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(54) Gravity casting apparatus with tilting die and method for gravity casting with tilting die

(57) A gravity casting apparatus with tilting die, comprising a die-casting machine (11) with which a corresponding die (12) is associated, elements (13) for feeding molten mass (18) in a casting inlet region (14) of the die (12), and elements (20) for cooling the die (12) before the casting step, which are associated with elements for distributing release agent inside at least one impression provided inside the die (12); the die is tiltable about at least one horizontal tilting axis which passes through the center of the inlet region of the die and said elements for feeding molten mass are constituted by at least one pressurized dosing furnace.

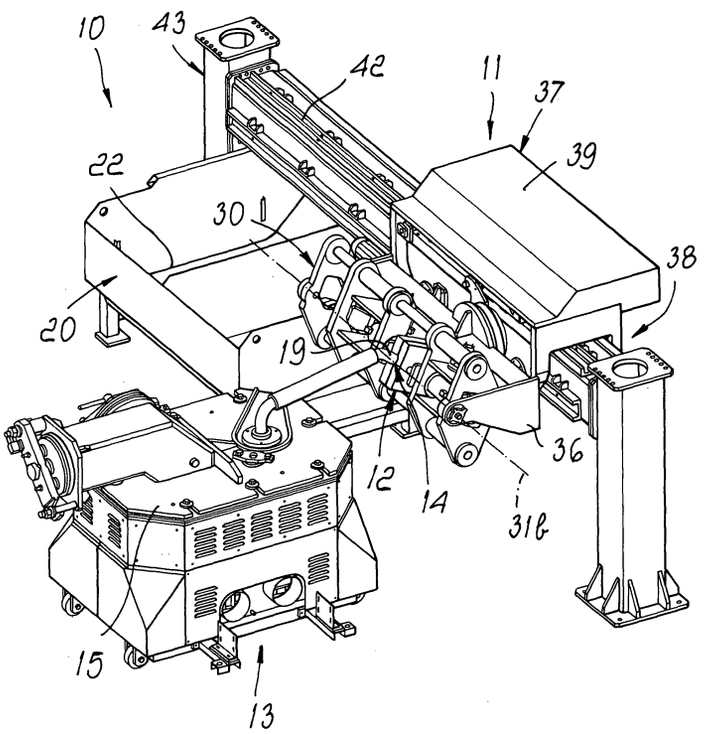

Fig. 4

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Description

[0001] The present invention relates to a gravity casting apparatus with tilting die.

[0002] The present invention is useful particularly but not exclusively in the production by casting of components for faucets and hydraulic connections and the like and in any case in all foundry processes that use permanent metallic dies.

[0003] The present invention also relates to a method for gravity casting with tilting die.

[0004] Currently, the foundry processes most widely used in the production of metal castings for the faucet industry and for the general hydraulic connection industry are substantially two: gravity casting in a tilting die and casting with a low-pressure furnace.

[0005] In the first case, the process is performed by an apparatus that comprises a die-casting machine, which comprises a device for opening/closing two die parts and allows the die thus formed to tilt during casting (by gravity, while the molten mass rises in level inside the impression) about two mutually perpendicular horizontal axes.

[0006] A first tilting axis is substantially parallel to the parting plane of the die; tilting about this axis allows so-called side casting, which is typically performed when the die comprises more than one impression or when filling must be performed laterally.

[0007] The second tilting axis is perpendicular to the parting plane of the die; tilting about this axis allows so-called front casting, which is performed typically when the die comprises a single impression.

[0008] The reason for tilting the die during casting is to ensure optimum casting quality.

[0009] In particular, with this tilting of the die, the rise of the molten mass inside the impression or impressions of the die is of the laminar type, thus avoiding turbulences that may allow the absorption of air bubbles in the molten mass; laminar motion also allows a controlled rise of the molten mass, avoiding sudden thermal variations on the die and a constant cooling interval.

[0010] Moreover, the molten mass touches the surface of the die without removing the layer of graphite (such as for example graphite applied before closing the die) that acts as a release agent and insulating agent, thus avoiding the formation of pitting and defects on the surface of the part.

[0011] Moreover, the rise of the molten mass allows good gas evacuation.

[0012] To perform casting, an operator draws from an open-top furnace, by means of ladle, a certain quantity of molten mass and pours it into an opening (feed area) provided in the die.

[0013] To pour the molten mass, the operator must follow the tilting of the die with the ladle, tracing a circular arc with the spout of said ladle; at the same time, the operator must rotate the ladle to empty it.

[0014] Although this operating method has been used for many years, it still has drawbacks.

[0015] First of all, in order to pour the molten mass while following a circular arc-like path, the operator must be particularly expert and skilled, and optimum repeatability of the operation is not always ensured.

[0016] Further, slag is present on the surface of the molten mass that is present in the open-top melting furnace, and the operator must not pick it up (which is not always possible) in order to avoid including it in the casting.

[0017] There are apparatuses which use, instead of a human operator, a robot that is programmed to perform the same movements.

[0018] This solution certainly solves the problems entailed by the human variable, but has significant machine costs; moreover, it does not completely avoid inclusions of slag and gas, which cause defects in the manufactured parts.

[0019] In view of the long setup times of the parameters of the machine, a robot in fact can be used conveniently when it is used for long production cycles, which entail mass-production of castings, something which the production market does not always require.

[0020] As regards the method for casting with a low-pressure oven, it uses particular dies that are functionally connected to a pressurized furnace by means of a feed tube.

[0021] Generally, the die is arranged above the furnace, while the tube connects the center of the tank of the oven (below the level of the molten mass) to the bottom of the die, which in this process is stationary (i.e., it does not oscillate).

[0022] By pressurizing the furnace, the mass rises along the tube and fills the die.

[0023] With this process, one has the same advantages that can be obtained with gravity casting in a tilting die, further avoiding the problems of slag present on the surface of the molten mass in open-top furnaces and the necessary skill and experience of the operator.

[0024] However, dies that can be used with low-pressure furnaces are extremely expensive, and their use is justified only for the mass-production of castings, in order to obtain economies of scale.

[0025] Currently, however, the market requires limited casting runs (a few hundred or thousand parts), and therefore, for cost containment reasons, apparatuses that use gravity casting dies are used, making it consequently impossible to achieve the quality of the castings that can be obtained by means of low-pressure casting processes.

[0026] The aim of the present invention is to provide a gravity casting apparatus with tilting die that solves the problems noted in known types.

[0027] Within this aim, an object of the present invention is to provide a gravity casting apparatus with tilting die that allows to obtain high-quality castings.

[0028] Another object of the present invention is to provide a gravity casting apparatus with tilting die that

allows to reduce the personnel assigned to the casting process.

[0029] Another object of the present invention is to provide a gravity casting apparatus with tilting die that can be produced with known technologies and systems.

[0030] This aim and these and other objects that will become better apparent hereinafter are achieved by a gravity casting apparatus with tilting die, comprising at least one die-casting machine with which a corresponding die is associated, means for feeding the molten mass in the casting inlet region of said die, and means for cooling the die before the casting step, which are associated with means for distributing release agent inside at least one impression provided inside said die, said die-casting machine comprising in turn a device for opening/closing said die and means for tilting said die about at least one substantially horizontal tilting axis, said apparatus being characterized in that said at least one tilting axis substantially passes through the center of said inlet region of said die, said means for feeding the molten mass being constituted by at least one pressurized dosing furnace, which can be connected functionally to said inlet region of said die by means of a corresponding feed channel that draws from below the level of the molten mass that is present inside said pressurized furnace, the end part of said channel directly connected to said inlet region being oriented downward along the direction in which the molten mass is fed.

[0031] Advantageously, the present invention comprises a method for gravity casting with tilting die that comprises the steps of:

- distributing a release agent onto the walls of at least one impression formed inside a die while said die is open,
- closing the die,
- moving mutually closer a casting inlet region of said die and a source for feeding a molten mass,
- pouring the molten mass into said die through said inlet region,
- simultaneously with the preceding pouring step, tilting said die with a preset direction of rotation about a preset substantially horizontal tilting axis that passes substantially through a center of said inlet region,
- once pouring has ended, moving said casting inlet region of said die and said molten mass supply source mutually apart,
- waiting for a preset molding time,
- opening the die and cooling it.

[0032] Conveniently, the invention further comprises a die-casting machine for tilting dies, which comprises a device for opening/closing a die and means for tilting said die about at least one substantially horizontal tilting axis, said machine being characterized in that said at least one tilting axis passes substantially through the center of the casting inlet region of said die in order to feed the molten mass.

[0033] Further characteristics and advantages of the invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment thereof, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figures 1a-1e are functional diagrams of the apparatus according to the invention, illustrating five successive steps which relate to a front-type casting;
Figures 2a-2e are functional diagrams of the apparatus according to the invention, illustrating five successive steps which relate to a side-type casting;
Figure 3 is a perspective view of the system according to the invention during a step in which the die parts are open;
Figure 4 is a perspective view of the apparatus according to the invention during the initial tilting step in front casting;
Figure 5 is a perspective view of the apparatus according to the invention during the initial tilting step in side casting;
Figure 6 is a plan view of a portion of the die-casting machine defined according to the invention;
Figure 7 is a perspective view of a portion of the die-casting machine defined according to the invention.

[0034] With reference to the figures, a gravity casting apparatus with tilting die according to the invention is generally designated by the reference numeral 10.

[0035] The apparatus 10 comprises a die-casting machine 11 (shown in Figures 3, 4, 5 and partially shown in Figures 6 and 7 but not in Figures 1 and 2), which will be described hereinafter and with which a corresponding die 12 is to be associated.

[0036] In Figures 1a-1e and 4, the die is of the type for front casting and is designated by the reference numeral 12a, while in Figures 2a-2e and 5 the die is of the type for side casting and is designated by the reference numeral 12b.

[0037] The apparatus 10 further comprises means 13 for feeding the molten mass into the casting inlet region 14 of the die 12.

[0038] The inlet region 14 is provided at the parting plane 12 along which the die 12 divides into two die parts 112.

[0039] Advantageously, the feeder means 13 are constituted, in this embodiment, by a pressurized dosing furnace 15, for example of the type for low-pressure casting.

[0040] The pressurized dosing furnace 15, during casting, is functionally connected to the inlet region 14 of the die 12 by means of a corresponding feed channel 16.

[0041] The feed channel 16 is constituted by a heated feed tube 17 that draws below the level of the molten mass 18 that is present inside the pressurized furnace 15.

[0042] The end part 19 of the feed tube 17 that is connected directly to the inlet region 14 is oriented downward, along the direction in which the molten mass is fed from the furnace 15 to the die 12, so as to achieve gravity casting into the die during the tilting of the die.

[0043] The apparatus 10 further comprises means 20 for cooling the die 12 before casting, which are associated with means for distributing a release agent inside the impression (or impressions, if the die is of the type with multiple impressions) formed inside the die.

[0044] The cooling means 20 comprise, for example, a tank 22 filled with cooling liquid (for example water), in which the die parts 112 are immersed by way of movements of the die-casting machine 11.

[0045] Advantageously, the tank 22 coincides with the release agent distribution means, since for example graphite (used indeed as a release agent) can be dispersed in the cooling liquid.

[0046] As an alternative, it is possible to distribute the release agent for example by means of a per se known spray distribution unit (not shown in the figures).

[0047] A die-casting machine 11, shown schematically in Figures 3, 4, 5 and partially shown in Figures 6 and 7, comprises a device 30 for opening/closing the molding die 12 and means 35 (described hereinafter) for tilting the die 12 about, in this embodiment, a pair of mutually perpendicular substantially horizontal tilting axes, respectively a first tilting axis 31 a, which is substantially parallel to the parting plane of the die 12, and a second tilting axis 31 b, which is substantially perpendicular to the parting plane of the die 12.

[0048] Rotation about one tilting axis 31 or the other is necessary depending on whether the casting to be performed is of the front or side type.

[0049] Conveniently, the tilting axes 31 are co-planar and pass substantially through the center of the inlet region 14 of the die 12.

[0050] The opening/closing device 30 comprises two mutually opposite closure units 32, of which a first one is fixed and a second one can move with respect to the first one on guiding columns 32a.

[0051] A respective articulation unit 33 is coupled to each closure unit 32.

[0052] The articulation units 33 have, on respective mutually opposite facing ends, flanges 34 for fixing to the die portions 112.

[0053] The articulation unit 33, which is known in principle, allows movements about two mutually perpendicular axes, which are designed to manage accessibility to the die parts 112 and their correct orientation when they are inserted in the tank 22 in order to cool them and wet them with the release agent.

[0054] The device 30 is pivoted about the second tilting axis 31b to an intermediate frame 36.

[0055] In turn, the intermediate frame 36 is pivoted to a supporting framework 37 about the first tilting axis 31b.

[0056] In this embodiment, the supporting framework 37 is associated with movement means 38, which are constituted by a carriage 39 that can slide in a controlled manner on a horizontal guide 42 that is formed on the beam of a portal 43 that is fixed to the ground.

[0057] The movement means 38 allow the device 30 to move in a linear manner from the region of the tank 22, where the die parts 112 are cooled and the release agent is applied, to the casting region in front of the furnace 15.

[0058] A variation of the movement means 38 (not shown in the figures) can also be constituted by a carousel that rotates the supporting framework 37 about a vertical axis.

[0059] The tilting means 35 comprise a first motor drive, designated schematically by the reference numeral 40, which is arranged on the intermediate frame 36 and allows the rotation of the press 30 about the axis 31b with respect to the intermediate frame 36.

[0060] The first motor drive 40 can be constituted for example by a gearmotor (not designated by a reference numeral in the figures), which is kinematically associated, for example by means of a chain, with a sprocket (both not designated by reference numerals in the figures), which is rigidly coupled to the press 30 and coaxial to the axis 31b, or in any case can be constituted by other movement means of a known electrical or hydraulic type.

[0061] Moreover, the tilting means 35 comprise a second motor drive, designated schematically by the reference numeral 41, which is arranged on the supporting framework 37 and acts on the intermediate frame 36 in order to rotate it about the first tilting axis 31a.

[0062] With particular reference to Figures 1a-1e and 2a-2e, in general the process for gravity casting in a tilting die according to the invention consists in distributing release agent onto the walls of the impression (or impressions) formed inside the open die 12.

[0063] At this point, the core of the casting (for example a faucet) is inserted in the impression and the die 12 is closed.

[0064] The casting inlet region 14 of the die 12 and the supply source of the molten mass, in this embodiment the end of the feed tube 17, are moved mutually closer (Figures 1a and 2a).

[0065] The molten mass is poured into the die 12 through the inlet region 14.

[0066] Simultaneously with the casting (Figures 1b, 1c, 1d and 2b, 2c, 2d), the tilting motion of the die 14 begins along a preset direction of rotation about a preset tilting axis 31, depending on whether front or side casting is being performed.

[0067] Since these horizontal tilting axes 31 pass substantially through the center of the inlet region 14, during the tilting of the die 12 (which coincides with the step for feeding molten mass into the inlet region 14 of the die 12), the inlet region 14 is substantially stationary with respect to the tilting of said die.

[0068] Once the casting step has ended (by interrupting the flow of liquid metal to the die), the casting inlet

region 14 of the die 12 and the end of the feed tube 17 are moved mutually apart (Figures 1e and 2e), and a preset solidification time, calculated according to the casting, is allowed to elapse.

[0069] Then the mold is opened, the casting is extracted and the die parts 112 are moved into the cooling tank 22 (see the die parts 112 shown in broken lines inside the tank 22 in Figures 3 and 4); since graphite is also present inside the tank, the release agent is applied simultaneously with the cooling operation, thus restarting the work cycle.

[0070] In practice it has been found that the invention thus described solves the problems noted in known types of gravity casting apparatus.

[0071] It should in fact be noted that the apparatus described above combines the advantages of gravity casting with tilting dies (low costs of the dies and short machine setup times) and the advantages provided by molding apparatuses with low-pressure furnaces (higher quality of the produced casting).

[0072] The resulting advantages are allowed by the fact of tilting the die, as in the case of gravity casting, without moving the center of the casting inlet region in the die and thus keeping the casting device, such as the feed tube that arises from the low-pressure furnace, motionless.

[0073] It is evident that a die-casting machine that allows to keep the center of the casting inlet region in the die stationary is useful also when it is not associated with low-pressure systems, since in a casting process of the "manual" type it spares the operator from the need to trace a circular arc with the casting ladle.

[0074] It should be noted that with the present invention it is also possible to perform combined castings by rotating the die both about the tilting axis 31 a and about the tilting axis 31b simultaneously, keeping stationary at all times the region for the inlet of the casting in the die.

[0075] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; all the details may further be replaced with other technically equivalent elements.

[0076] In practice, the materials employed, so long as they are compatible with the specific use, as well as the dimensions, may be any according to requirements and to the state of the art.

[0077] The disclosures in Italian Patent Application No. PD2003A000115 from which this application claims priority are incorporated herein by reference.

[0078] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A gravity casting apparatus with tilting die, comprising at least one die-casting machine (11) with which a corresponding die (12) is associated, means (13) for feeding the molten mass (18) in the casting inlet region (14) of said die (12), and means (20) for cooling the die (12) before the casting step, which are associated with means for distributing release agent inside at least one impression provided inside said die (12), said die-casting machine (11) comprising in turn a device (30) for opening/closing said die (12) and means (35) for tilting said die (12) about at least one substantially horizontal tilting axis (31), said apparatus (10) being **characterized in that** said at least one tilting axis (31) substantially passes through the center of said inlet region (14) of said die (12), said means (13) for feeding the molten mass (18) being constituted by at least one pressurized dosing furnace (15), which can be connected functionally to said inlet region (14) of said die (12) by means of a corresponding feed channel (16) that draws from below the level of the molten mass (18) that is present inside said pressurized furnace (15), the end part of said channel (19) directly connected to said inlet region (14) being oriented downward along the direction in which the molten mass (18) is fed.

2. The casting apparatus according to claim 1, **characterized in that** said pressurized furnace (15) is of the low-pressure type.

3. The casting apparatus according to claim 2, **characterized in that** said feed channel (16) is constituted by a heated feed tube (17).

4. The casting apparatus according to one or more of the preceding claims, **characterized in that** said cooling means (20) comprise a tank (22), which is filled with cooling liquid and in which the die portions (112) that compose said die (12) are immersed by means of movements of said die-casting machine (11).

5. The casting apparatus according to one or more of claims 1 to 3, **characterized in that** said cooling means (20) comprise a tank (22), which is filled with cooling liquid and release agent in liquid form and in which the die portions (112) that compose said die (12) are immersed by means of movements of said die-casting machine (11).

6. The casting apparatus according to one or more of claims 1 to 4, **characterized in that** said means for distributing the release agent (20) comprise a spray distribution unit.

7. The casting apparatus according to one or more of the preceding claims, **characterized in that** it comprises two substantially horizontal tilting axes (31), which are mutually perpendicular and co-planar and pass substantially through the center of the inlet region (14) of said die (12), said pair of axes (31) comprising respectively a first tilting axis (31a), which is substantially parallel to the parting plane of said die (12), and a second tilting axis (31 b), which is substantially perpendicular to the parting plane of said die (12).

8. The casting apparatus according to claim 7, **characterized in that** said opening/closure device (30) comprises two mutually opposite closing units (32), a first fixed one and a second one that can move with respect to the first one along guiding columns (32a), a respective articulation unit (33) being rigidly coupled on each one of said closure units (32), said articulation units (33) having, on mutually opposite facing ends, respective flanges (34) for fixing to respective die portions (112), said flanges (34) being pivoted to said articulation units (33) about said second tilting axis (31b), said opening/closure device (30) being pivoted about said second tilting axis (31b) to an intermediate frame (36), said intermediate frame (36) being in turn pivoted to a supporting framework (37) about said first tilting axis (31a).

9. The casting apparatus according to claim 8, **characterized in that** said tilting means (35) comprise a first motor drive (40), which is arranged on said intermediate frame (36) and is kinematically associated with the rotation of said press (30) about said second tilting axis (31 b), said tilting means (35) further comprising a second motor drive (41), which is arranged on said supporting framework (37) and acts on said intermediate frame (36) in order to rotate it about said first tilting axis (31a).

10. The casting apparatus according to claims 8 or 9, **characterized in that** said supporting framework (37) is associated with means (38) for movement from the region for cooling the die portions to a region preset for casting.

11. The casting apparatus according to claim 10, **characterized in that** said movement means (38) are constituted by a carriage (39), which can move in a controlled manner on a horizontal guide (42) provided on the beam of a portal (43) that is fixed to the ground.

12. A method for gravity casting with tilting die, consisting in:

-- distributing a release agent onto the walls of at least one impression formed inside said die (12) while said die is open,
-- closing said die (12),
-- moving mutually closer a casting inlet region (14) of said die (12) and a source for feeding molten mass,
-- pouring molten mass into said die (12) through said inlet region (14),
-- simultaneously with the preceding pouring step, tilting said die (12) with a preset direction of rotation about a preset substantially horizontal tilting axis (31) that passes substantially through the center of said inlet region (14),
-- once pouring has ended, moving said casting inlet region (14) of said die (12) and said molten mass supply source mutually apart,
-- waiting for a preset solidification time,
-- opening the die and cooling it.

13. The casting method according to claim 12, **characterized in that** said source for feeding the molten mass corresponds to a corresponding feed channel (16), which is functionally connected to a pressurized dosing furnace (15), said feed channel (16) drawing below the level of the molten mass that is present inside said pressurized furnace (15), the end part (19) of said channel (16) directly connected to said inlet region (14) being oriented downward along the direction in which the molten mass is fed.

14. The casting process according to claim 13, **characterized in that** it comprises, when the die (12) is open and after the step for distributing the release agent, a step for inserting the core of the casting inside said at least one impression.

15. A die-casting machine for tilting dies, comprising a device (30) for opening/closing a die (12) and means (35) for tilting said die (12) about at least one substantially horizontal tilting axis (31), said machine (11) being **characterized in that** said at least one tilting axis (31) passes substantially through the center of a casting inlet region (14) of said die (12) in order to feed molten mass.

16. The die-casting machine according to claim 15, **characterized in that** it comprises two substantially horizontal tilting axes (31), which are mutually perpendicular and co-planar and pass substantially through the center of the inlet region (14) of said die (12), said pair of axes (31) comprising respectively a first tilting axis (31a), which is substantially parallel to the parting plane of said die (12), and a second tilting axis (31 b), which is substantially perpendicular to the parting plane of said die (12).

17. The die-casting machine according to claim 16, **characterized in that** said opening/closing device (30) comprises two mutually opposite closure units

(32), a first unit being fixed and a second unit being movable with respect to the first unit along guiding columns (32a), a respective articulation unit (33) being rigidly coupled on each one of said closure units (32), said articulation units (33) having, on their mutually opposite and facing ends, respective flanges (34) for fixing to respective die portions (112), said flanges (34) being pivoted to said articulation units (33) about said second tilting axis (31b), said opening/closure device (30) being pivoted about said second tilting axis (31b) to an intermediate frame (36), which in turn is pivoted to a supporting framework (37) about said first tilting axis (31a).

18. The die-casting machine according to claim 17, **characterized in that** said tilting means (35) comprise a first motor drive (40), which is arranged on said intermediate frame (36) and is kinematically associated with the rotation of said device (30) about said second tilting axis (31b), said tilting means (35) further comprising a second motor drive (41), which is arranged on said supporting framework (37) and acts on said intermediate frame (36) in order to rotate it about said first tilting axis (31a).

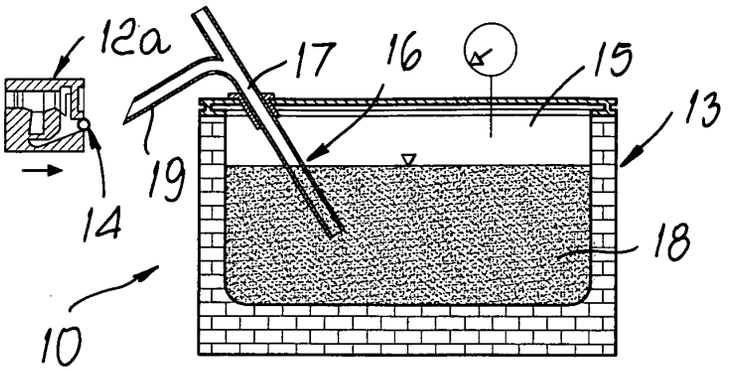


Fig. 1a

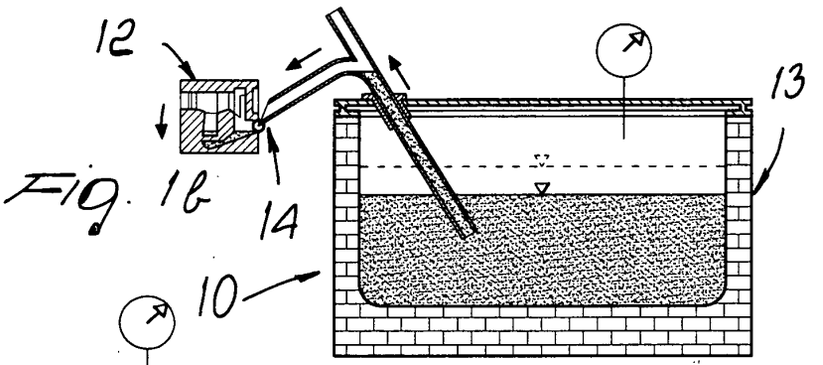


Fig. 1b

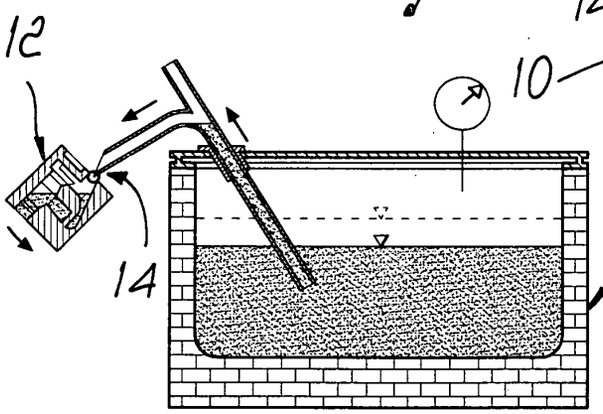


Fig. 1c

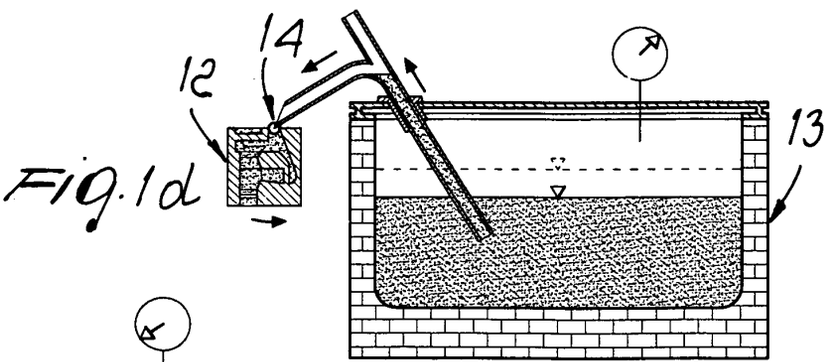


Fig. 1d

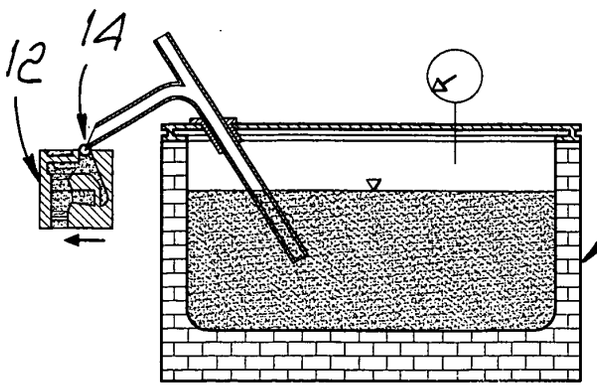


Fig. 1e

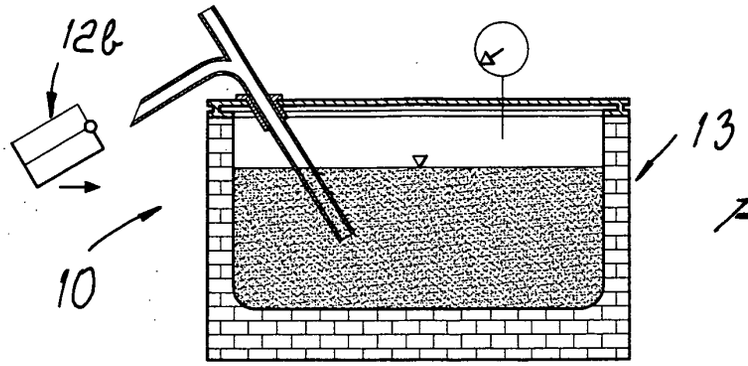


Fig. 2a

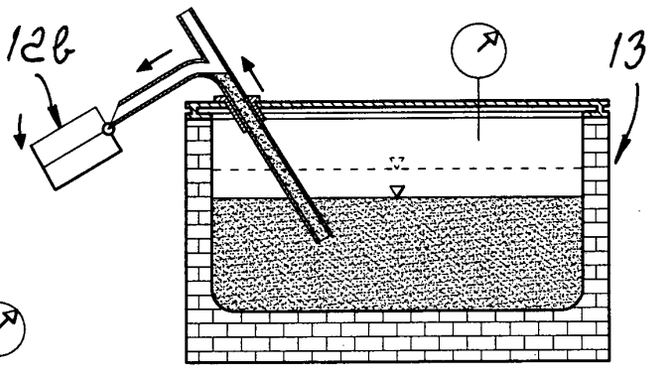


Fig. 2b

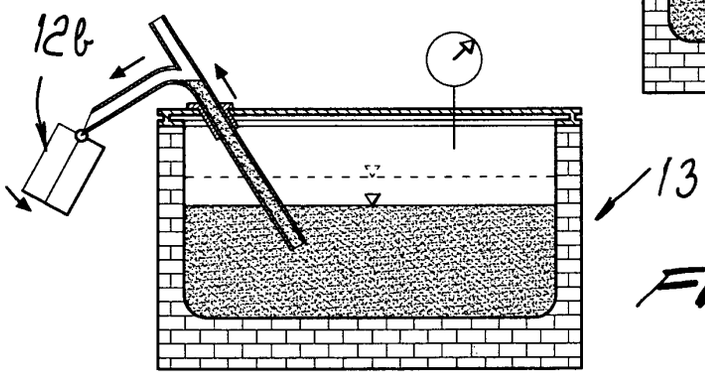
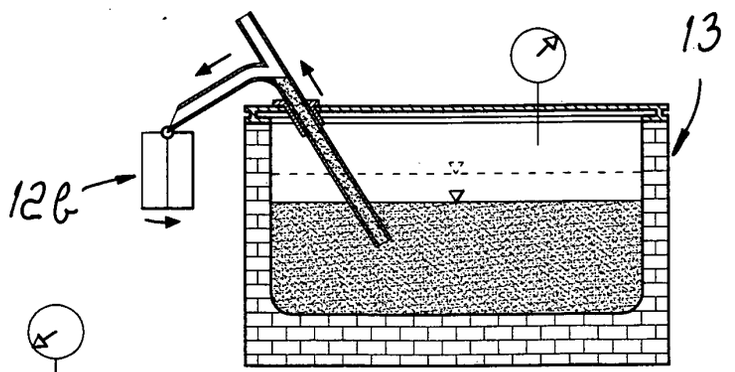


Fig. 2c



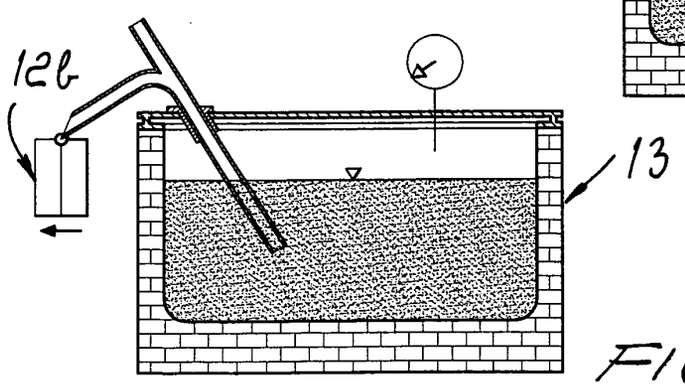


Fig. 2d

Fig. 2e

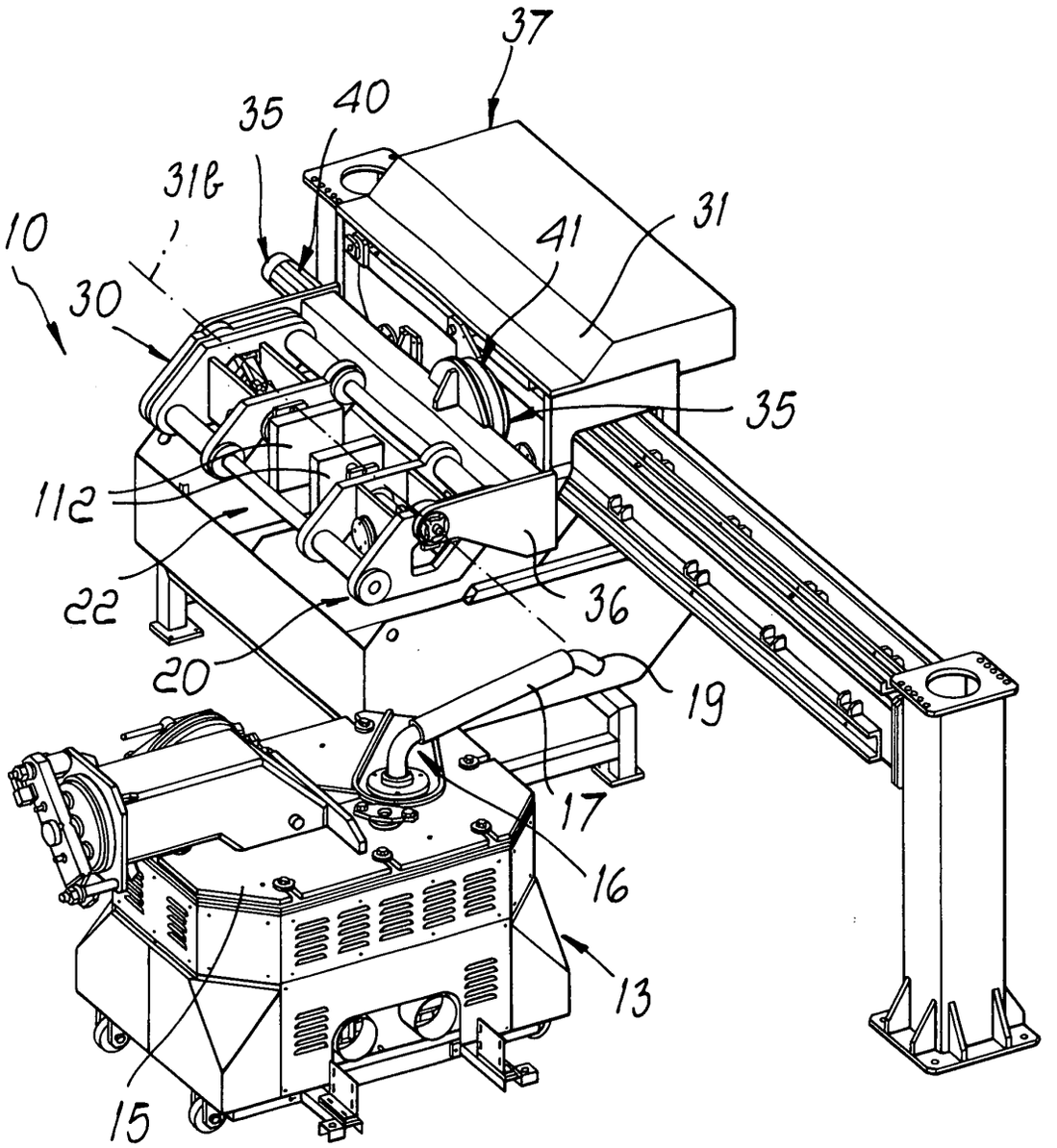


Fig. 3

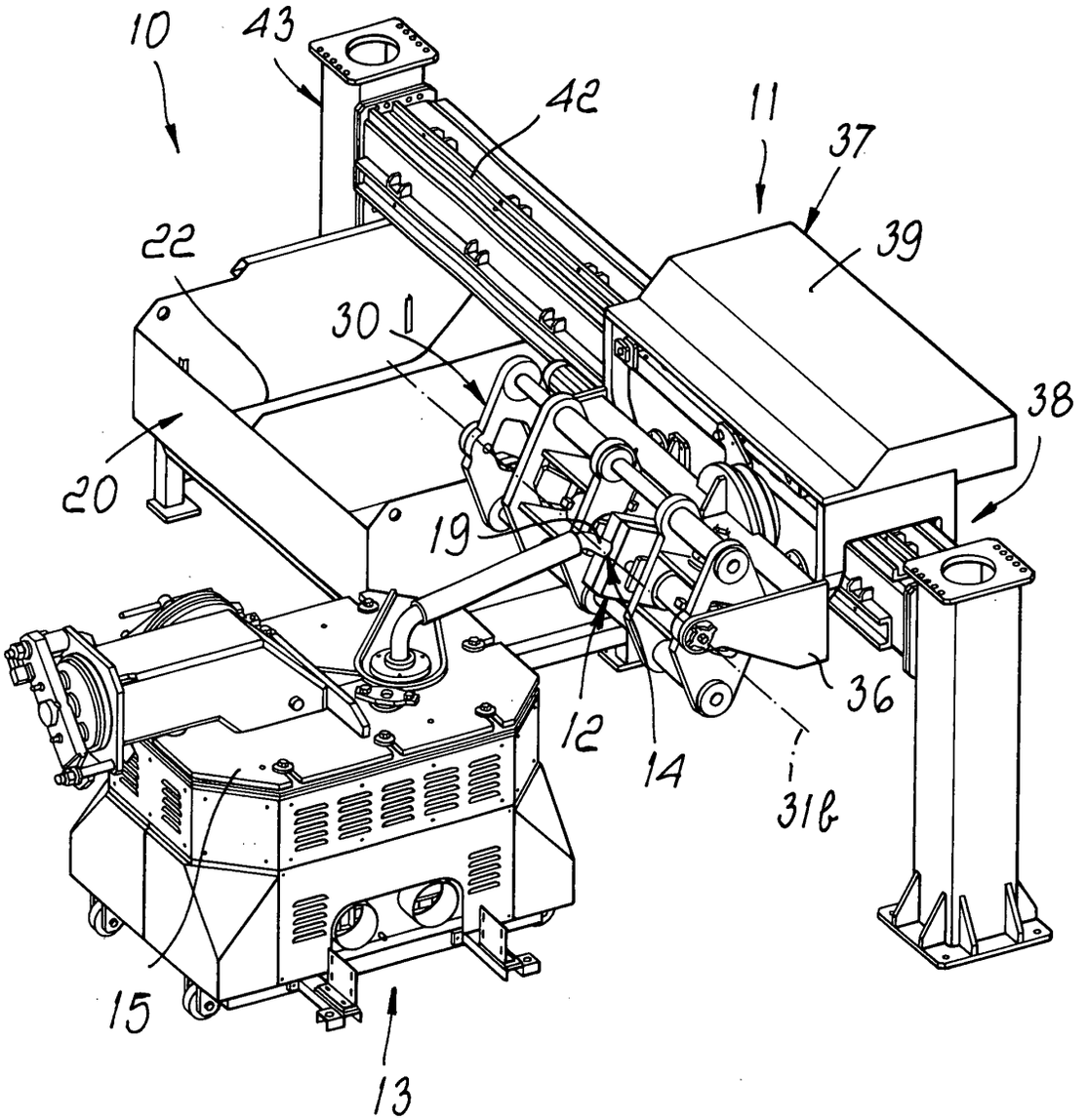


Fig. 4

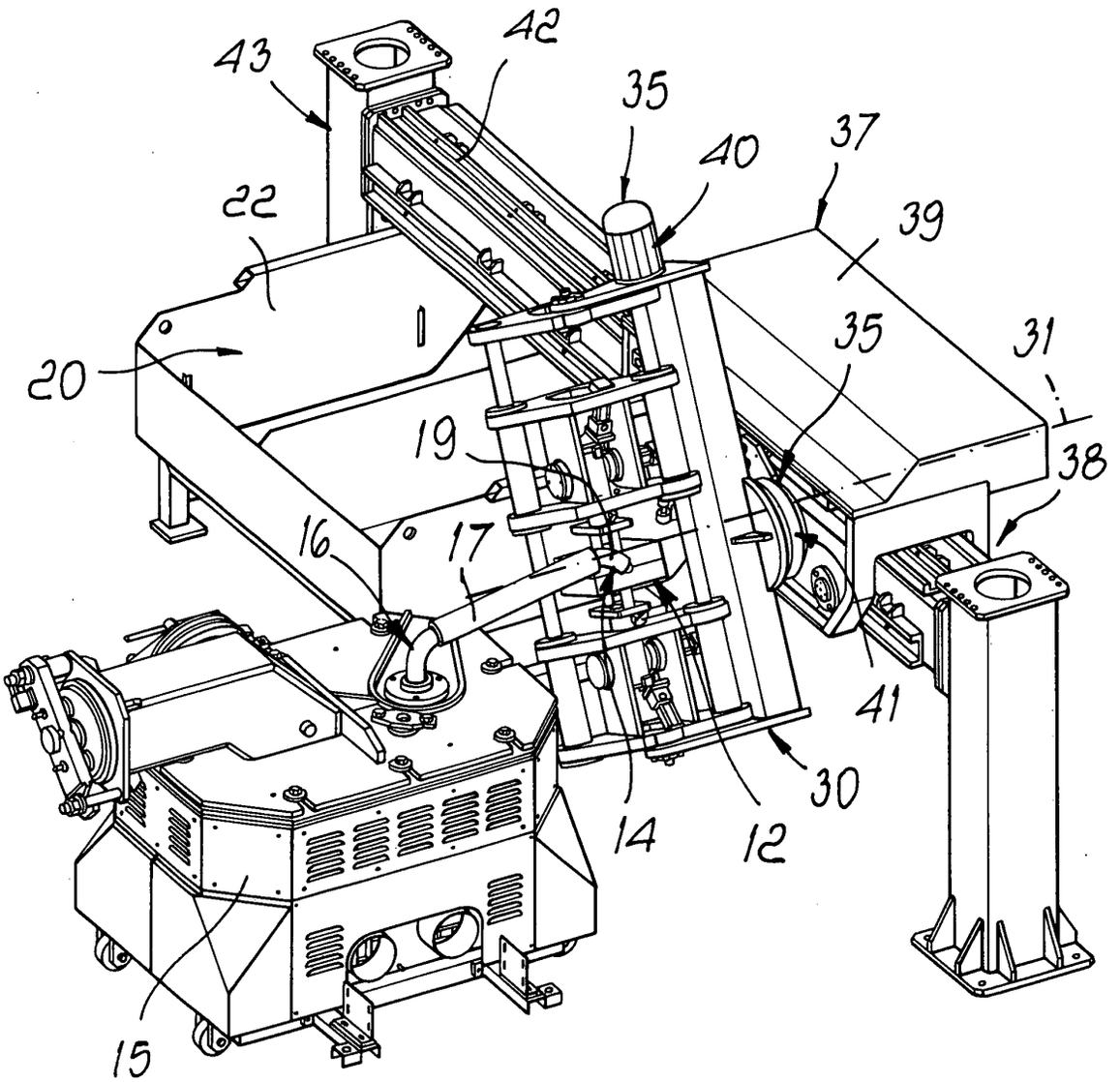
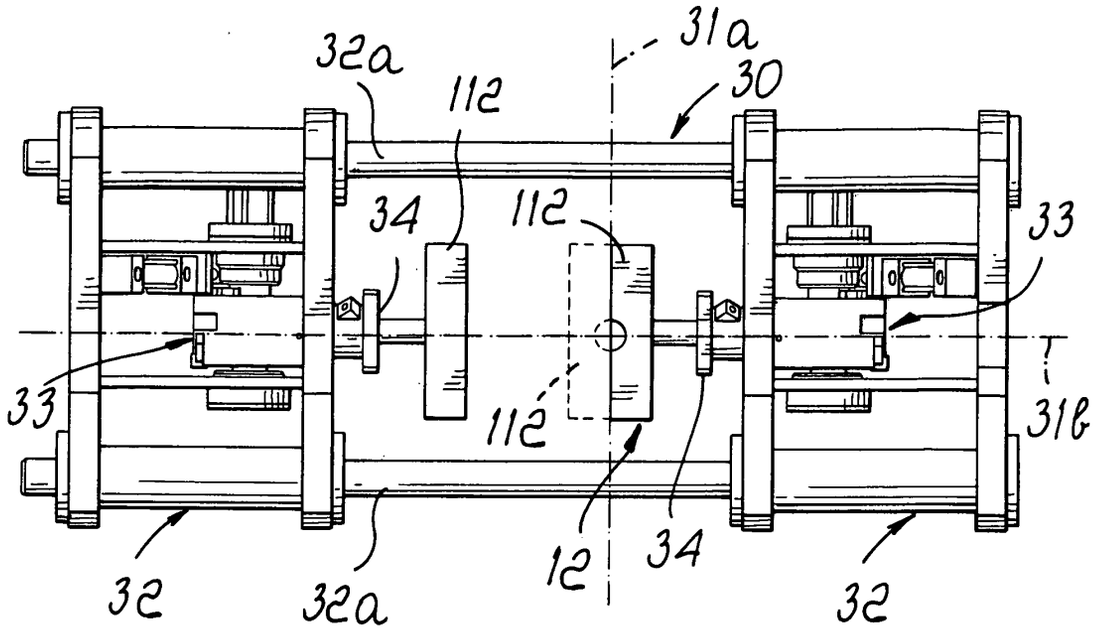


Fig. 5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31b
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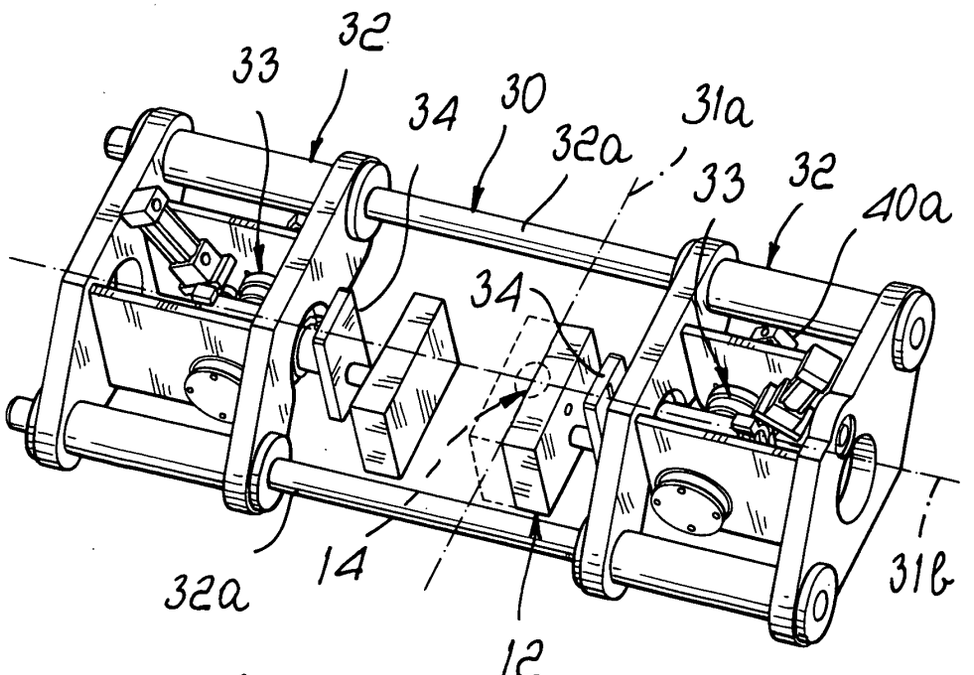
32a
32

Fig. 6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31b

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 04 01 2069

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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
The Hague	22 September 2004	Mailliard, A

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