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(54) ROCKER ARM ASSEMBLY, USE OF A ROCKER ARM ASSEMBLY, CASTING MOLD AND CASTING PROCESS

(57) The invention relates to a rocker arm assembly (2) for fixing a core (6), in particular a sand core, inside a casting mold (4), comprising: a first lever (22), and a second lever (24) that is set up to exert pressure on the core (6). The invention also relates to a use of a rocker arm assembly, to a casting mold comprising at least one rocker arm assembly and a casting process using a casting mold with at least one rocker arm assembly.

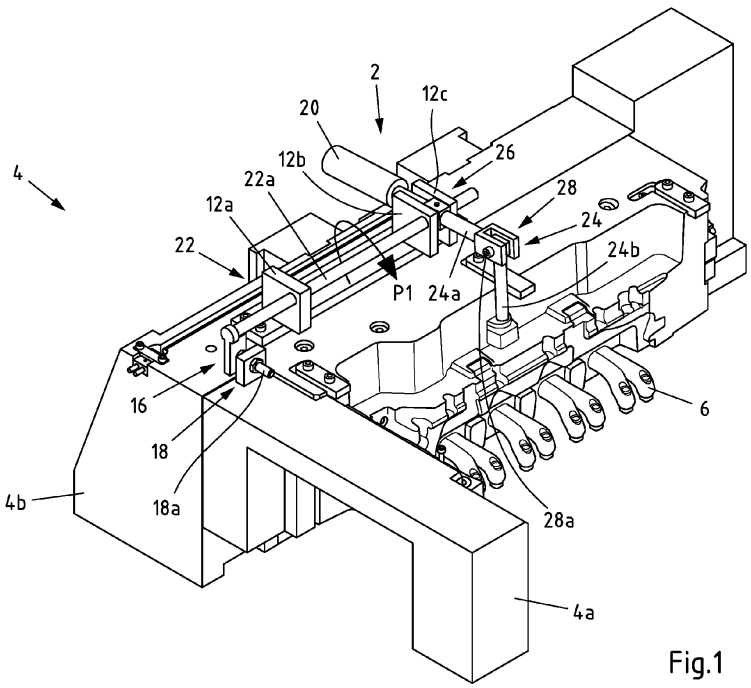

Fig.1

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Description

[0001] The present invention relates to a rocker arm assembly for fixing a core, in particular a sand core, inside a casting mold, comprising: a first lever, and a second lever that is set up to exert pressure on the (sand) core. The present invention also relates to the use of a rocker arm assembly, a casting mold, and a casting process.

[0002] Semi-permanent mold (SPM) casting is a metal casting process characterized by using (re-)usable metal molds and (sand) cores to shape at least partly internal passages in cast components. The molds typically comprise at least two parts, wherein the cores are being put into place before the two parts are placed together. The molten metal flows into a mold cavity and surrounds the at least one (sand) core while filling the mold cavity. When the casting is removed from the mold the at least one (sand) core is removed from the casting leaving an internal passage in the casing.

[0003] The casting mold contains a negative impression of the component to be cast as the molten metal will be poured or filled into the mold. As many cast components are designed to contain complex interiors where there may be spaces where the molten metal should not enter during casting, (sand) cores are regularly used. For example, (sand) cores are often used to create complex components of automobile parts, in particular engine parts.

[0004] The (sand) core is specifically designed as the negative form of the complex interior structure of the component to be cast. For example, when casting a component meant to be used as an engine block for a vehicle, such as an automobile, the block contains complex internal (hollow) structures meant for example for housing the cylinders. A (sand) core can be used to generate these internal structures. (Sand) cores are usually made using sand and a binder, but some processes also use permanent cores made of metal. (Sand) cores are also used to produce further types of cavities in castings, such as cavities for liquid cooling in engine blocks and cylinder heads.

[0005] To produce the (sand) cores, negative forms are used. For the process of casting the component using (sand) cores, the specifically produced (sand) cores are placed into a casting mold, in particular into a metal mold. Then the casting mold is closed and molten metal, typically iron, steel, bronze, brass, aluminum, magnesium alloys or various pot metal alloys, which often include lead, tin and zinc, is poured or filled into the mold. After being filled with liquid metal, the metal is undergoing a solidification process. The mold is then opened and the at least one core is subsequently removed, revealing a casting, which may be subject to further post-processing steps, especially of the surface of the cast component.

[0006] To obtain a component by casting with internal and external dimensions within specific tolerance limits it is important that the at least one core is reliably held into place during the casting process. This is specifically difficult, as by pouring or filling the molten metal into the casting mold the core tends to move, which is called core flotation. Core flotation leads to deviations in the dimensions of the cast component from the specifications, especially in the dimensions of the inner structures of the cast component, or even to breaking apart of the (sand) core and therefore to a failure of the cast process.

[0007] To help anchor the core in place, it is known to fix the cores to the inner surface of the mold and/or to use so-called chaplets. Chaplets are often made of the same metal as the casting, as some of the chaplet metal will be incorporated into the casting itself. To bond securely with the rest of the casting, the chaplet's surface must melt after having fulfilled its task of keeping the core in place. The design of chaplets is therefore a tricky metallurgical process and is avoided whenever possible since there is always the possibility of introducing weaknesses or casting defects into the cast part when using a chaplet.

[0008] Therefore, the present invention is faced with the problem of providing an improved device and method for fixing a (sand) core during a casting process, in particular during a semi-permanent mold casting process, which helps at least reducing the problem of core movement.

[0009] According to a first aspect of the present invention, said problem is solved by a rocker arm assembly for fixing a core, in particular a sand core, inside a casting mold, comprising: a first lever, and a second lever that is set up to exert pressure on the core, characterized in that, the second lever is connected to the first lever via a connection such that movement of the first lever, in particular a rotation of the first lever, in a first direction, leads to transmission of force to the second lever to exert pressure on the core.

[0010] The rocker arm assembly helps avoiding core movement without introducing weaknesses or alterations into the material of the cast component by fixing the core using the two levers. Additionally, the rocker arm assembly is re-usable and can be repeatedly used with a (re-usable) casting mold to fix cores in numerous casting processes, in particular in semi-permanent mold casting processes. At the same time, the rocker arm assembly is relatively simple in construction and therefore itself low error-prone as well as cost-effective.

[0011] The first lever of the rocker arm assembly is preferably movably mounted, preferably using bearings. The bearings can for example be at least partly arranged on the casting mold. The second lever of the rocker arm assembly is set up to exert pressure on the core. Preferably, by exerting pressure on the core, the core is fixed inside the casting mold, which means it is held in position, especially during the casting process when molten metal is poured or filled into the casting mold. This way core movement can be significantly reduced or even prevented.

[0012] The first lever of the rocker arm assembly is preferably set up to transfer the force generated by its movement via the connection to the second lever, which

is preferably set up to then translate the force to exerting pressure on the sand core. This can be achieved, preferably, by movement, in particular by rotation, of the second lever caused by the movement, in particular by the rotation, of the first lever. Preferably the second lever is connected to the first lever via a connection such that movement, in particular rotation, of the first lever in a first direction is translated to movement, in particular rotation, of the second lever, in particular in a direction different to the direction of movement of the first lever, to exert pressure on the core. The connection is preferably set up accordingly.

[0013] Hence, according to the described rocker arm assembly or an embodiment thereof, with the use of the connection and the second lever connected to it, the direction of the force of the first lever, caused by the movement, in particular by the rotation, of the first lever in the first direction, can be changed in a direction suited for fixation of a core, in particular of the sand core, and thus fixing the core by exerting pressure on it. The rocker arm assembly therefore In particular is set up to translate the force, with which the first lever is moved or driven, into a force, with which the second lever is driven, namely into the direction of the core to exert pressure on it.

[0014] The first lever and/or the second lever preferably comprise metal as a material, for example high temperature steel or a high temperature steel alloy, so that they are durable and can endure several casting processes without changing form or losing functionality.

[0015] It is preferred that the second lever is connected to the first lever via the connection such that movement, in particular the rotation, of the first lever in a second direction, which can be opposite to the first direction, causes the second lever to not exert pressure on the (sand) core (anymore), for example by not transferring force to the second lever in the direction towards the core (anymore). This way the core can easily be removed from the casting mold, for example by knocking or washing the sand out of the mold. It can be further possible, that the second lever is connected to the first lever via the connection such that when the first lever is not moved, in particular rotated, in the first direction (anymore), the second lever is caused to not exert pressure on the core (anymore). This means the second lever can be caused to not exert pressure on the core anymore, e.g. the pressure on the core can be released, for example by moving, in particular rotating, the first lever in a direction opposite to the first direction and also moving, in particular rotating, the second lever in a direction which is opposite to the movement causing the second lever to exert pressure on the core, or by just not transferring force on the first lever along the first direction anymore, in particular without moving the first lever in the opposite direction.

[0016] According to a second aspect of the invention, there is disclosed the use of the rocker arm assembly or an embodiment thereof for fixing a (sand) core inside a casting mold, in particular in a (re-usable) metal casting mold.

[0017] Preferably, the aforementioned rocker arm assembly or an embodiment thereof is used for fixing a core, in particular a sand core, inside a casting mold for casting a component of a vehicle, especially an automobile, for example an engine block.

[0018] According to a third aspect of the invention, there is disclosed a casting mold, in particular a (re-usable) metal casting mold, comprising at least one aforementioned rocker arm assembly or an embodiment thereof.

[0019] According to a fourth aspect of the invention, there is disclosed a casting process, in particular a semi-permanent mold casting process, comprising the steps of: providing a casting mold, preferably an aforementioned casting mold, preferably a (re-usable) metal casting mold comprising at least two parts, or an embodiment thereof, and a core, in particular a sand core, inside the casting mold, closing the casting mold, wherein via at least one trigger mechanism of at least one rocker arm assembly, preferably at least one aforementioned rocker arm assembly or an embodiment thereof, a first lever is moved, in particular rotated, in a first direction, whereby force is transferred to a second lever so that the second lever exerts pressure on the core, pouring or filling liquid metal into the casting mold, optionally allowing the liquid metal to at least partially solidify, and opening the casting mold, wherein the pressure exerted on the core by the second lever is released.

[0020] Preferably, the first lever is moved, in particular rotated, in a first direction whereby the second lever connected to the first lever is moved to exert pressure on the core. In particular, the second lever is connected to the first lever via a connection. The pressure exerted on the core by the second lever can be released for example with the aid of a counterweight, which may be arranged at or on the first lever or the second lever.

[0021] The advantages for the use of the rocker arm assembly, the casting mold and the casting process correspond to the advantages described for the rocker arm assembly or an embodiment thereof.

[0022] Further various preferred embodiments of the rocker arm assembly, the use of a rocker arm assembly, the casting mold and the casting process are described below, wherein the various embodiments can be combined with one another and apply accordingly to embodiments of the rocker arm assembly, the use of a rocker arm assembly, the casting mold, and the casting process, in particular the semi-permanent mold casting process.

[0023] According to a first exemplary embodiment of the rocker arm assembly, the first lever is a shaft that is rotatably mounted, and the second lever is connected to the shaft via the connection such that rotation of the shaft in the first direction leads to transmission of force to the second lever to exert pressure on the core. For example, by the transmission of force to the second lever, the second lever is moved to exert pressure on the core. Preferably, the shaft of the rocker arm assembly is rota-

tably mounted, for example bearings are used for mounting the shaft. The bearings can for example be at least partly arranged on the casting mold.

[0024] The shaft is preferably set up to transfer its rotational force via the connection to the second lever. The connection is preferably setup accordingly. Hence, with the use of the connection and the lever connected to it, the direction of the rotational force of the shaft can be changed in the direction of the core to exert pressure on it. The rocker arm assembly according to this embodiment is therefore in particular set up to translate the rotational force, with which the shaft is driven, into a force, with which the second lever is driven, into the direction of the core to exert pressure on it. The first direction into which the first lever is moved preferably is a first rotational direction according to the afore-described first embodiment of the rocker arm assembly.

[0025] According to a further embodiment of the rocker arm assembly, the second lever comprises a first arm and a second arm, wherein the first arm is connected to the first lever via the connection and the second arm is set up to exert pressure on the core, and wherein the first arm and the second arm are connected via a joint. This way, the rocker arm assembly allows for a greater flexibility in changing the direction of the force transferred from the first lever to the second lever as the second lever comprises two arms which thanks to their connection via the joint can themselves change the direction of the force transferred to the second lever. Preferably, the rocker arm assembly and especially the first lever is set up to translate the movement of the first lever, for example the rotation of the shaft used as first lever, in the first direction to movement of the first arm of the second lever via the connection. Further, the joint is preferably set up to transfer this movement of the first am of the second lever to movement of the second arm of the second lever to exert pressure on the core.

[0026] According to a further embodiment of the rocker arm assembly, a trigger mechanism is arranged at or on the first lever in such a way that by triggering the trigger mechanism the first lever is moved in the first direction. With the aid of the trigger mechanism arranged at or on the first lever, fixing of the core can be triggered by another process or action, for example a process or action linked to a casting process. This helps automatizing fixing the sand core inside the casting mold, especially during a casting process. If the first lever is a shaft, preferably by triggering the trigger mechanism the shaft is moved in the first direction, which preferably is a rotational direction.

[0027] According to a further embodiment of the rocker arm assembly, the trigger mechanism comprises a push plate arranged at or on the first lever in such a way that by pushing the push plate the first lever is moved in the first direction. This way a rather simple and low error-prone mechanism can be used as a trigger mechanism to trigger the movement of the first lever in the first direction and eventually causing the second lever to exert pressure on the core thereby fixing the core in the casting mold. Pushing the push plate can be achieved by a variety of different processes such as an element, for example an element fixed to the casting mold, pushing the push plate. This can be achieved, for example, by moving at least the part of the rocker arm assembly containing the push plate in direction towards at least a part of the casting mold or vice versa. Preferentially, the trigger mechanism comprises a push plate arranged at or on the first lever, which can be a shaft, in such a way that by pushing the push plate the first lever is moved, preferentially rotated, in a first rotational direction.

[0028] According to a further embodiment of the rocker arm assembly, the rocker arm assembly comprises fastening means for at least partly arranging the rocker arm assembly on the casting mold. This way the rocker arm assembly can be securely mounted to the casting mold. It is possible that at least a first part of the rocker arm assembly is arranged on at least a first part of the casting mold while other parts of the rocker arm assembly are arranged on further parts of the casting mold. For example, at least the first lever, possibly with the aid of respective bearings, is arranged on a side part of the casting mold. The second lever or the connection between the first and the second lever can also be arranged at or on this side part of the casting mold or solely be connection to the first lever and not be arranged onto (a part of) the casting mold itself.

[0029] According to a further embodiment of the rocker arm assembly, a counterweight is arranged at or on the first lever or at or on the second lever. Preferably, the counterweight is arranged and constructed in such a way that it causes the second lever to release the pressure exerted on the core once the first lever is not moved in the first direction anymore or moved in a second direction, which can be opposite the first direction, so that no force causing the second lever to exert pressure on the core is transferred to the second lever anymore. This way the core can easily be removed from the casting mold, for example by knocking or washing the (sand) core out of the mold.

[0030] The counterweight can be arranged on the second lever, for example at the end opposite the core of the second lever. Else, the counterweight can be arranged on the first lever, for example at the end opposite the connection of the first lever.

[0031] According to an embodiment of the casting mold, the casting mold comprises at least a center part and a first side part and/or a second side part, wherein the first side part and the second side part are preferably arranged on opposite sides of the center part, and one rocker arm assembly is arranged at or on the first side part and/or the second side part. This way the casting mold can be built up of different mountable parts and can be opened or closed by moving the respective parts in a direction towards each other or away from each other. This way a greater flexibility for placing the core inside the casting mold and for fixing it is achieved.

[0032] According to a further embodiment of the casting mold, the at least one rocker arm assembly comprises a trigger mechanism arranged at or on the first lever, and the trigger mechanism is arranged such that closing the casting mold by moving at least one of the side parts in the direction of the center part causes a respective movement of the first lever of the rocker arm assembly in the first direction. This way closing the casting mold can be used to cause the rocker arm assembly to fix the core before a casting process is started and molten metal is poured or filled into the closed casting mold.

[0033] Preferably, the at least one rocker arm assembly is configured such that when no more force is transferred by the respective first lever to the respective second lever, for example when the first lever is not moved in the first direction causing the second lever to exert pressure on the core, and/or the casting mold is opened, in particular by moving at least one of the side parts away from the center part, the pressure exerted on the core by the second lever is released. In particular, the respective trigger mechanism of the rocker arm assembly arranged on a side part is arranged in such a way that closing or opening the mold by moving the side part towards or away from the center part causes the second lever to exert or release pressure on the (sand) core. A counterweight can be arranged at or on the respective first lever or second lever of each of the rocker arm assemblies causing the second lever to release the pressure on the (sand) core.

[0034] The respective trigger mechanism can be triggered for example by pushing a push plate comprised by the trigger mechanism, in particular due to a pushing element arranged on the center part such that when the side part is moved towards the center part and thereby closing the casting mold, the pushing element pushes the push plate whereby the first lever is caused to move in the first direction and transferring a force to the second lever.

[0035] According to a preferred embodiment the at least one pushing element comprises adjusting means for adjusting the force exerted to the push plate. Hereby, the trigger mechanism may be individually adjusted with regard to the specific (sand) core used.

[0036] Further advantageous exemplary embodiments of the invention are indicated by the following detailed description of a number of practical examples of the present invention, in particular in connection with the figures.

[0037] The figures attached to the application, however, are only intended to be used for the purpose of clarification, and not to determine the scope of protection of the invention.

[0038] The attached drawings are intended only as examples reflecting the general concept of the present invention. In particular, features shown in the figures should not in any way be considered an essential component part of the invention.

[0039] In the following, the invention will be described in more detail with reference to the figures.

Fig. 1 shows an exemplary embodiment of a casting mold with a rocker arm assembly in a schematic and perspective view,

Fig. 2 shows the casting mold of Fig. 1 from another perspective, and

Fig. 3 shows a schematic sectional view of the casting mold of Fig. 1.

[0040] Fig. 1 depicts an exemplary embodiment of a casting mold 4 with a rocker arm assembly 2 in a schematic and perspective view. In Fig. 2 the casting mold 4 of Fig. 1 is shown from another perspective. The rocker arm assembly 2 is used for fixing a sand core 6 inside the casting mold 4. In the example shown in Fig. 1-3, the casting mold 4 is built up from different (metal) parts 4a, 4b, which can be moved with respect to each other to open and close the casting mold. Here, the casting mold comprises at least a center part 4a and a first side part 4b. The casting mold 4 can further comprise a second side part (not shown) and each of the first side part 4b and the second side part can be arranged on opposite sides of the center part 4a. At or on each of the first side part 4a and the second side part one rocker arm assembly 2 can be arranged, where here only one rocker arm assembly 2 is shown on the first side part 4b. The first side part 4b and the second side part (not shown) can be constructed as sliders so that by sliding the parts in the direction of the center part 4a the casting mold 4 can be closed and by sliding the parts in the opposite direction, thus away from the center part 4a, the casting mold 4 can be opened.

[0041] The rocker arm assembly 2 comprises a first lever 22, which is constructed as a shaft 22a in this example, and a second lever 24, which is set up to exert pressure on the sand core 6. The second lever 24 is connected to the first lever 22 via a connection 26, such that movement of the first lever 22 in a first direction leads to transmission of force to the second lever 24 to exert pressure on the sand core 6. The second lever 24 comprises a first arm 24a and a second arm 24b, wherein the first arm 24a is connected to the first lever 22 via the connection 26 and the second arm 24b is set up to exert pressure on the sand core 6 and the arms 24a, 24b are connected via a joint 28. In this example, the joint 28 comprises a screw 28a connecting the first arm 24a and the second arm 24a such that they can be moved around the joint 28 relatively to each other. This is well evident in Fig. 3, which shows a schematic sectional view of the casting mold 4 of Fig. 1 and 2. In the figures, for the sake of overview, the casting mold 4 is only partly shown and can compose more than the shown parts, or the shown parts, such as the center part 4a, are only partly shown.

[0042] In the exemplary embodiment shown in Fig. 1-3, the first lever 22 as a shaft 22a is rotatably mounted with the aid of bearings 12a-c. The rocker arm assembly 2 is arranged on the first side part 4b. For this purpose, the rocker arm assembly 2 includes fastening means 8 to

secure the rocker arm assembly 2 to the side part 4b. The fastening means 8 in this example comprise a plate 10 and screws 14 to secure the plate 10 onto the side part 4b. The bearings 12a-c are arranged on the plate 10. The second lever 24 is connected to the shaft 22a via the connection 26 such that rotation of the shaft 22a in the first direction leads to transmission of force to the second lever 24 to exert pressure on the sand core 6. Here, rotation of the shaft 22a in a first rotational direction (arrow P1 in Fig. 1) as the first direction leads to transmission of force onto the second lever 2. This is realized by the connection 26 comprising a pin 26a arranged on the outer circumference of the shaft 22a (see Fig. 3). Due to the pin 26a the first arm 24a and thanks to the joint 28 also the second arm 24b are moved in a rotational manner (arrow P2 in Fig. 3) around the joint 28 and in a direction towards the sand core 6 to exert pressure on it. Thus, fixing the sand core 6 is achieved due to the movement of the first lever 22 in the first direction.

[0043] As can be seen in Fig. 1 and Fig. 2, a trigger mechanism 16 is arranged on the end of the lever 22 opposite the connection 26. The trigger mechanism 16 is arranged on the first lever 22 in such a way that by triggering the trigger mechanism 16 the first lever 22 is moved in the first direction. Here, the trigger mechanism 16 comprises a push plate 16a arranged at the end of the first lever 22 opposite the connection 26 in such a way that by pushing the push plate 16a the first lever 22 is moved in the first direction: the shaft 22a as first lever 22 is rotated in the first rotational direction P1 when the push plate 16a is pushed against from the direction of the center part 4a.

[0044] The trigger mechanism 16, i.e. the push plate 16a, is arranged such that closing the casting mold 4 by moving the side part 4b in the direction of the center part 4a causes a movement of the first lever 22 in the first direction: the side part 4a comprises a pushing element 18, here formed as a protruding screw 18a, which pushes the push plate 16a so that the shaft 22a is rotated in the first rotational direction P1 when the side part 4b is moved towards the center part 4a of the casting mold and thereby closing the casting mold 4.

[0045] The rocker arm assembly 2 is configured such that when no more force is transferred by the first lever 22 to the second lever 24, for example when the first lever 22 is not moved in the first direction (anymore), the pressure exerted on the sand core by the second lever 24 is released. This can be achieved for example by opening the casting mold 4 due to moving the first side part 4b in a direction away from the center part 4a. When the casting mold is opened, the trigger mechanism 16, i.e. the push plate 16a in this example, is not being triggered anymore and hence the shaft 22a as the first lever 22 does not transfer force anymore to the second lever 24 to exert pressure on the sand core 6.

[0046] The release of the pressure on the sand core 6 enacted by the second lever 24 can be assisted or caused by a counterweight 20. The counterweight 20 is, as can be seen in particular in Fig. 3, is arranged at the second lever 24, namely at the end of first arm 24a of the second lever 24 opposing the joint 28. This way the counterweight 20 enacts a force at least partly in the opposite direction to the force transferred from the first lever 22 to the second lever 24 when the first lever 22 is moved in the first direction. When no more force is transferred from the first lever 22 to the second lever 24 due to movement of the first lever 22 in the first direction, for example when the casting mold 4 is opened, the force enacted by the counterweight 20 on the second lever 24 leads to release of the pressure exerted by the second lever 24 on the sand core 6.

[0047] Further, it can be possible that a counterweight 20 is arranged at or on the first lever 22. For example, the push plate 16a itself can act as a counterweight 20 leading to a movement of the push plate 16a in a direction opposite to the first rotational direction P1 when the push plate 16a is not pushed in a direction towards the side part 4b anymore, e.g. when the casting mold 4 is opened by moving the side part 4b away from the center part 4a. This way, in particular at the end of a casting process, the sand core 6 can be easily removed when the casting mold 4 is opened.

[0048] This solution has been developed under the Nemak Izmir Ar-Ge merkezi initiative.

Claims

1. Rocker arm assembly (2) for fixing a core (6), in particular a sand core, inside a casting mold (4), comprising:

   - a first lever (22), and
   - a second lever (24) that is set up to exert pressure on the core (6), **characterized in that,**
   - the second lever (24) is connected to the first lever (22) via a connection (26) such that movement, in particular a rotation, of the first lever (22), in particular in a first direction, leads to transmission of force to the second lever (24) to exert pressure on the core (6).

2. Rocker arm assembly (2) according to claim 1, **characterized in that,**

   - the first lever is a shaft (22a) that is rotatably mounted, and
   - the second lever (24) is connected to the shaft (22a) via the connection (26) such that rotation of the shaft (22a) in the first direction leads to transmission of force to the second lever (24) to exert pressure on the core (6).

3. Rocker arm assembly (2) according to claim 1 or 2, **characterized in that,**

- the second lever (24) comprises a first arm (24a) and a second arm (24b), wherein the first arm (24a) is connected to the first lever (22) via the connection (26) and the second arm (24b) is set up to exert pressure on the core (6), and
- the first arm (24a) and the second arm (24b) are connected via a joint (28).

4. Rocker arm assembly (2) according to one of claims 1 to 3,
characterized in that,

- a trigger mechanism (16) is arranged at or on the first lever (22) in such a way that by triggering the trigger mechanism (16) the first lever (22) is moved, in particular rotated, in the first direction.

5. Rocker arm assembly (2) according to claim 4,
characterized in that,

- the trigger mechanism (16) comprises a push plate (16a) arranged at or on the first lever (22) in such a way that by pushing the push plate (16a) the first lever (22) is moved, in particular rotated, in the first direction.

6. Rocker arm assembly (2) according to one of claims 1 to 5,
characterized in that,

- the rocker arm assembly (2) comprises fastening means (8) for at least partly arranging the rocker arm assembly (2) on the casting mold (4).

7. Rocker arm assembly (2) according to one of claims 1 to 6,
characterized in that,

- a counterweight (20) is arranged at or on the first lever (22) or at or on the second lever (24).

8. Use of a rocker arm assembly (2) according to one of claims 1 to 7 for fixing a core (6), in particular a sand core, inside a casting mold (4).

9. Casting mold (4) comprising at least one rocker arm assembly (2) according to one of claims 1 to 7.

10. Casting mold (4) according to claim 9,
characterized in that,

- the casting mold (4) comprises at least a center part (4a) and a first side part (4b) and/or a second side part, wherein the first side part (4b) and the second side part are preferably arranged on opposite sides of the center part (4a), and
- one rocker arm assembly (2) is arranged at or on the first side part (4b) and/or the second side part.

11. Casting mold (4) according to claim 10,
characterized in that,

- the at least one rocker arm assembly (2) comprises a trigger mechanism (16) arranged at or on the first lever (22), and
- the trigger mechanism (16) is arranged such that closing the casting mold (4) by moving at least one of the side parts (4b) in the direction of the center part (4a) causes a movement, in particular a rotation, of the first lever (22) of the rocker arm assembly (2) in the first direction.

12. Casting process, in particular a semi-permanent mold casting process, comprising the steps of:

- providing a casting mold (4), preferably a casting mold (4) according to one of claims 9 to 11, and a core (6), in particular a sand core, inside the casting mold (4),
- closing the casting mold (4), wherein via at least one trigger mechanism (16) of at least one rocker arm assembly (2), preferably at least one rocker arm assembly (2) according to one of claims 1 to 7, a first lever (22) is moved, in particular is rotated, in a first direction, whereby force is transferred to a second lever (24) so that the second lever (24) exerts pressure on the core (6),
- pouring or filling liquid metal into the casting mold (4),
- optionally allowing the liquid metal to at least partially solidify, and
- opening the casting mold (4), wherein the pressure exerted on the core (6) by the second lever (24) is released.

Amended claims in accordance with Rule 137(2) EPC.

1. Casting mold (4) comprising at least one rocker arm assembly (2) for fixing a core (6), in particular a sand core, during a casting process inside the casting mold (4),
comprising:

- a first lever (22), and
- a second lever (24) that is set up to exert pressure on the core (6), **characterized in that,**
- the second lever (24) is connected to the first lever (22) via a connection (26) such that movement, in particular a rotation, of the first lever (22) in a first direction leads to transmission of force to the second lever (24) in a direction different to the first direction of movement of the first lever

(22)_to exert pressure on the core (6), wherein a trigger mechanism (16) is arranged at or on the first lever (22) in such a way that by triggering the trigger mechanism (16) the first lever (22) is moved, in particular rotated, in the first direction.

2. Casting mold (4) according to claim 1, **characterized in that,**

- the first lever is a shaft (22a) that is rotatably mounted, and
- the second lever (24) is connected to the shaft (22a) via the connection (26) such that rotation of the shaft (22a) in the first direction leads to transmission of force to the second lever (24) to exert pressure on the core (6).

3. Casting mold (4) according to claim 1 or 2, **characterized in that,**

- the second lever (24) comprises a first arm (24a) and a second arm (24b), wherein the first arm (24a) is connected to the first lever (22) via the connection (26) and the second arm (24b) is set up to exert pressure on the core (6), and
- the first arm (24a) and the second arm (24b) are connected via a joint (28).

4. Casting mold (4) according to claim 1, **characterized in that,**

- the trigger mechanism (16) comprises a push plate (16a) arranged at or on the first lever (22) in such a way that by pushing the push plate (16a) the first lever (22) is moved, in particular rotated, in the first direction.

5. Casting mold (4) according to one of claims 1 to 4, **characterized in that,**

- the rocker arm assembly (2) comprises fastening means (8) for at least partly arranging the rocker arm assembly (2) on the casting mold (4).

6. Casting mold (4) according to one of claims 1 to 5, **characterized in that,**

- a counterweight (20) is arranged at or on the first lever (22) or at or on the second lever (24).

7. Casting mold (4) according to one of claims 1 to 6, **characterized in that,**

- the casting mold (4) comprises at least a center part (4a) and a first side part (4b) and/or a second side part, wherein the first side part (4b) and the second side part are preferably arranged on opposite sides of the center part (4a), and
- one rocker arm assembly (2) is arranged at or on the first side part (4b) and/or the second side part.

8. Casting mold (4) according to claim 7, **characterized in that,**

- the at least one rocker arm assembly (2) comprises a trigger mechanism (16) arranged at or on the first lever (22), and
- the trigger mechanism (16) is arranged such that closing the casting mold (4) by moving at least one of the side parts (4b) in the direction of the center part (4a) causes a movement, in particular a rotation, of the first lever (22) of the rocker arm assembly (2) in the first direction.

9. Casting process, in particular a semi-permanent mold casting process, comprising the steps of:

- providing a casting mold (4) according to one of claims 1 to 8 and a core (6), in particular a sand core, inside the casting mold (4),
- closing the casting mold (4), wherein via at least one trigger mechanism (16) of at least one rocker arm assembly (2) , a first lever (22) is moved, in particular is rotated, in a first direction, whereby force is transferred to a second lever (24) so that the second lever (24) moves in a direction different to the direction of movement of the first lever (22) and exerts pressure on the core (6),
- pouring or filling liquid metal into the casting mold (4),
- allowing the liquid metal to at least partially solidify, and
- opening the casting mold (4), wherein the pressure exerted on the core (6) by the second lever (24) is released.

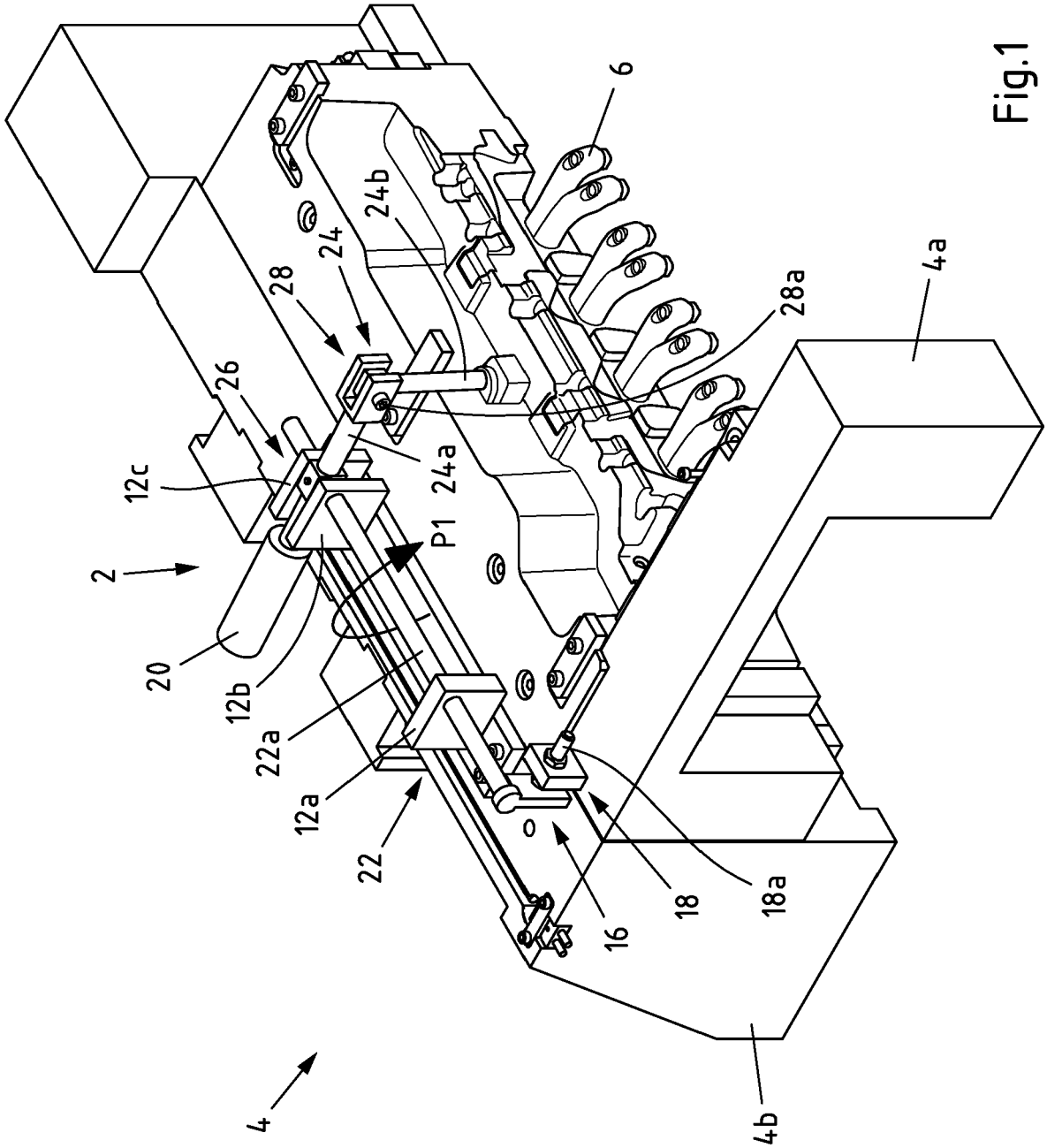

Fig.1

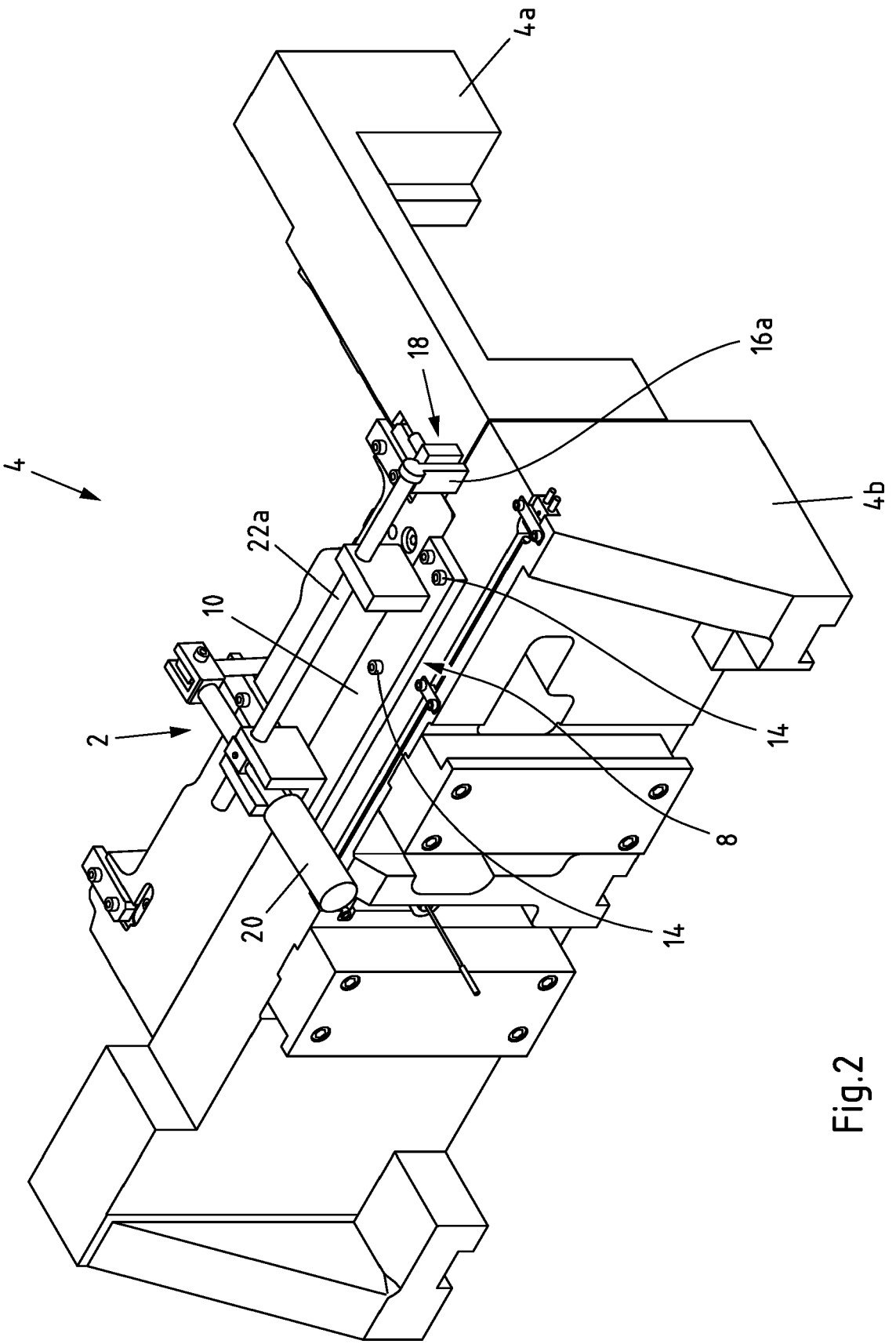

Fig.2

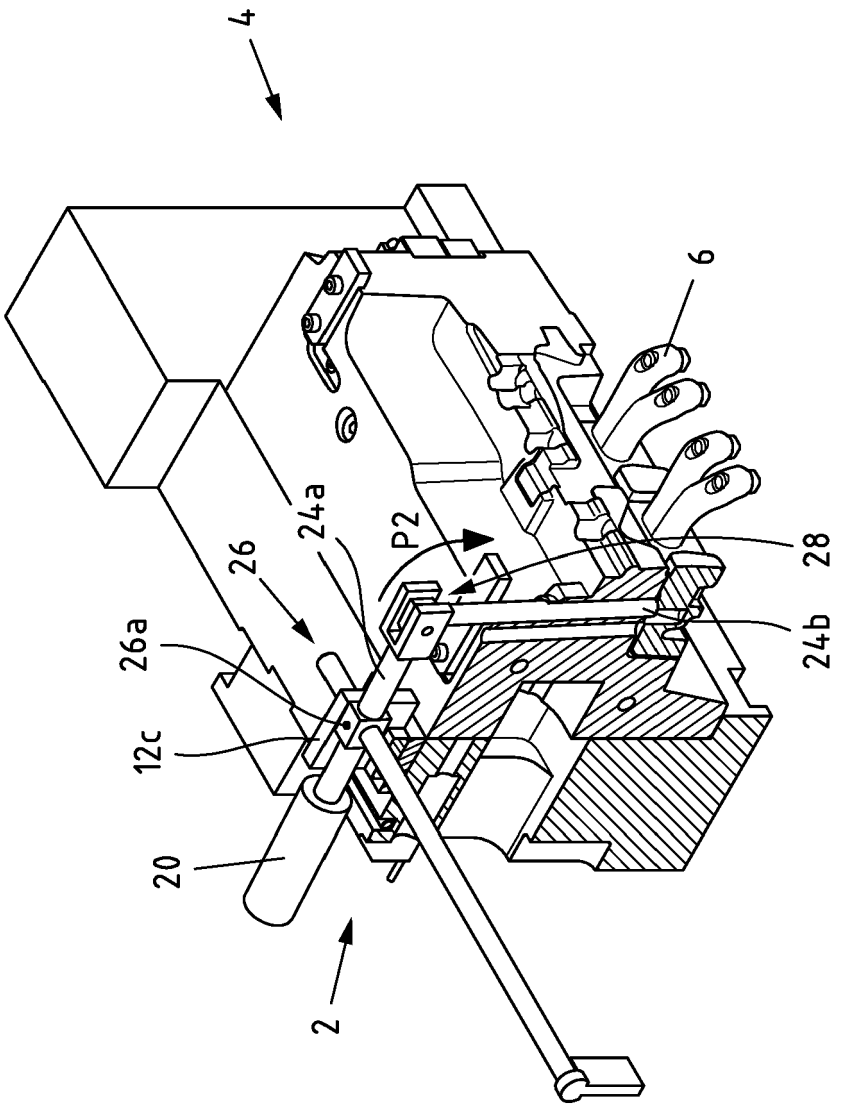

Fig.3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 8126

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 927 415 A1 (SINTOKOGIO LTD [JP]) 4 June 2008 (2008-06-04)	1-11	INV. B22C9/10
A	* paragraph [0053]; figures 14-16 *	12	B22C21/14
X	US 4 765 389 A (KNUDSEN SOREN E [DK]) 23 August 1988 (1988-08-23)	1-11	
A	* claim 1; figure 1 *	12	
X	US 2004/011499 A1 (KNUDSEN SOREN DANIS [DK]) 22 January 2004 (2004-01-22)	1-11	
A	* claim 3; figures 1-8 *	12	
X	JP S59 218240 A (NISSAN MOTOR) 8 December 1984 (1984-12-08)	1-11	
A	* claim 1; figure 3 * * See the machine translated appendix *	12	
X	US 2022/347904 A1 (NATO MITSUTOSHI [JP] ET AL) 3 November 2022 (2022-11-03) * paragraphs [0054], [0083]; figures 6,16-26 *	1-12	TECHNICAL FIELDS SEARCHED (IPC)
X	CN 112 756 560 A (JINHUA BAOLIN TECH CO LTD) 7 May 2021 (2021-05-07)	1-11	B22C B22D
A	* claim 1; figures 1,2 *	12	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 April 2024	Momeni, Mohammad

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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08-04-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1927415 A1	04-06-2008	BR PI0705825 A	15-07-2008
		CN 101573195 A	04-11-2009
		EA 200702259 A1	30-06-2008
		EP 1927415 A1	04-06-2008
		JP 4991755 B2	01-08-2012
		JP WO2008068947 A1	18-03-2010
		KR 20080050307 A	05-06-2008
		US 2010018664 A1	28-01-2010
		WO 2008068947 A1	12-06-2008
US 4765389 A	23-08-1988	AT E45896 T1	15-09-1989
		BR 8700322 A	08-12-1987
		CN 86101959 A	05-08-1987
		DK 37386 A	25-07-1987
		EP 0230933 A1	05-08-1987
		ES 2010509 B3	16-11-1989
		GR 3000214 T3	31-12-1990
		IN 164736 B	20-05-1989
		JP H0456700 B2	09-09-1992
		JP S62173210 A	30-07-1987
		SU 1561817 A3	30-04-1990
		US 4765389 A	23-08-1988
US 2004011499 A1	22-01-2004	AU 1513401 A	11-06-2002
		DE 60016471 T2	03-11-2005
		EP 1337359 A1	27-08-2003
		ES 2233476 T3	16-06-2005
		US 2004011499 A1	22-01-2004
		WO 0243901 A1	06-06-2002
JP S59218240 A	08-12-1984	NONE	
US 2022347904 A1	03-11-2022	CN 114555261 A	27-05-2022
		JP 6970730 B2	24-11-2021
		JP 2021087977 A	10-06-2021
		US 2022347904 A1	03-11-2022
		WO 2021112052 A1	10-06-2021
CN 112756560 A	07-05-2021	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82