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(54) FEEDING DEVICE AND SYSTEM AND HIGH PRESSURE MOULDING METHOD

(57) The invention discloses a feeding device, a feeding system, and a high-pressure molding method that belong to the technical field of casting, the feeding device comprising a locating element for connecting with a sleeve and a knock-off element connected with the locating element, in which: the locating element is in the shape of a disk with a through hole at the center, and a boss extending upwards is provided at the center of the locating element at the location of the through hole; the knock-off element is tube-shaped, with its upper part being cylinder-shaped and lower part being cone-shaped, and the upper part of the knock-off element is interference fitted in the boss of the locating element; the locating element and knock-off element are both made of metal. In present invention, the pressure subjected by the sleeve is reduced by the relative displacement between the locating element and the knock-off element that results from friction, thus achieving an effect of buffering and protecting the sleeve relatively well. The problems of sand loss resulting from the contact and friction between the knock-off core and the sleeve and the sleeve being prone to inclination in the prior art can be avoided in the invention.

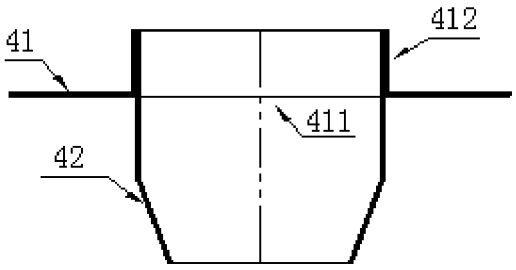

Figure 4

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Description

Technical Field

[0001] The invention relates to the technical field of molding, and in particular to a feeding device, a feeding system, and a high-pressure molding method that uses such feeding device and feeding system.

Background Art

[0002] During casting process, the volume of the vast majority of molten metals will contract during cooling and solidification, which is called shrinkage. If no measures are taken to deal with this phenomenon, defects of shrinkage cavity/porosity will be formed inside the solidified metal castings. To prevent casting defects, it is necessary to ensure that, during the solidification of a casting, supplementary molten metal is available for filling the cavities formed inside the casting as a result of the contraction of the molten metal's volume. This process is called "feeding a casting" and the liquid storage chamber for supplying the molten metal for feeding is called a sleeve. The sleeve needs to be removed from the casting after the shakeout of the casting. To facilitate the removal of the sleeve, a knock-off core (also known as a breaker core) can be provided at the opening of the sleeve, thereby reducing the contact area between the sleeve and the casting and at the same time forming a necking structure between the sleeve and the casting. During the removal of the sleeve, stress is concentrated at the knock-off core's opening, thus facilitating the removal of the sleeve.

[0003] High-pressure molding production line has been in use since the 1960s, and is an efficient molding method. It is a manufacturing method that makes wet molding sands (also called green sands) into sand molds by the advancement of a high-pressure molding plate. This method has the advantages of high productive efficiency and high quality molding, and the obtained castings having excellent surface smoothness and high precision. However, high-pressure molding production line imposes special requirements on sleeves in the feeding process. A sleeve in a sand mold must withstand the molding pressure due to the extrusion on the wet molding sands exerted by the high-pressure molding plate during molding. At the same time, in order to facilitate cutting the sleeve from casting after pouring and to reduce the impact of hot spots formed by the hot sleeve on the structure of the casting , a knock-off core is generally provided at the bottom of the sleeve in contact with the casting.

[0004] Currently, common knock-off cores for sleeves are truncated-cone-shaped knock-off cores and metal knock-off cores.

[0005] A truncated-cone-shaped knock-off core 11 is illustrated in Figure 1. A knock-off opening 13 is provided in the knock-off core. The material of the knock-off core 11 can be coated sand, chromite sand, ceramic materials, or the same material as that of the sleeve 12. The problems with this type of knock-off core during use are: during the process of high-pressure molding, the knock-off core provides almost no buffering for the pressure subjected by the sleeve, and the sleeve itself will still be subjected to the molding pressure due to the extrusion on the wet molding sands exerted by the high-pressure molding plate, thereby being prone to damage and increasing the cost for fabricating the sleeve; the knock-off core is prone to rupture or fragmentation, thus resulting in poor subsequent demolding, and at the same time, sand grains generated by the knock-off core can easily fall into the molding cavity, which, if not cleaned, will cause defects of sand holes and gas porosity in castings.

[0006] A metal knock-off core 21 is illustrated in Figure 2. The upper part of this type of knock-off core is of a circular cylinder shape, while its lower part is circular-cone-shaped. The upper part performs a function of locating and guiding during mounting, whereas the lower part mainly performs a function of narrowing the sleeve neck to facilitate the removal of the sleeve 22. During use, the upper circular cylinder part of the knock-off core is inserted into the inner cavity of the sleeve. Several sand ribs (not illustrated), circumferentially evenly distributed, are provided on the inner wall of the sleeve close to the upper end. The sand ribs perform a function of fixing the knock-off core and achieving the locating of the knock-off core along its axial direction.

[0007] The problems with this type of knock-off core during use are as follows.

(1) During the process of high-pressure molding, while the relative displacement between the knock-off core and the sleeve that results from friction achieves the effect of reducing the pressure subjected by the sleeve, thus performing the function of buffering and protecting the sleeve relatively well, during this process, the sand ribs of the sleeve may be damaged, and the damaged sand grains may enter the molding cavity, which, if not cleaned in time, will cause the defects of sand holes and gas porosity in the molding cavity, rendering the casting unusable.

(2) Such a knock-off core has relatively stringent requirements for the size of the sleeve, and the presence of the sand ribs also makes the shape of the sleeve more complex, thus affecting the productive efficiency and yield rate of the sleeve.

(3) With demolding inclination provided within the inner cavity of the sleeve and the upper part of the knock-off core being of a circular cylinder shape, a poor coaxiality will occur during the insertion-fitting of those two. Therefore, when the high-pressure molding plate extrudes the sand mold, the sleeve is prone to inclination, resulting in poor feeding during casting. Moreover, due to the inclination of the sleeve, the locating rod insertion-fitted within the sleeve also inclines or bends, resulting in poor demolding.

[0008] Another type of metal knock-off core 31 is illustrated in Figure 3. This knock-off core consists of a circular cylinder tube part 311 and a circular cone tube part 312 that are connected to each other up and down. The upper end of the circular cylinder tube part 311 is provided with several cutouts 313 that are arranged circumferentially. During use, the circular cylinder tube part undergoes elastic deformation and contracts towards its center, causing a wedge-type fitting structure formed between the two parts. A knock-off core of this structure also reduces the pressure subjected by the sleeve through the friction effect, thus performing a function of buffering and protecting the sleeve relatively well. Moreover, it is not necessary to provide sand ribs on the inner wall of the sleeve. The problems with this type of knock-off core during use are: although it mitigates the problem of sand loss due to wearing in the knock-off core illustrated in Figure 2, this problem cannot be completely avoided since the fitting between the knock-off core and the sleeve is still interference fit, and at the same time, other problems associated with the knock-off core illustrated in Figure 2 have not been resolved.

Summary of the Invention

[0009] The technical problem that the invention aims to resolve is to provide a feeding device, a feeding system, and a high-pressure molding method that perform a function of buffer protection for a sleeve while avoiding the problems of sand loss caused by the contact and friction between the knock-off core and the sleeve and the sleeve being prone to inclination.

[0010] To resolve the above-mentioned technical problems, the technical solutions provided by the invention are as follows.

[0011] In one aspect, a feeding device is provided, comprising a locating element for connecting with a sleeve and a knock-off element connected with the locating element, in which:

the locating element is in the shape of a disk with a through hole at the center, and a boss extending upwards is provided at the center of the locating element at the location of the through hole;
the knock-off element is tube-shaped, with its upper part being cylinder-shaped and lower part being cone-shaped, and the upper part of the knock-off element is interference fitted in the boss of the locating element;
the locating element and the knock-off element are both made of metal.

[0012] Further, the through hole at the center of the locating element is a circular through hole, the upper part of the knock-off element is of a circular cylinder shape, and the lower part of the knock-off element is of a circular cone shape.

[0013] Further, the transition connection between the upper part of a circular cylinder shape and the lower part of a circular cone shape of the knock-off element is a circular arc.

[0014] Further, the bottom opening of the knock-off element is in the shape of a trapezoid, a square, an oval, a U-shape, or a V-shape.

[0015] In another aspect, a feeding system comprising a sleeve and the above-mentioned feeding device is provided, the locating element of the feeding device is bonded to the opening of the sleeve, the outer diameter of the boss of the locating element is smaller than or equal to the inner diameter of the opening of the sleeve, and the boss of the locating element is located inside the opening of the sleeve.

[0016] Further, the upper end surface of the knock-off element of the feeding device is flush with the upper end surface of the locating element.

[0017] In yet another aspect, a high-pressure molding method is provided which comprises:

Step (1): placing the above-mentioned feeding system at a predetermined location of a mold;
Step (2): pouring enough molding sands into the mold, so that the molding sands cover the feeding system;
Step (3): extruding the molding sands along the axial direction of the sleeve, so that the knock-off element of the feeding device gradually moves towards the inside of the sleeve along the boss of the locating element, until a desired sand mold is obtained.

[0018] Further, during the Step (1), the upper end surface of the knock-off element of the feeding device is flush with the upper end surface of the locating element in the feeding system.

[0019] Further, during the Step (1), in the feeding system, the upper part of the sleeve is provided with a locating hole, and a locating rod is provided on the mold, the locating rod passes through the knock-off element of the feeding device and the sleeve's inner cavity and out of the locating hole;
the bottom opening of the knock-off element of the feeding device is clearance fitted or transition fitted with the locating rod.

[0020] The benefits of the invention include:

During use, the feeding device of the invention is bonded to the opening of the sleeve so that the locating element is flush with the lower end surface of the sleeve and the boss of the locating element is located inside the inner cavity of the sleeve, such that during the production process of high-pressure molding, the pressure subjected by the sleeve is reduced by the relative displacement between the locating element and the knock-off element that results from friction, thus achieving an effect of buffering and protecting the sleeve relatively well; moreover, because both the locating element and the knock-off

element are made of metal, the problem of sand loss resulting from the contact and friction between the knock-off core and the sleeve in the prior art can be avoided in the invention. Also, because the locating element is arranged to be flush with the lower end surface of the sleeve and the boss of the locating element performs the function of guiding the knock-off element, during the process of high-pressure molding, the problem of the sleeve being prone to inclination in the prior art is avoided as well.

Brief Description of the Drawings

[0021]

Figure 1 is a schematic view of a truncated-cone-shaped knock-off core of the prior art in the use state;
Figure 2 is a schematic view of a metal knock-off core of the prior art in the use state;
Figure 3 is a schematic view of the structure of another metal knock-off core of the prior art;
Figure 4 is a schematic view of the cross-sectional structure of a feeding device of the invention;
Figure 5 is an exploded schematic view of the feeding device shown in Figure 4;
Figure 6 is a schematic view illustrating the first status of a feeding system of the invention during the production process of high-pressure molding;
Figure 7 is a schematic view illustrating the second status of a feeding system of the invention during the production process of high-pressure molding.

Detailed Description

[0022] To make clearer the technical problem that the invention aims to resolve, the technical solution and advantages of the invention, detailed description will be made below with reference to the accompanying drawings and specific embodiments.

[0023] In one aspect, the invention provides a feeding device, as illustrated in Figures 4 and 5, comprising a locating element 41 for connecting with a sleeve and a knock-off element 42 for connecting with the locating element 41, in which:

the locating element 41 is in the shape of a disk with a through hole 411 at the center, and a boss 412 extending upwards is provided at the center of the locating element 41 at the location of the through hole 411;
the knock-off element 42 is tube-shaped, with its upper part being cylinder-shaped and the lower part being cone-shaped, and the upper part of the knock-off element 42 is interference fitted in the boss 412 of the locating element 41;
the locating element 41 and the knock-off element 42 are both made of metal, such as carbon steel, stainless steel, ductile iron, aluminum alloy, copper alloy, etc.

[0024] During use, the feeding device of the invention is bonded to the opening of the sleeve so that the locating element is flush with the lower end surface of the sleeve and the boss of the locating element is located inside the inner cavity of the sleeve, such that during high-pressure molding production, the pressure subjected by the sleeve is reduced by the relative displacement between the locating element 41 and the knock-off element 42 that results from friction, thus achieving an effect of buffering and protecting the sleeve relatively well; moreover, because both the locating element 41 and the knock-off element 42 are made of metal, the problem of sand loss resulting from the contact and friction between the knock-off core and the sleeve in the prior art can be avoided in the invention. Also, because the locating element 41 is arranged to be flush with the lower end surface of the sleeve, and the boss 412 of the locating element 41 performs the function of guiding the knock-off element 42, during the process of high-pressure molding, the problem of the sleeve being prone to inclination in the prior art is avoided as well.

[0025] The upper part of the knock-off element 42 of the feeding device of the invention is interference fitted in the boss 412 of the locating element 41. This interference fitting securely connects the locating element 41 and the knock-off element 42 together, and ensures that there would be no relative displacement between those two elements when this feeding device is mounted to the sleeve and during subsequent procedures such as transportation; only when those two elements are subjected to the extrusion exerted by the high-pressure molding plate during the production process of high-pressure molding, friction occurs between those two elements and results in relative displacement between them, thus providing buffering protection for the sleeve.

[0026] In the invention, to facilitate production and processing, the through hole 411 at the center of the locating element 41 is preferably a circular through hole, and correspondingly, the upper part of the knock-off element 42 is of a circular cylinder shape, and the lower part of the knock-off element 42 is of a circular cone shape. Of course, the through hole can also be of a different shape such as a square, which will not affect the implementation of the invention's technical solution. Also, to facilitate production, the transition connection between the upper part of circular cylinder shape and the lower part of circular cone shape of the knock-off element 42 is preferably a circular arc. In addition, the bottom opening of the knock-off element 42 can be of various shapes such as a trapezoid, square, oval, U-shape or V-shape.

[0027] In the invention, the height of the boss 412 of the locating element 41 is preferably set relatively small so as to reduce the contact area between this feeding device and molten metal to reduce the chilling effect of the feeding device to the molten metal. As for the sizes

of various parts of the locating element 41 and the knock-off element 42 (height, thickness, etc.), a person skilled in the art can make case-by-case adjustments based on the invention's principle of providing buffer protection for the sleeve.

[0028] In another aspect, the invention provides a feeding system, as illustrated in Figures 6 to 7, comprising a sleeve and the above-mentioned feeding device. The locating element 41 of the feeding device is bonded to the opening of the sleeve 51. The outer diameter of the boss of the locating element 41 is smaller than or equal to the inner diameter of the opening of the sleeve 51, with the boss of the locating element 41 located inside the opening of the sleeve 51 (i.e., protruding into the inner cavity of the sleeve 51).

[0029] Preferably, as illustrated in Figure 4, the upper end surface of the knock-off element 42 of the feeding device is flush with the upper end surface of the locating element 41 (i.e., the upper end surface of the boss 412), thus making it easy to determine the initial heights of the feeding device and the feeding system comprising the feeding device, thereby making it easy to ensure that in case of multiple sleeves, the necks of the multiple sleeves are of identical height after high-pressure molding, which ensures the effects of the feeding.

[0030] In still another aspect, the invention provides a high-pressure molding method comprising:

Step (1): placing the above-mentioned feeding system at a predetermined location of a mold;

Step (2): pouring enough molding sands into the mold, so that the molding sands cover the feeding system (as illustrated in Figure 6);

Step (3): extruding the molding sands along the axial direction of the sleeve, so that the knock-off element 42 of the feeding device gradually moves towards the inside of the sleeve 51 along the boss of the locating element 41 (the result is as illustrated in Figure 7), until a desired sand mold is obtained.

[0031] The material selection for the sand mold, and the other steps of the high-pressure molding process or the like are the same as those in the prior art, which are not described here.

[0032] In Step (1), the upper end surface of the knock-off element 42 of the feeding device is preferably flush with the upper end surface of the locating element 41 in the feeding system, thus making it easy to determine the initial heights of the feeding device and the feeding system comprising the feeding device, thereby making it easy to ensure that in case of multiple sleeves, the necks of the multiple sleeves are of identical height after high-pressure molding, which ensures the effects of the feeding.

[0033] In Step (1), to facilitate the mounting of the sleeve, the upper part of the sleeve 51 in the feeding system may be provided with a locating hole 53, and a locating rod 52 may be provided on the mold, and then the locating rod 52 may pass through the knock-off element 42 of the feeding device and the inner cavity of the sleeve 51 and out of the locating hole 53.

[0034] The bottom opening of the knock-off element 42 of the feeding device may either be clearance fitted or transition fitted with the locating rod 52, which will not affect the implementation of the invention's technical solution.

[0035] In conclusion, the benefits of the invention are as follows.

(1) In the invention, the pressure subjected by the sleeve is reduced by the relative displacement between the locating element and the knock-off element that results from friction, thus achieving the effect of buffering and protecting the sleeve relatively well; moreover, because both the locating element and the knock-off element are made of metal, sand loss resulting from the direct contact and friction between the knock-off core and the sleeve in the prior art is avoided in the invention.

(2) Because the locating element is arranged to be flush with the lower end surface of the sleeve, and the boss of the locating element performs a function of guiding the knock-off element (and at the same time ensures the coaxiality), the problem of the sleeve being prone to inclination during the production process of high-pressure molding is avoided as well in the invention.

(3) The invention lowers the requirements for the size of the sleeve, and it is not necessary to provide sand ribs on the inner wall of the sleeve, thus simplifying the shape of the sleeve and increasing productive efficiency and yield rate of the sleeve;

(4) The upper end surface of the knock-off element of the feeding device may be flush with the upper end surface of the locating element, thus, compared to the prior art, making it easier to determine the initial heights of the feeding device and the feeding system comprising the feeding device, thereby making it easy to ensure that, in case of multiple sleeves, the necks of the multiple sleeves are of identical height after high-pressure molding, which ensures the effects of the feeding;

(5) In the invention, the height of the boss of the locating element may be set relatively small, so as to reduce the contact area between the feeding device and molten metal to reduce the chilling effect of the feeding device to the molten metal.

[0036] The above descriptions are preferred embodiments of the invention. It should be noted that for those of ordinary skill in the art, a number of improvements and modifications may be made without departing from the principles of the invention, and these improvements and modifications should be considered within the protection scope of the invention.

Claims

1. A feeding device, **characterized in that** it comprises a locating element for connecting with a sleeve, and a knock-off element connected with the locating element, in which:

   the locating element is in the shape of a disk with a through hole at the center, and a boss extending upwards is provided at the center of the locating element at the location of the through hole;
   the knock-off element is tube-shaped, with its upper part being cylinder-shaped and lower part being cone-shaped, and the upper part of the knock-off element is interference fitted in the boss of the locating element;
   the locating element and the knock-off element are both made of metal.

2. The feeding device according to claim 1, **characterized in that** the through hole at the center of the locating element is a circular through hole, the upper part of the knock-off element is of a circular cylinder shape, and the lower part of the knock-off element is of a circular cone shape.

3. The feeding device according to claim 2, **characterized in that** the transition connection between the upper part of a circular cylinder shape and the lower part of a circular cone shape of the knock-off element is a circular arc.

4. The feeding device according to claim 1, **characterized in that** a bottom opening of the knock-off element is in the shape of a trapezoid, a square, an oval, a U-shape, or a V-shape.

5. A feeding system, **characterized in that** it comprises a sleeve and the feeding device of any one of claims 1 to 4, the locating element of the feeding device being bonded to the opening of the sleeve, the outer diameter of the boss of the locating element being smaller than or equal to the inner diameter of the opening of the sleeve, and the boss of the locating element being located inside the opening of the sleeve.

6. The feeding system according to claim 5, **characterized in that** the upper end surface of the knock-off element of the feeding device is flush with the upper end surface of the locating element.

7. A high-pressure molding method, **characterized in that** it comprises:

   Step (1): placing the feeding system of claim 5 at a predetermined location of a mold;
   Step (2): pouring enough molding sands into the mold, so that the molding sands cover the feeding system;
   Step (3): extruding the molding sands along the axial direction of the sleeve, so that the knock-off element of the feeding device gradually moves towards the inside of the sleeve along the boss of the locating element, until a desired sand mold is obtained.

8. The method according to claim 7, **characterized in that**, during the Step (1), the upper end surface of the knock-off element of the feeding device is flush with the upper end surface of the locating element in the feeding system.

9. The method according to claim 7, **characterized in that**, during the Step (1), in the feeding system, the upper part of the sleeve is provided with a locating hole, and a locating rod is provided on the mold, the locating rod passing through the knock-off element of the feeding device and the sleeve's inner cavity and out of the locating hole;
   the bottom opening of the knock-off element of the feeding device is clearance fitted or transition fitted with the locating rod.

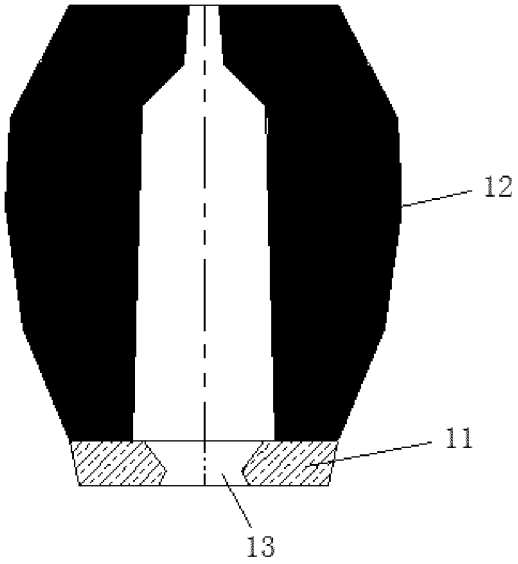

Figure 1

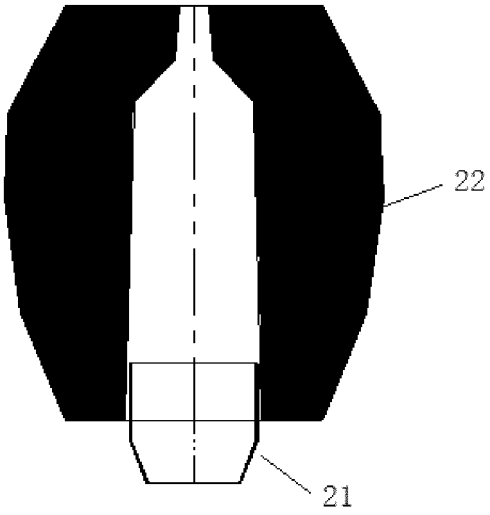

Figure 2

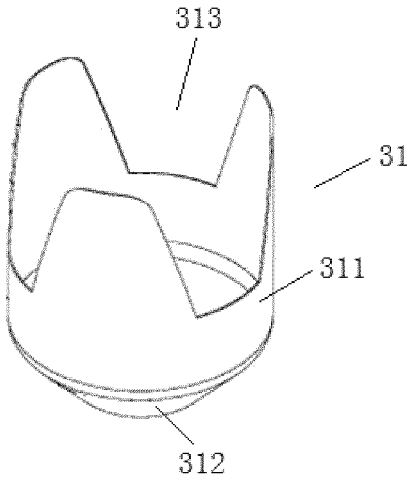

Figure 3

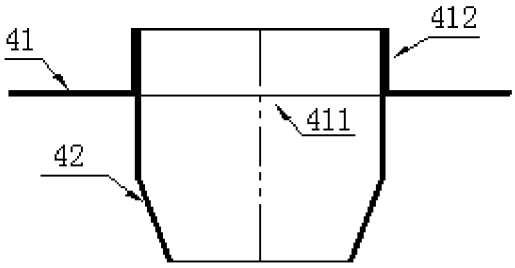

Figure 4

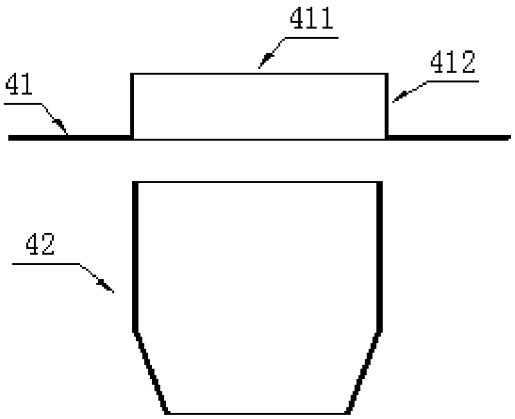

Figure 5

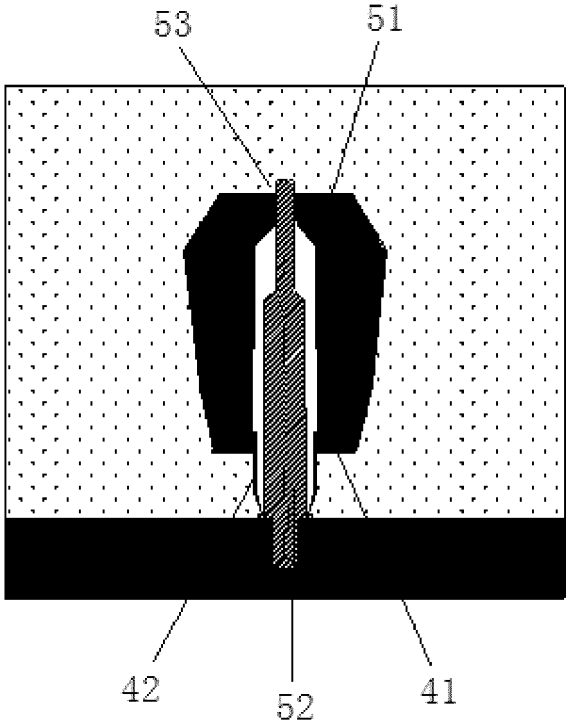

Figure 6

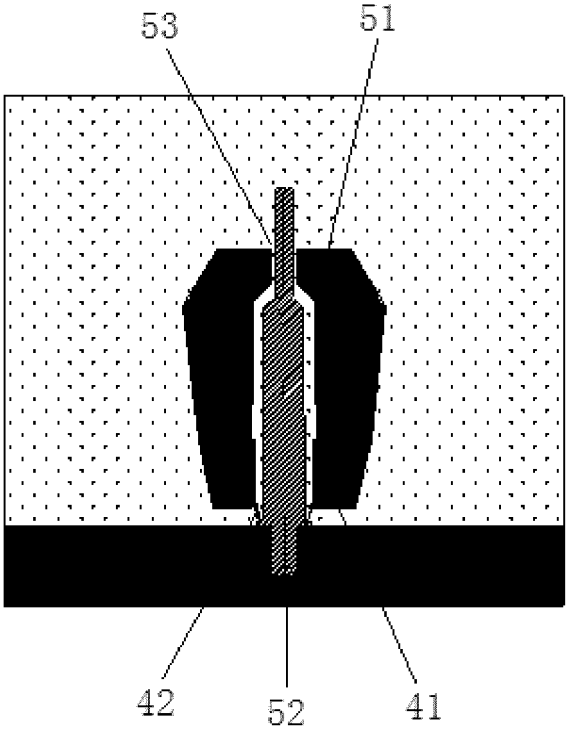

Figure 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/088988

A. CLASSIFICATION OF SUBJECT MATTER

B22C 9/08 (2006.01) i; B22D 31/00 (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)

B22C, B22D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

CNPAT, CNKI, CNTXT, VEN: sprue, feeding, knock-off, fragile, sand mould, riser, feeder, washburn, cut, knock, casting, mold, locat+, convex

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 201702324 U (LIUHE FOUNDRY INDUSTRY (KUNSHAN) CO., LTD.), 12 January 2011 (12.01.2011), see description, paragraphs [0012]-[0013], and figures 1-2	1-9
Y	CN 203541446 U (TIANJIN CACLCO TECHNOLOGY CO., LTD.), 16 April 2014 (16.04.2014), see claims 1-3, and figures 1-2	1-9
Y	CN 104001861 A (CSR CHANGZHOU AUTO PARTS CO., LTD.), 27 August 2014 (27.08.2014), see description, paragraphs [0029]-[0038], and figures 1-5	7-9
A	CN 103551511 A (SHENYANG UNIVERSITY OF TECHNOLOGY), 05 February 2014 (05.02.2014), see the whole document	1-9
A	CN 201030421 Y (DEXING CASTING CO., LTD., JIANGXI COPPER GROUP), 05 March 2008 (05.03.2008), see the whole document	1-9
A	US 4141406 A (FOSECO TRADING AG), 27 February 1979 (27.02.1979), see the whole document	1-9
A	DE 202013104836 U1 (FOSECO INT.), 13 March 2014 (13.03.2014), see the whole document	1-9

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 June 2015 (08.06.2015)	**03 July 2015 (03.07.2015)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **YU, Shu** Telephone No.: (86-10) **62085377**

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