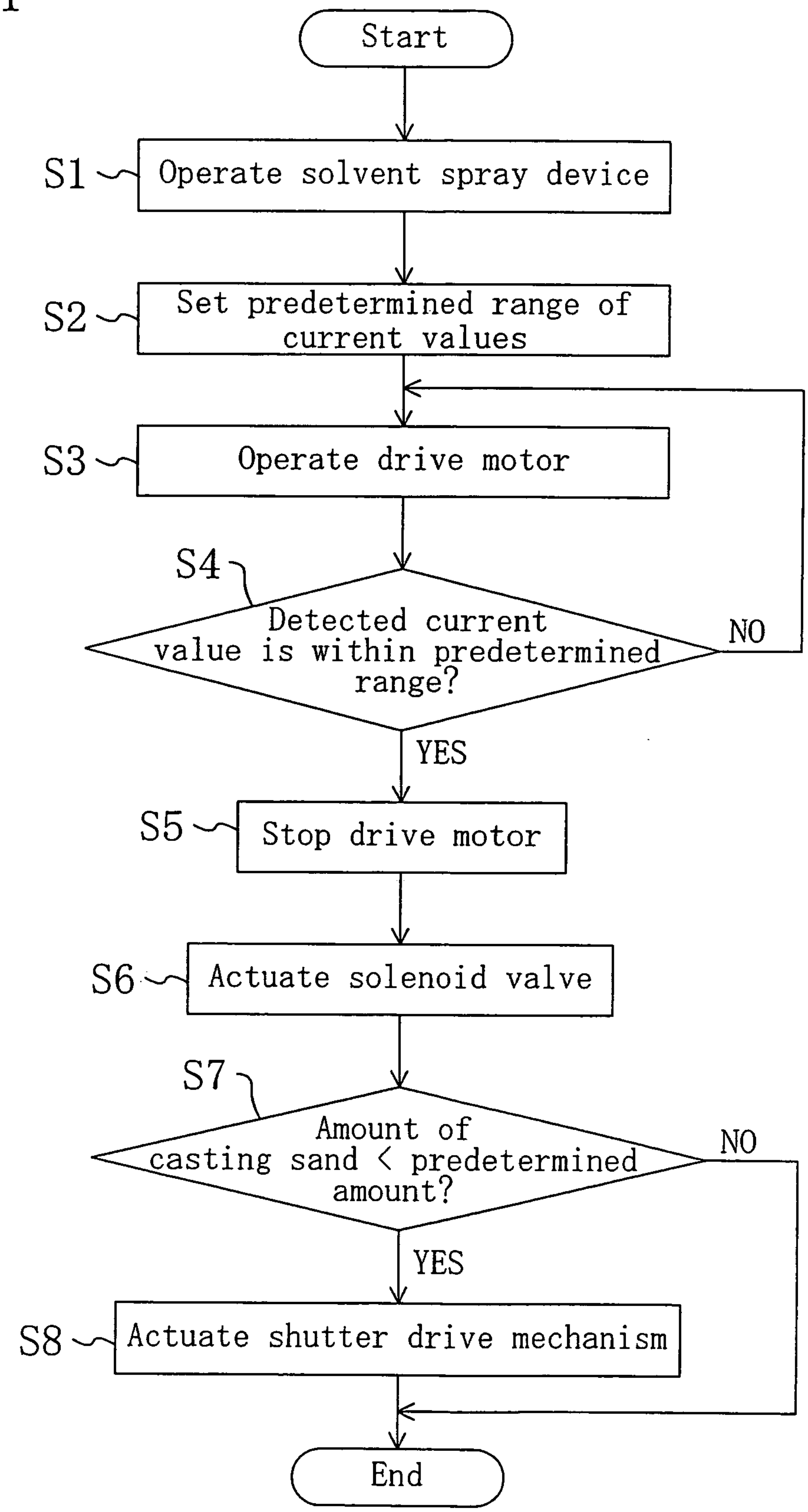

Stirring resistance (N·m)
30
25
20
15
10
5
0
1.00
1.20
1.40
1.60
1.80
Bulk density (g/cm³)

FIG. 4


Start
S1
Operate solvent spray device
S2
Set predetermined range of current values
S3
Operate drive motor
S4
Detected current value is within predetermined range?
NO
YES
S5
Stop drive motor
S6
Actuate solenoid valve
S7
Amount of casting sand < predetermined amount?
NO
YES
S8
Actuate shutter drive mechanism
End

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 00 4056

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 July 2007	Gavriliu, Alexandru

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