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(71) Applicant: **Elti Suisse S.A.**
**6745 Giornico (CH)**

(72) Inventor: **Pedrali, Andrea**
**25051, CEDEGOLO BS (IT)**

(74) Representative: **Modiano, Micaela Nadia et al**
**Modiano & Partners**
**Via Meravigli, 16**
**20123 Milano (IT)**

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(54) **Machine for performing heat treatment of mechanical parts shaped like a solid of rotation, in particular for hardening railroad wheels or the like**

(57) A machine for performing heat treatment of mechanical parts shaped like a solid of rotation, particularly for hardening railroad wheels or the like. The machine comprises: a tank (2), which is adapted to accommodate at least the portion of a mechanical part (3) to be treated, means (61) for supplying a treatment fluid to the tank (2), and means (62) for supporting the mechanical part (3) in the tank (2) so that the axis of the mechanical part (3) is arranged substantially vertically, the machine further comprises first means (63) for dispensing a treatment fluid, which are arranged in the tank (2) and have a dispensing direction that is oriented toward the lateral surface of the mechanical part (3) placed on the supporting means (62) in the tank (2).

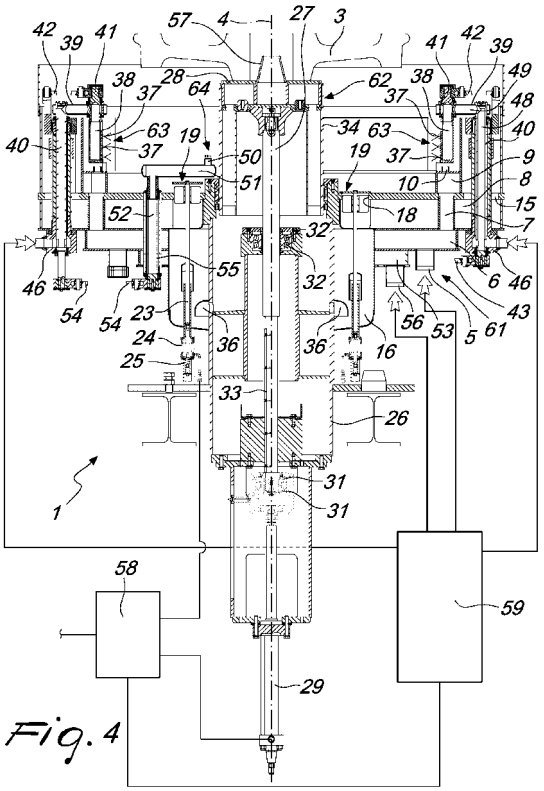


Fig. 4

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## Description

**[0001]** The present invention relates to a machine for performing heat treatment of mechanical parts shaped like solids of rotation, in particular for hardening railroad wheels or the like.

**[0002]** As is known, in the production of railroad wheels, which are made of steel, the hardening heat treatment to which the wheels must be subjected is a very important aspect. Hardening, for satisfying the requirements of mechanical strength, usually affects the tread of the wheel by including or excluding the protruding lateral edge that axially delimits said tread on one side, or can be required also for other parts of the wheel, such as for example the annular portion located on the side of the wheel that is furthest from the lateral edge.

**[0003]** For performing the hardening heat treatment of railroad wheels, mainly two methods are used:

- the immersion method;
- the spray method.

**[0004]** The immersion method, disclosed for example in DE-OS-2017632, consists in supporting the wheel so that its axis is vertical and in immersing it gradually in a tank that contains a cooling liquid. The immersion of the wheel can vary, and specific regions of the wheel can be shielded so that the cooling performed by the liquid affects only certain regions, resulting in a heat treatment effect that is differentiated by regions, known as "selective hardening".

**[0005]** This hardening method, in contrast with an extremely simple plant for its execution, has the drawback of not allowing high rates of cooling and thus of being unsuitable to thermally treat newly engineered materials that require higher cooling rates.

**[0006]** Another drawback of this method is the reduced possibility of setting up and controlling precisely the hardening parameters, which makes it practically impossible to repeat precisely the treatment in order to obtain substantially equal mechanical characteristics for an equal number of mechanical parts treated.

**[0007]** Moreover, the reduced cooling rate has the effect of slowing down the entire production line.

**[0008]** The spray method is generally performed by supporting the wheel so that its axis is vertical and by arranging nozzles so that they face the tread or other preset regions of the wheel and propelling, by means of said nozzles, a cooling liquid against the region to be cooled. During the treatment, the wheel is generally turned about its own axis. A method of this type is disclosed, for example, in EP-1772558.

**[0009]** This method, too, has the drawback of reaching cooling rates that are not always able to completely meet the hardening requirements of newly engineered steels.

**[0010]** Moreover, even with this method it is difficult to be able to repeat precisely a specific treatment so as to be able to ensure the required hardening result.

**[0011]** In recent years there has been a constant search for an improvement of the quality standard of railroad wheels, in order to meet the requirements of the sector, which has led to the creation of new steels which, in order to fully utilize their potential, require heat treatments which can be configured in each instance in terms of cooling rate, ranging over a specific and broad work range. Moreover, another requirement that is particularly felt in the field of heat treatments is to obtain cooling conditions that are extremely precise and precisely repeatable so as to provide adequate guarantee of uniformity as regards the achievement of specific mechanical characteristics in the treated parts.

**[0012]** The machines currently used to perform the hardening methods cited above do not meet these requirements or meet them only partially.

**[0013]** The aim of the present invention is to provide a machine for performing heat treatment of mechanical parts shaped like a solid of rotation, particularly for hardening railroad wheels or the like, which can operate according to parameters that can vary precisely so as to meet the most disparate requirements.

**[0014]** Within this aim, an object of the invention is to provide a machine that can repeat heat treatment cycles precisely so as to obtain qualitatively high and uniform treatment effects.

**[0015]** Another object of the invention is to provide a machine that can be configured and can operate both according to the immersion method and according to the spray method, depending on the requirements.

**[0016]** Another object of the invention is to provide a machine that, in particular, can reach without problems the desired cooling rates required in the heat treatment of recently formulated steels.

**[0017]** This aim and these and other objects that will become better apparent hereinafter are achieved by a machine for performing heat treatment of mechanical parts shaped like a solid of rotation, particularly for hardening railroad wheels or the like, comprising:

- a tank that is adapted to accommodate at least the portion of a mechanical part to be treated;
- means for supplying a treatment fluid to said tank;
- means for supporting the mechanical part in said tank so that the axis of said mechanical part is arranged substantially vertically;

characterized in that it comprises first means for dispensing a treatment fluid, which are arranged in said tank with their dispensing direction oriented towards the lateral surface of the mechanical part that is placed on said supporting means in said tank.

**[0018]** Further characteristics and advantages will become better apparent from the description of a preferred but not exclusive embodiment of the machine according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a perspective view of the machine according to the invention, with some elements omitted for the sake of simplicity and for greater clarity;

Figure 2 is a perspective view of the machine according to the invention, taken from a different angle with respect to Figure 1, with some elements omitted for the sake of simplicity and greater clarity;

Figure 3 is a schematic top plan view of the machine according to the invention, highlighting the lines for supplying the treatment fluid and with some elements omitted for the sake of simplicity and greater clarity;

Figure 4 is a schematic sectional view of the machine according to the invention, taken along a plurality of vertical planes, in order to illustrate several elements of the machine and with some other elements omitted for the sake of simplicity and greater clarity;

Figure 5 is a schematic sectional view, taken along the line V-V of Figure 3;

Figure 6 is an enlarged-scale view of a detail of Figure 4;

Figures 7 and 8 are schematic top plan views of the configuration of the machine during the treatment of two mechanical parts having different diameters.

**[0019]** With reference to the figures, the machine according to the invention, generally designated by the reference numeral 1, comprises a tank 2 that is adapted to accommodate at least a portion of a mechanical part 3 to be treated, which is constituted, in the illustrated embodiment, by a railroad wheel.

**[0020]** In the illustrated embodiment, the tank 2 has a polygonal plan shape, but it may also have a circular plan shape or another shape according to the requirements.

**[0021]** The machine is provided with means 61 for supplying a treatment fluid to the tank 2 and with means 62 for supporting the mechanical part 3 to be treated so that the rotation axis of the mechanical part 3 is arranged substantially vertically.

**[0022]** According to the invention, the machine comprises first means 63 for dispensing a treatment fluid, which are arranged in the tank 2 and have a dispensing direction that is oriented towards the lateral surface of the mechanical part 3 that is arranged on the supporting means 62 in the tank 2.

**[0023]** The tank 2 extends around a vertical axis which constitutes the main axis 4 of the machine.

**[0024]** The means 61 for supplying the treatment fluid to the tank 2 comprise one or more ports 5 which are connected to a first chamber 6 which extends around the main axis 4 below the bottom of the tank 2. Said first chamber 6 is connected, by means of connecting ducts 7 which have a vertical axis and pass through a second chamber 8, which also extends around the main axis 4 between the first chamber 6 and the bottom of the tank 2, to an annular duct 9 located on the bottom of the tank 2. The annular duct 9 supplies outlets 10 which have a vertical axis and on which filler nozzles 11 are fitted; said nozzles have an elbow-shaped body so that the dispensing direction of the jets emitted by said filler nozzles 11 is substantially horizontal and inclined with respect to a direction which is radial with respect to the main axis 4. In this manner, the filler nozzles 11, besides conveying the treatment fluid into the tank 2, also cause a rotary motion, around the main axis 4, of the treatment fluid located in the tank 2.

**[0025]** The corners of the tank 2 are delimited by vertical walls 12 in which the face that is oriented towards the main axis 4 is shaped like a portion of a cylindrical surface whose axis coincides with the main axis 4. In this manner, the set of said vertical walls 12 defines a cylindrical surface interrupted by recesses 13.

**[0026]** The corner regions 14 delimited by the lateral walls of the tank 2 and by said vertical walls 12 are connected, by means of adapted passages 15 defined on the bottom of said corner regions 14, to the second chamber 8, which in turn is connected to a central discharge chamber 16, which is connected to a discharge port 17. In practice, the upper edge of the vertical walls 12 that delimit the corner regions 14 of the tank 2 defines the level of the free surface 80 of the treatment fluid that is introduced in the tank 2 when it is in liquid state, i.e., when it is constituted by a treatment liquid.

**[0027]** The bottom of the tank 2 is connected, by means of one or more drain holes 18, to the central discharge chamber 16. At each one of said drain holes 18 there are plugs 19, which can be actuated automatically in order to block the associated drain hole 18 in order to allow the filling of the tank 2 with the treatment liquid or in order to open the associated drain hole 18 so as to discharge the treatment liquid introduced previously into the tank 2.

**[0028]** More particularly, each plug 19 is composed of a plate 20 which has a vertical axis and is provided, on its lower side, with a gasket 21 that can be engaged with the bottom of the tank 2 around the associated drain hole 18. Each plug 19, below the plate 20, has guiding fins 22 which can be engaged slidingly with the corresponding drain hole 18 so as to keep the plug 19 correctly positioned with respect to the corresponding drain hole 18. The plate 20 is fixed to the upper end of a rod 23 having a vertical axis, which is connected to the stem of the piston of a fluid-operated cylinder 24 whose body is supported by the supporting structure of the machine. The fluid-operated cylinder 24 can be supplied with a pressurized fluid so as to actuate the upward movement of the rod 23 and of the plate 20, i.e., actuate the opening of the corresponding drain hole 18. The upward movement of the rod 23 and the plate 20 is contrasted by a return spring 25, which, when the fluid-operated cylinder 24 is connected to the discharge, causes the lowering of the rod 23 and of the plate 20, actuating the closure of the corresponding drain hole 18.

**[0029]** Advantageously, the machine is provided with means for varying the position of the mechanical part 3 with respect to the free surface 80 of the treatment liquid in the tank 2.

**[0030]** More particularly, a hollow cylinder 26 whose axis coincides with the main axis 4 is fixed to the center of the bottom of the tank 2. The hollow cylinder 26 supports, so that it can slide along the main axis 4 and rotate about said main axis 4, a main shaft 27, to the upper end of which a disk-like element 28 is coaxially and jointly connected. The main shaft 27 and the disk-like element 28 constitute the supporting means 62 for the mechanical part 3, which is rested on the disk-like element 28, as will become better apparent hereinafter.

**[0031]** The means for varying the position of the mechanical part 3 with respect to the free surface 80 of the treatment liquid in the tank 2 comprise means for the translation of the supporting means 62 along a substantially vertical direction.

**[0032]** More particularly, the translation means comprise a fluid-operated cylinder 29, which is fixed with its body to the lower end face of the hollow cylinder 26 and is arranged coaxially to the main shaft 27 and thus with its axis at the main axis 4. The fluid-operated cylinder 29 is connected, by means of the stem of its piston, to the lower end of the main shaft 4 so that an actuation of the fluid-operated cylinder 29 generates a lifting or lowering of the main shaft 27 along the main axis 4.

**[0033]** The main shaft 27, moreover, is connected to the output shaft of an electric gearmotor 30, whose actuation causes the rotation of the main shaft 27 about its own axis, which coincides with the main axis 4 with respect to the hollow cylinder 26 and thus the tank 2. For this purpose, the main shaft 27 is supported by the hollow cylinder 26 so that it can rotate about its own axis by way of pairs of bearings 31, 32 and the main shaft 27 is provided with a tab 33 that extends along part of the length of the main shaft 27, so as to maintain the connection, during rotation about the main axis 4, between the main shaft 27 and the output shaft of the gearmotor 30 during the translation of the main shaft 27 along the main axis 4.

**[0034]** The disk-like element 28 closes in an upward region a cylindrical jacket 34, whose axis coincides with the main axis 4, and such cylindrical jacket 34 mates, so as to allow axial sliding, with the hollow cylinder 26 by means of the interposition of sealing gaskets 35.

**[0035]** The inside of the hollow cylinder 26 is connected to the central discharge chamber 16 by one or more lateral openings 36.

**[0036]** The first dispensing means 63 comprise first nozzles 37 for dispensing treatment fluid, which face the lateral surface of the mechanical part 3 arranged on the supporting means 62, and there are first means for moving the first nozzles 37 along a direction with a radial component with respect to the main axis 4.

**[0037]** More specifically, the first nozzles 37 are supported by box-like bodies 38, which are arranged around the main axis 4 and are accommodated in the recesses 13 located between the vertical walls 12 that delimit the corner regions 14 of the tank 2. Each box-like body 38 is shaped substantially like a parallelepiped and bears the first nozzles 37 on one of its lateral faces. Each box-like body 38 is supported, so that it can rotate about a vertical axis, at the end of a supporting arm 39, which is fixed, with its opposite end, to the upper end of a shaft 40 which has a vertical axis and is supported, so that it can rotate about its own axis, by the tank 2. Each box-like body 38 is fixed to a pivot 41, which has a vertical axis and is mated, so that it can rotate about its own axis, with the supporting arm 39. The pivot 41 is connected, by means of a linkage 42, to a region of the tank 2 that is spaced from the axis of the shaft 40. Thanks to this connection, a rotation of the shaft 40 about its own axis in relation to the tank 2 causes a rotation of the supporting arm 39 and therefore a movement of the corresponding box-like body 38 toward or away from the main axis 4 and, at the same time, causes a partial rotation of the box-like body 38 about the axis of the pivot 41 in relation to the supporting arm 39. In this manner, when, by way of the rotation of the shaft 40 about its own axis, the distance of the corresponding box-like body 30 from the main axis 4 is changed, it is possible to maintain the desired orientation of the first nozzles 37 in relation to the lateral surface of the mechanical part 3, as will become better apparent hereinafter. It should be noted that the length of the connecting rod 42 can be adjusted during the setup of the machine so as to adjust, according to the requirements, the orientation of the first nozzles 37 with respect to the lateral surface of the mechanical part 3 that they face.

**[0038]** The lower end of each shaft 40 protrudes downwardly from the bottom of the tank 2 and the ends of the several shafts 40 are kinematically connected to each other by way of linkages 43 so that the rotation imposed on one shaft 40 about its own axis is transmitted to the other shafts 40.

**[0039]** The first movement means comprise a linear actuator 44, which is operated by a corresponding electric motor 45, which is connected to the bottom of the tank 2 and is connected to a shaft 40.

**[0040]** A supply coupling 46 is arranged around the end portion of each one of the shafts 40 that protrudes downwardly from the tank 2, above the region where the linkages 43 are connected, the supply coupling being connected to a corresponding duct 47 for supplying the treatment fluid to the first nozzles 37. Inside each shaft 40 there is an axial duct 48, which is connected to a duct 49, which is defined in the supporting arm 39 and leads into the corresponding box-like body 38. Each shaft 40, at the corresponding supply coupling 46, is provided with lateral openings for the flow of the treatment fluid from the supply coupling 46 to the axial duct 48.

**[0041]** Advantageously, the machine according to the invention comprises second means 64 for dispensing a treatment fluid, which are arranged proximately to the bottom of the tank 2 and propel such fluid toward the surface of the mechanical part 3 that is directed toward the bottom of the tank 2.

**[0042]** Said second dispensing means 64 comprise second nozzles 50 for dispensing the treatment fluid,

which face the surface of the mechanical part 3, arranged on the supporting means 62, that is directed toward the bottom of the tank 2, and there are second means for moving the second nozzles 50 along a direction with a radial component with respect to the main axis 4.

**[0043]** More particularly, each one of the second nozzles 50 is connected to a hollow arm 51, which is arranged inside the tank 2 proximately to its bottom on a substantially horizontal plane and is fitted over the upper end of a hollow shaft 52, which has a vertical axis and is arranged substantially flush with the bottom of the tank 2. Each hollow shaft 52 is supported by the tank 2 so that it can rotate about its own axis and passes through the second chamber 8, the first chamber 6 and a third chamber 53, which is arranged below the first chamber 6 around the central discharge chamber 16. Each hollow shaft 52 protrudes, with its lower end, below the third chamber 53 and said lower end can be connected, in a manner similar to the one described with reference to the shafts 40, to an actuator which can be operated so as to cause the rotation of the hollow shafts 52 about their respective axes.

**[0044]** Advantageously, as an alternative to this solution, as shown, the lower end of each one of the hollow shafts 52 is connected, by means of a lever system 54, to one of the shafts 40 so as to be able to use, in order to move the second nozzles 50 around the axis of the corresponding hollow shaft 52, the linear actuator 44 that moves the first nozzles 37 around the axis of the shafts 40.

**[0045]** In this manner it is possible to vary the position of the first nozzles 37 and of the second nozzles 50 with respect to the mechanical part 3, for example in order to adapt the position of the first nozzles 37 and of the second nozzles 50 to the diameter of the mechanical part 3, as shown particularly in Figures 7 and 8, by simply actuating the linear actuator 44. The lever system 54 that connects the hollow shafts 52 to the shafts 40 can be provided so as to transmit the rotary motion between the two shafts 40 and 52 with an adequate ratio for the correct positioning of the second nozzles 50 with respect to the mechanical part 3.

**[0046]** The region of each hollow shaft 52 that is located in the third chamber 53 is crossed by at least one passage 55 for the treatment fluid that must be supplied to the second nozzles 50, and the third chamber 53 can be connected, through a port 56, to a supply duct of such fluid.

**[0047]** It should be noted that if propulsion of the treatment fluid also onto the surface of the mechanical part 3 that is directed toward the bottom of the tank 2 is not required, the hollow arms 51 may be omitted and the upper end of the hollow shafts 52 may be closed by a plug, as shown in Figure 5.

**[0048]** The disk-like element 28 is arranged so that its axis lies at the main axis 4 and defines, with its upper face, a substantially horizontal resting contact surface for the mechanical part 3. The disk-like element 28 has a central protrusion 57 for facilitating the positioning of the mechanical part 3 with its axis at the main axis 4.

**[0049]** If the surface of the mechanical part 3 that is directed toward the bottom of the tank 2 has to be protected against contact with the treatment fluid, the disk-like element 28 can have a larger diameter than the one shown, and its upper face can be provided with a sealing layer, which can engage the regions of the mechanical part 3 that one wishes to preserve from contact with the treatment fluid.

**[0050]** Advantageously, the machine is provided with means for controlling the position of the disk-like element 28 along the main axis 4 and with means for controlling the position of the first nozzles 37 and of the second nozzles 50, if provided, with respect to the main axis 4.

**[0051]** The means for controlling the position of the disk-like element 28 along the main axis 4 may be constituted by a linear encoder, of a known type, which is associated or integrated with a fluid-operated cylinder 29.

**[0052]** The means for controlling the position of the first nozzles 37 and/or of the second nozzles 50 can be constituted by an encoder, of a known type, which is fitted on, or connected to, the linear actuator 44, which as mentioned moves both the first nozzles 37 and the second nozzles 38.

**[0053]** Conveniently, the machine comprises a control and monitoring element 58 of the programmable electronic type, by way of which it is possible to control and vary the parameters of the heat treatment according to preset programs, so as to be able to achieve precise and reliable repeatability of the treatments performed.

**[0054]** More particularly, the control and monitoring element 58 is connected to the fluid-operated cylinder 29 and to the encoder that controls the positioning of the disk-like element 28 along the main axis 4 so as to actuate and control the translation of the disk-like element 28 and therefore of the mechanical part 3 along the main axis 4, and also vary the speed with which the mechanical part 3 is translated along the main axis 4.

**[0055]** The control and monitoring element 58 is connected to the electric gearmotor 30, which can be provided with a variable-speed electric motor with an encoder or other device for controlling the rotation rate, so as to control and actuate the speed at which the mechanical part 3 is rotated about the main axis 4.

**[0056]** The control and monitoring element 58, moreover, is connected to a central supply unit 59, which supplies the nozzles 11, 37 and 50 so as to vary, according to preset programs, the characteristics of the treatment fluid.

**[0057]** More particularly, the treatment fluid that is introduced in the tank 2 through the filler nozzles 11, as well as the treatment fluid that is supplied to the nozzles 37 and 50, is preferably constituted by water or compressed air, optionally with the addition of specific polymers, or by a mixture of said components.

**[0058]** The several components of the treatment fluid supplied to the tank 2 and of the treatment fluid supplied

to the nozzles 37 and 50 are supplied to the central supply unit 59, in which it is possible to vary the composition, the flow-rate and the pressure of the fluid that is supplied to the nozzles 11, 37 and 50 by way of drivable components of a known type, such as for example electric valves, flow meters, pressure gauges, flow-rate regulators and pressure regulators. The central supply unit 59, by way of the electric valves, the flow regulators and pressure regulators, the flow-rate and pressure measurement units, is controlled by the control and monitoring element 58 according to preset programs.

**[0059]** Optionally, it is possible to provide, along the supply line of the treatment fluid, heating means and temperature sensors which are also functionally connected to the control and monitoring element 58, which varies and controls the treatment fluid temperature according to preset programs.

**[0060]** Obviously, some of the control and monitoring operations described above, instead of being managed by the control and monitoring element 58, might be managed manually. In this case the components of the machine to be managed manually are not connected to the control and monitoring element 58 or may be disconnected from such control and monitoring element 58 if needed.

**[0061]** It should be noted that the box-like bodies 38 are supplied individually through corresponding ducts 47, so that the control and monitoring element 58 can actuate, simultaneously or sequentially, all or part of the first nozzles 37.

**[0062]** For the sake of completeness in description, it should be noted that the nozzles 11, 37 and 50 can be of the flat fan, solid stream, solid cone or hollow cone type according to the requirements.

**[0063]** Operation of the machine according to the invention is as follows.

**[0064]** If the machine must perform a heat treatment that requires the complete or partial immersion of the mechanical part 3 in a treatment liquid, the tank 2 is filled with the treatment liquid, which is introduced in the tank 2 by way of the filling nozzles 11, which are supplied by the annular duct 9, in turn supplied through the port 5. When the tank 2 is full, the free surface 80 of the treatment liquid is at the level of the upper end of the vertical walls 12 and the box-like bodies 38 are arranged in the recesses 13. The mechanical part 3 to be cooled is placed on the disk-like element 28, which is placed beforehand above the free surface 80 so that its axis coincides with the main axis 4.

**[0065]** By actuating the fluid-operated cylinder 29, the disk-like element 28 is lowered, allowing the gradual immersion of the mechanical part 3 in the treatment liquid, and during the immersion the main shaft 27, and thus the mechanical part 3, can be rotated about the main axis 4 in the same direction of rotation as the treatment liquid, or in the opposite direction, depending on the mechanical characteristics required for the article to be tempered.

**[0066]** Immersion of the mechanical part 3 can be complete or it can be stopped so as to immerse specific regions of the mechanical part 3 that must be cooled faster than other regions. Thus, for example, if the mechanical part 3 is constituted by a railroad wheel arranged with its lateral rim on the side opposite to its side resting on the disk-like element 28, as shown, immersion can be stopped before the lateral rim is immersed, so as to cool rapidly only the wheel tread.

**[0067]** It should be noted that the waiting time of the mechanical part 3 before immersion, the speed with which the mechanical part 3 is immersed, the extent of the immersion, its rotation rate about the main axis 4, as well as the temperature and quality of the treatment liquid introduced in the tank 2 and the total treatment time, are parameters that can be managed with extreme precision by the control and monitoring element 58 according to preset programs.

**[0068]** If the machine must perform a heat treatment that requires spray cooling of the mechanical part 3, the tank 2 is not filled with the treatment liquid but the mechanical part 3 is placed on the disk-like element 28, arranged in the tank 2 and turned about the main axis 4 in a manner similar to what has already been described with reference to cooling by immersion.

**[0069]** Thanks to the actuation of the linear actuator 44, the position of the first nozzles 37 and the second nozzles 50, if provided, is adapted to the dimensions of the mechanical part 3. The first nozzles 37 and the second nozzles 50 are thus supplied with the treatment fluid, which is propelled onto the mechanical part 3, cooling it.

**[0070]** In this case also, the waiting time of the mechanical part 3 before the actuation of the first nozzles 37 and optionally of the second nozzles 50, the rotation rate of the mechanical part 3 about the main axis 4, the temperature, the pressure, the flow-rate and the quality of the treatment fluid supplied to the nozzles 37 and 50, the number of box-like bodies 38 and thus of the first nozzles 37 that are supplied, as well as the total treatment time, are parameters that can be managed with extreme precision by the control and monitoring element 58 according to preset programs.

**[0071]** It should be noted that in heat treatments that do not require partial or complete immersion of the mechanical part 3 in a liquid, the treatment fluid dispensed through the filler nozzles 11 can be in gaseous form and can be constituted, for example, by compressed air optionally with the addition of specific polymers.

**[0072]** In practice, the machine according to the invention, in the particular application for performing the hardening of railroad wheels and/or similar products such as wheel rims and wheel hubs for railroad vehicles, can perform different hardening types, including:

- hardening by full immersion;
- selective hardening of the tread alone, by partial immersion of the mechanical part 3;
- selective spray hardening of the tread alone, by way of the first nozzles 37;

- selective spray hardening of the tread by way of the first nozzles 37 and of the side of the mechanical part that lies opposite the side of the rim by way of the second nozzles 50;
- delayed hardening;
- interrupted quenching;
- air hardening;
- air normalizing;
- air stress relieving.

**[0073]** In practice it has been found that the machine according to the invention fully achieves the intended aim, since by being able to perform various types of cooling with parameters that can vary with high precision, it is able to meet the most disparate requirements in terms of heat treatments, being adapted also for the hardening of recently formulated steels, which are extremely critical in treatment.

**[0074]** Moreover, the machine according to the invention, by being able to manage the treatment parameters according to preset programs, ensures high precision in the repetitiveness of the treatments, achieving high and uniform quality standards.

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

**[0076]** In practice, the materials used, as well as the dimensions, may be any according to requirements and to the state of the art.

**[0077]** 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 machine for performing heat treatment of mechanical parts shaped like a solid of rotation, particularly for hardening railroad wheels or the like, comprising:

   - a tank (2), adapted to accommodate at least the portion of a mechanical part (3) to be treated;
   - means (61) for supplying a treatment fluid to said tank (2);
   - means (62) for supporting the mechanical part (3) in said tank (2) so that the axis of said mechanical part (3) is arranged substantially vertically; **characterized in that** it comprises first means (63) for dispensing a treatment fluid, which are arranged in said tank (2) and with a dispensing direction oriented toward the lateral surface of the mechanical part (3) that is placed on said supporting means (62) in said tank (2).

2. The machine according to claim 1, **characterized in that** it comprises means for varying the position of the mechanical part (3) with respect to the free surface (80) of the treatment fluid, in liquid state, in said tank (2).

3. The machine according to claims 1 and 2, **characterized in that** said means for varying the position of the mechanical part (3) with respect to the free surface (80) of the treatment fluid, in liquid state, comprise means for the translation of said supporting means (62) along a substantially vertical direction.

4. The machine according to one or more of the preceding claims, **characterized in that** it comprises means for the actuation of said supporting means (62) with a rotation movement about a main axis (4) in order to rotate the mechanical part (3) that is arranged on said supporting means (62) with its axis at said main axis (4).

5. The machine according to one or more of the preceding claims, **characterized in that** said first dispensing means (63) comprise first nozzles (37) for dispensing said treatment fluid which face the lateral surface of the mechanical part (3) arranged on said supporting means (62), first means being provided for moving said first nozzles (37) along a direction with a radial component with respect to said main axis (4).

6. The machine according to one or more of the preceding claims, **characterized in that** it comprises second means (64) for dispensing a treatment fluid, which are arranged proximately to the bottom of said tank (2) and with a dispensing direction that is oriented toward the surface of the mechanical part (3) which is directed toward the bottom of said tank (2).

7. The machine according to one or more of the preceding claims, **characterized in that** said second dispensing means (64) comprise second nozzles (50) for dispensing said treatment fluid which face the surface of the mechanical part (3), arranged on said supporting means (62), that is directed toward the bottom of said tank (2), second means being provided for moving said second nozzles (50) along a direction with a radial component with respect to said main axis (4).

8. The machine according to one or more of the preceding claims, **characterized in that** said supporting means (62) comprise a disk-like element (28) whose axis coincides with said main axis (4) and which defines a substantially horizontal resting contact surface for the mechanical part (3) to be treated.

**9.** The machine according to one or more of the preceding claims, **characterized in that** said disk-like element (28) is provided with sealing means which can engage the side of the mechanical part (3) that is designed to be directed toward the bottom of said tank (4).

**10.** The machine according to one or more of the preceding claims, **characterized in that** said first movement means and said second movement means are connected to each other for varying the position of said first nozzles (37) and said second nozzles (50) with respect to said main axis (4) according to the diameter of the mechanical part (3).

**11.** The machine according to one or more of the preceding claims, **characterized in that** comprises means for controlling the position of said disk-like element (28) along said main axis (4).

**12.** The machine according to one or more of the preceding claims, **characterized in that** it comprises means for controlling the position of said first nozzles (37) and/or of said second nozzles (50) with respect to said main axis (4).

**13.** The machine according to one or more of the preceding claims, **characterized in that** said means (61) for supplying said treatment fluid comprise filler nozzles (11) arranged on the bottom of said tank (2) and with a dispensing direction that has an inclined component with respect to the radial direction relative to said main axis (4) in order to induce a rotary motion of the treatment fluid in said tank (2).

**14.** The machine according to one or more of the preceding claims, **characterized in that** it comprises means for varying the characteristics of said treatment fluid.

**15.** The machine according to one or more of the preceding claims, **characterized in that** said means for varying the characteristics of said treatment fluid introduced in said tank (2) and/or supplied to said nozzles (11, 37, 50) comprise at least one of the following:

- means for varying the composition;
- means for varying the flow-rate;
- means for varying the pressure;
- means for varying the temperature.

**16.** The machine according to one or more of the preceding claims, **characterized in that** it comprises a control and monitoring element (58) of the programmable electronic type, which is functionally connected to at least one of the following:

- said first movement means;
- said second movement means;
- said means for actuating said supporting means (62);
- said means for varying the position of the mechanical part (3) with respect to the free surface (80) of the treatment fluid, in liquid state, in said tank (2);
- said means for varying the composition;
- said means for varying the pressure;
- said means for varying the flow-rate;

for its actuation as a function of a preset treatment program.

**17.** The machine according to one or more of the preceding claims, **characterized in that** said treatment fluid comprises water.

**18.** The machine according to one or more of the preceding claims, **characterized in that** said treatment fluid comprises water and/or air with the addition of polymers.

**19.** The machine according to one or more of the preceding claims, **characterized in that** said treatment fluid comprises air.

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

**1.** A machine for performing heat treatment of mechanical parts shaped like a solid of rotation, particularly for hardening railroad wheels or the like, comprising:

- a tank (2), adapted to accommodate at least the portion of a mechanical part (3) to be treated;
- means (61) for supplying a treatment fluid to said tank (2);
- means (62) for supporting the mechanical part (3) in said tank (2) so that the axis of said mechanical part (3) is arranged substantially vertically;
- first means (63) for dispensing a treatment fluid, which are arranged in said tank (2) and with a dispensing direction oriented toward the lateral surface of the mechanical part (3) that is placed on said supporting means (62) in said tank (2), said first dispensing means (63) comprising first nozzles (37) for dispensing said treatment fluid which face the lateral surface of the mechanical part (3) arranged on said supporting means (62), first means being provided for moving said first nozzles (37) along a direction with a radial component with respect to said main axis (4);
- means for varying the position of the mechan-

ical part (3) with respect to the free surface (80) of the treatment fluid, in liquid state, in said tank (2), said means for varying the position of the mechanical part (3) with respect to the free surface (80) of the treatment fluid, in liquid state, comprising means for the translation of said supporting means (62) along a substantially vertical direction;

- means for the actuation of said supporting means (62) with a rotation movement about a main axis (4) in order to rotate the mechanical part (3) that is arranged on said supporting means (62) with its axis at said main axis (4);
- second means (64) for dispensing a treatment fluid, which are arranged proximately to the bottom of said tank (2) and with a dispensing direction that is oriented toward the surface of the mechanical part (3) which is directed toward the bottom of said tank (2),t said second dispensing means (64) comprising second nozzles (50) for dispensing said treatment fluid which face the surface of the mechanical part (3), arranged on said supporting means (62), that is directed toward

the bottom of said tank (2), second means being provided for moving said second nozzles (50) along a direction with a radial component with respect to said main axis (4).

**2.** The machine according to one or more of the preceding claims, **characterized in that** said supporting means (62) comprise a disk-like element (28) whose axis coincides with said main axis (4) and which defines a substantially horizontal resting contact surface for the mechanical part (3) to be treated.

**3.** The machine according to one or more of the preceding claims, **characterized in that** said disk-like element (28) is provided with sealing means which can engage the side of the mechanical part (3) that is designed to be directed toward the bottom of said tank (4).

**4.** The machine according to one or more of the preceding claims, **characterized in that** said first movement means and said second movement means are connected to each other for varying the position of said first nozzles (37) and said second nozzles (50) with respect to said main axis (4) according to the diameter of the mechanical part (3).

**5.** The machine according to one or more of the preceding claims, **characterized in that** comprises means for controlling the position of said disk-like element (28) along said main axis (4).

**6.** The machine according to one or more of the preceding claims, **characterized in that** it comprises means for controlling the position of said first nozzles (37) and/or of said second nozzles (50) with respect to said main axis (4).

**7.** The machine according to one or more of the preceding claims, **characterized in that** said means (61) for supplying said treatment fluid comprise filler nozzles (11) arranged on the bottom of said tank (2) and with a dispensing direction that has an inclined component with respect to the radial direction relative to said main axis (4) in order to induce a rotary motion of the treatment fluid in said tank (2).

**8.** The machine according to one or more of the preceding claims, **characterized in that** it comprises means for varying the characteristics of said treatment fluid.

**9.** The machine according to one or more of the preceding claims, **characterized in that** said means for varying the characteristics of said treatment fluid introduced in said tank (2) and/or supplied to said nozzles (11, 37, 50) comprise at least one of the following:

- means for varying the composition;
- means for varying the flow-rate;
- means for varying the pressure;
- means for varying the temperature.

**10.** The machine according to one or more of the preceding claims, **characterized in that** it comprises a control and monitoring element (58) of the programmable electronic type, which is functionally connected to at least one of the following:

- said first movement means;
- said second movement means;
- said means for actuating said supporting means (62);
- said means for varying the position of the mechanical part (3) with respect to the free surface (80) of the treatment fluid, in liquid state, in said tank (2);
- said means for varying the composition;
- said means for varying the pressure;
- said means for varying the flow-rate;

for its actuation as a function of a preset treatment program.

**11.** The machine according to one or more of the preceding claims, **characterized in that** said treatment fluid comprises water.

**12.** The machine according to one or more of the preceding claims, **characterized in that** said treat-

ment fluid comprises water and/or air with the addition of polymers.

**13.** The machine according to one or more of the preceding claims, **characterized in that** said treatment fluid comprises air.

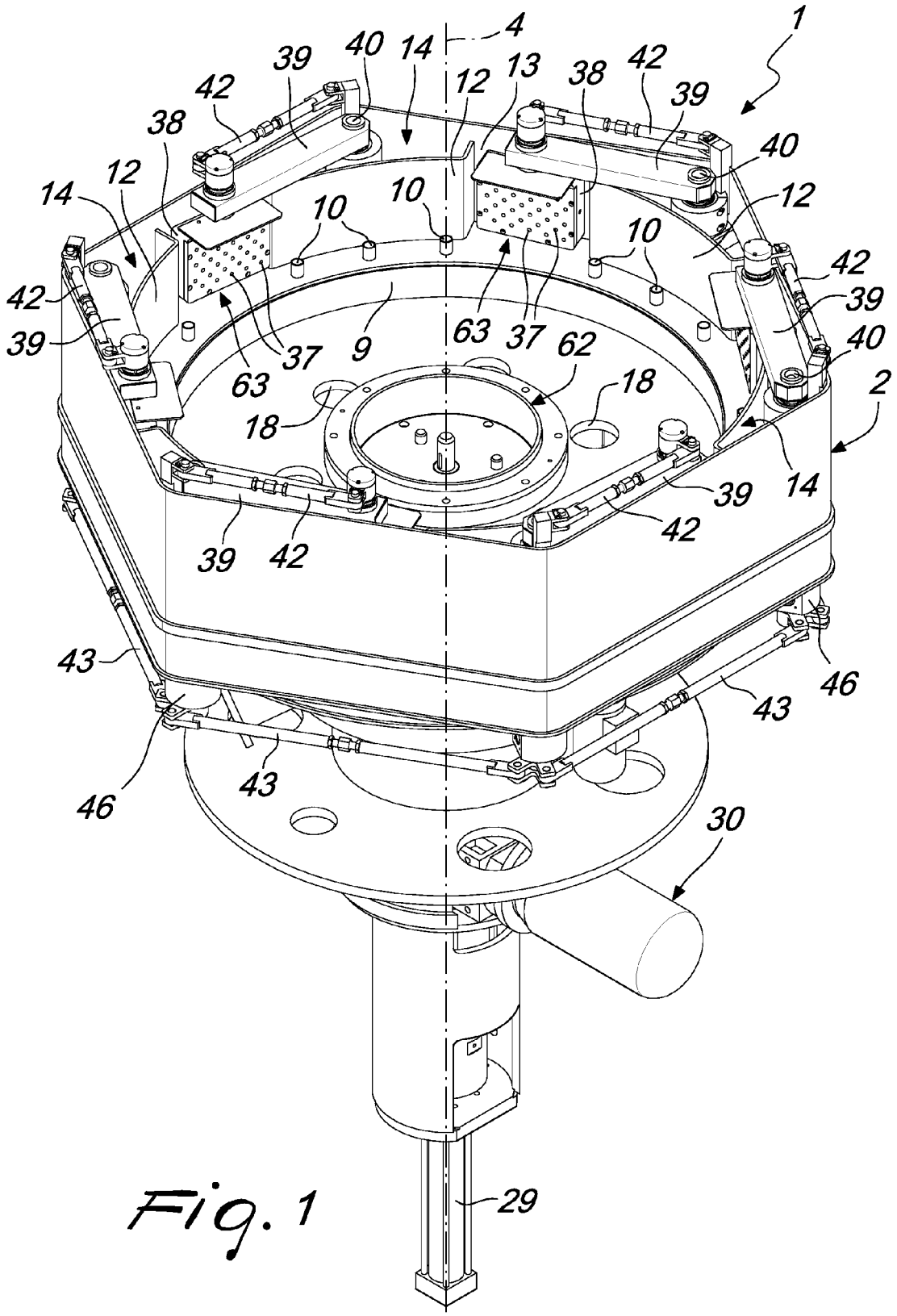



Fig. 1

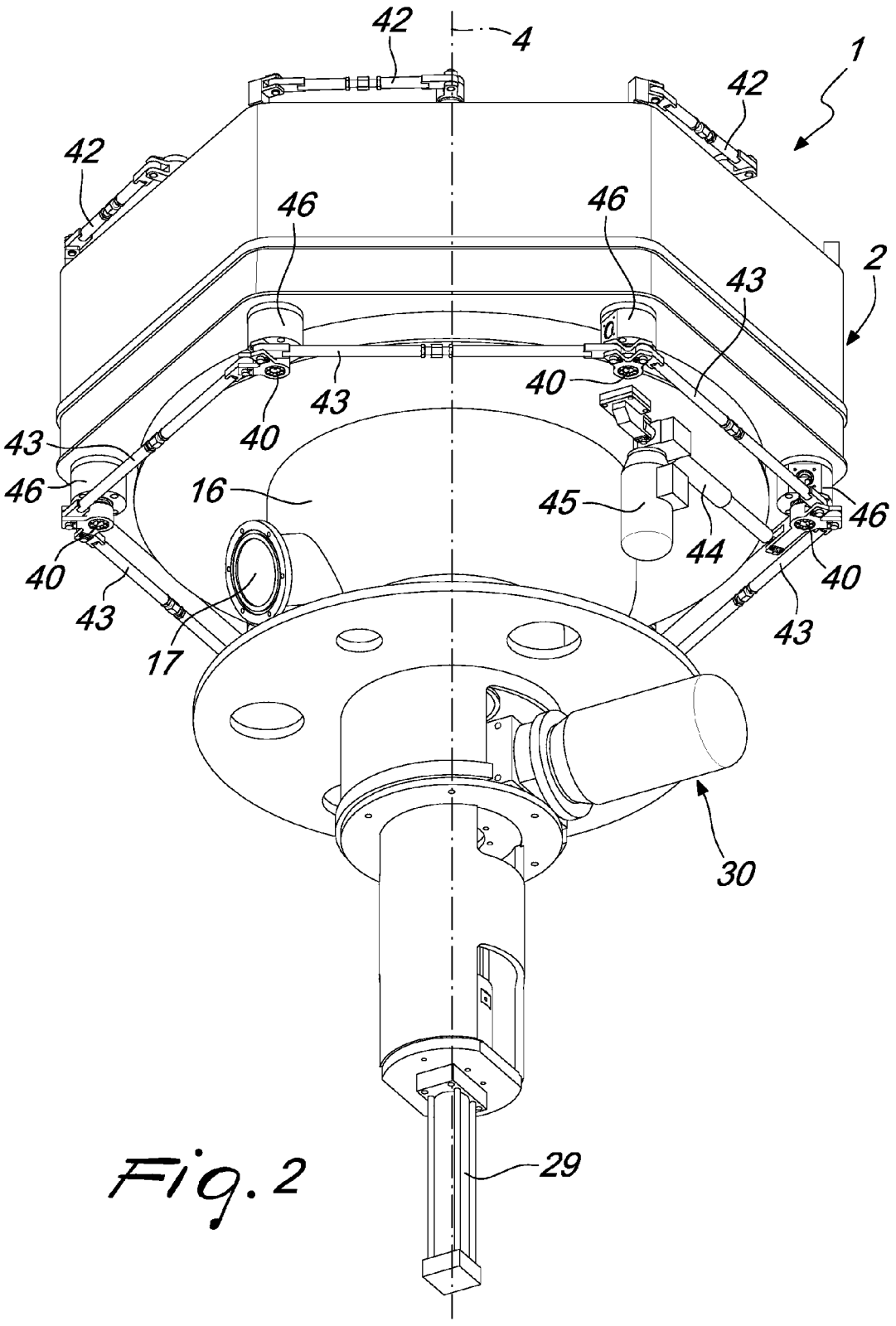
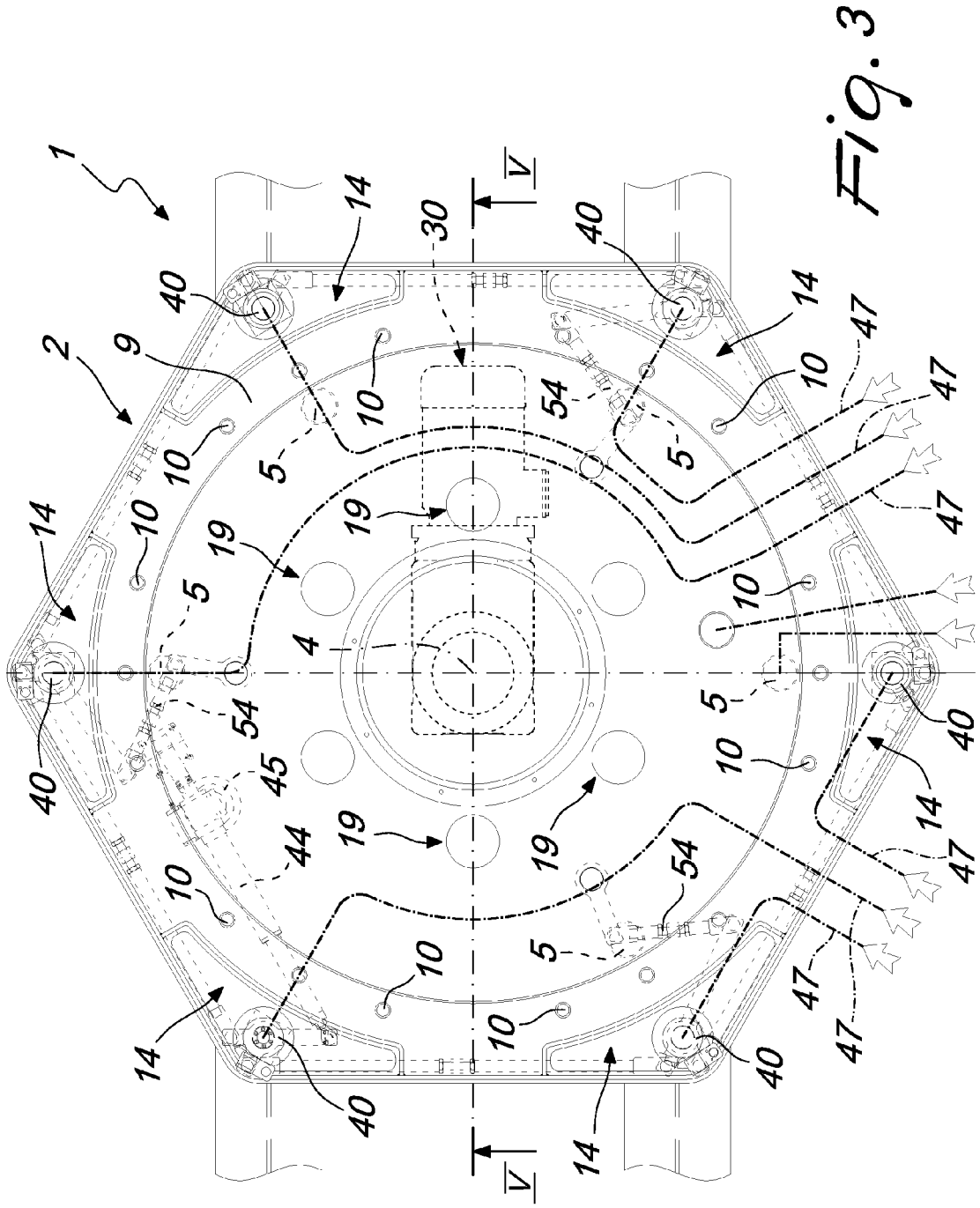



Fig. 2

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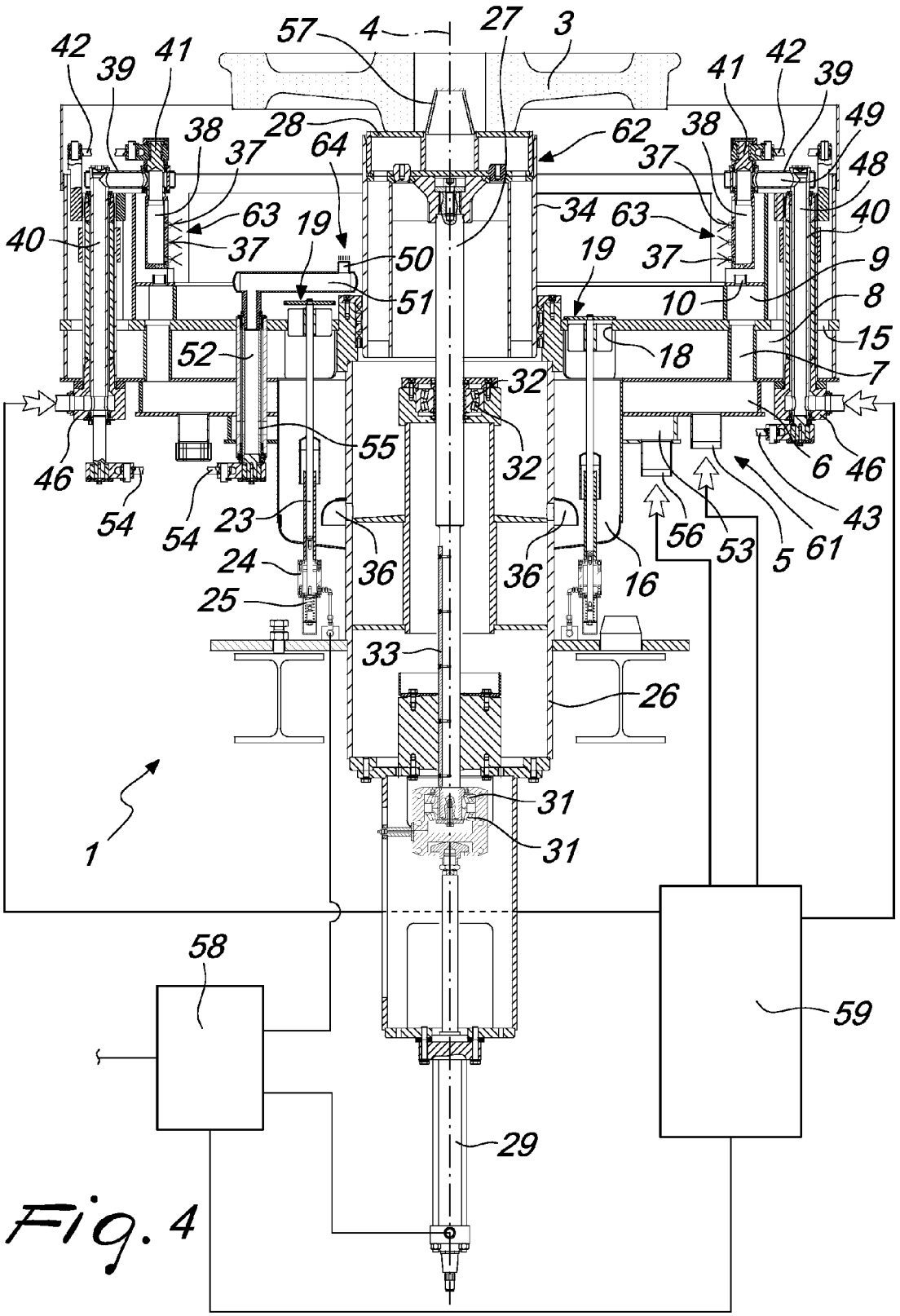
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Fig. 4

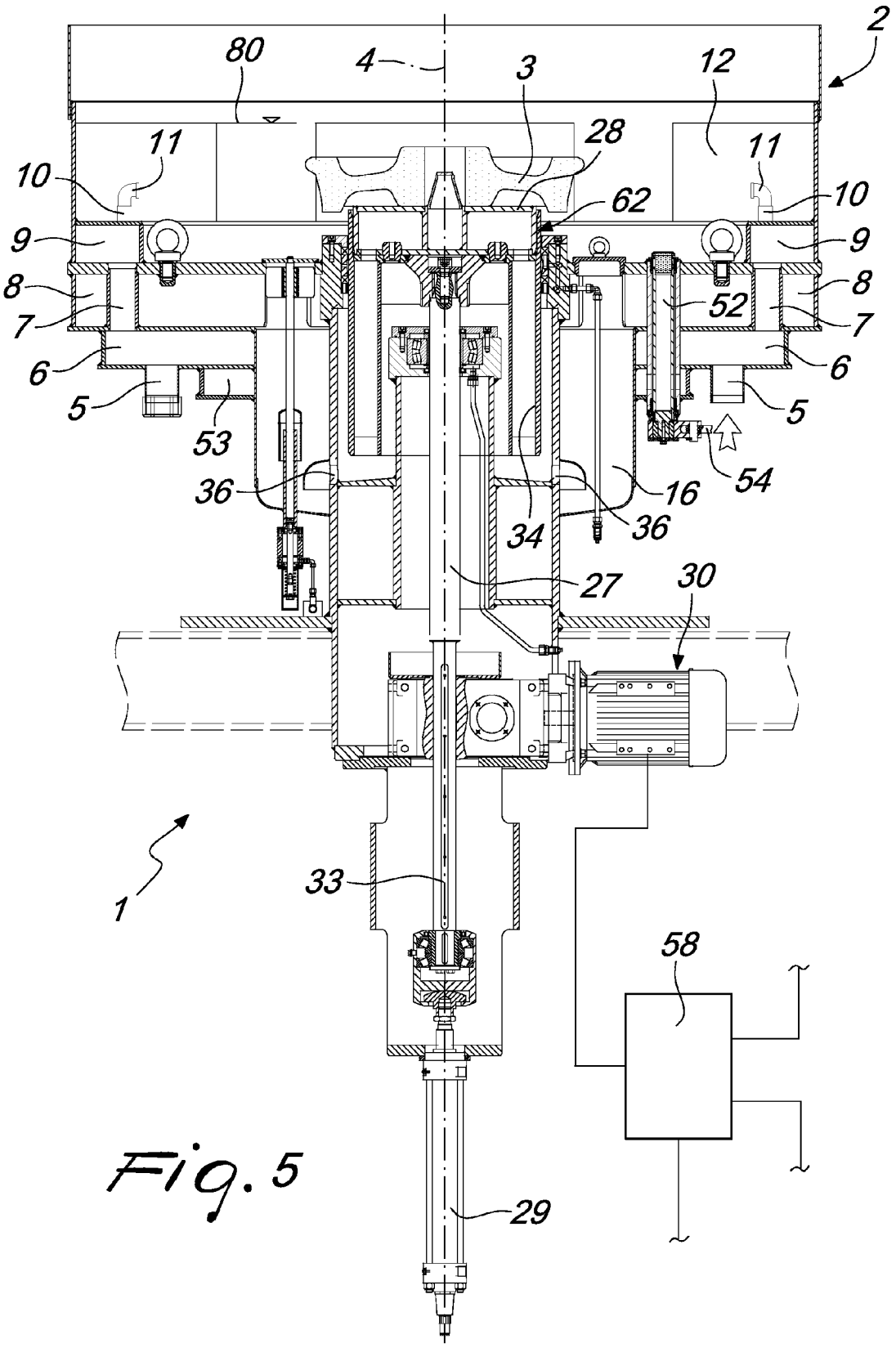
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Fig. 5

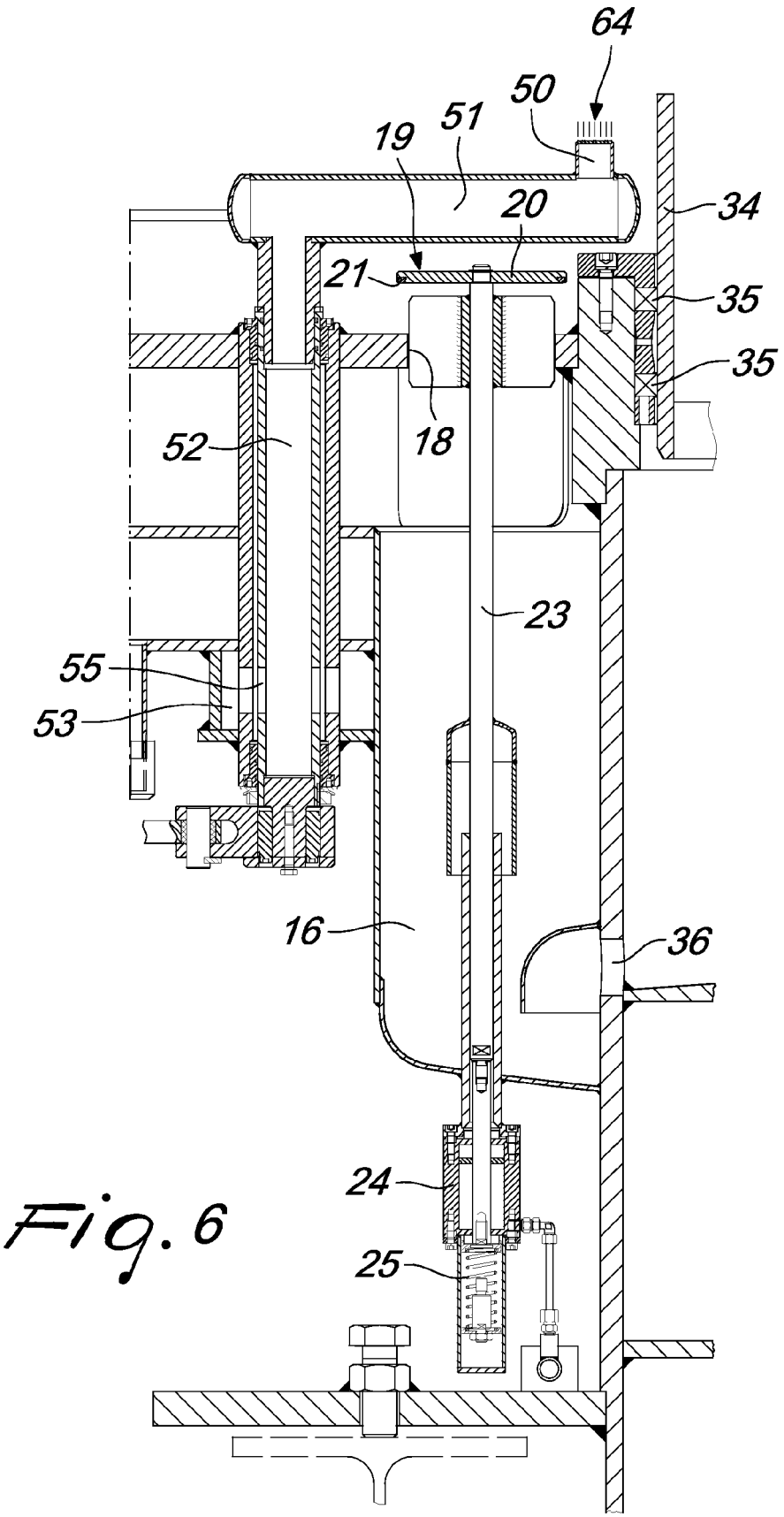


Fig. 6

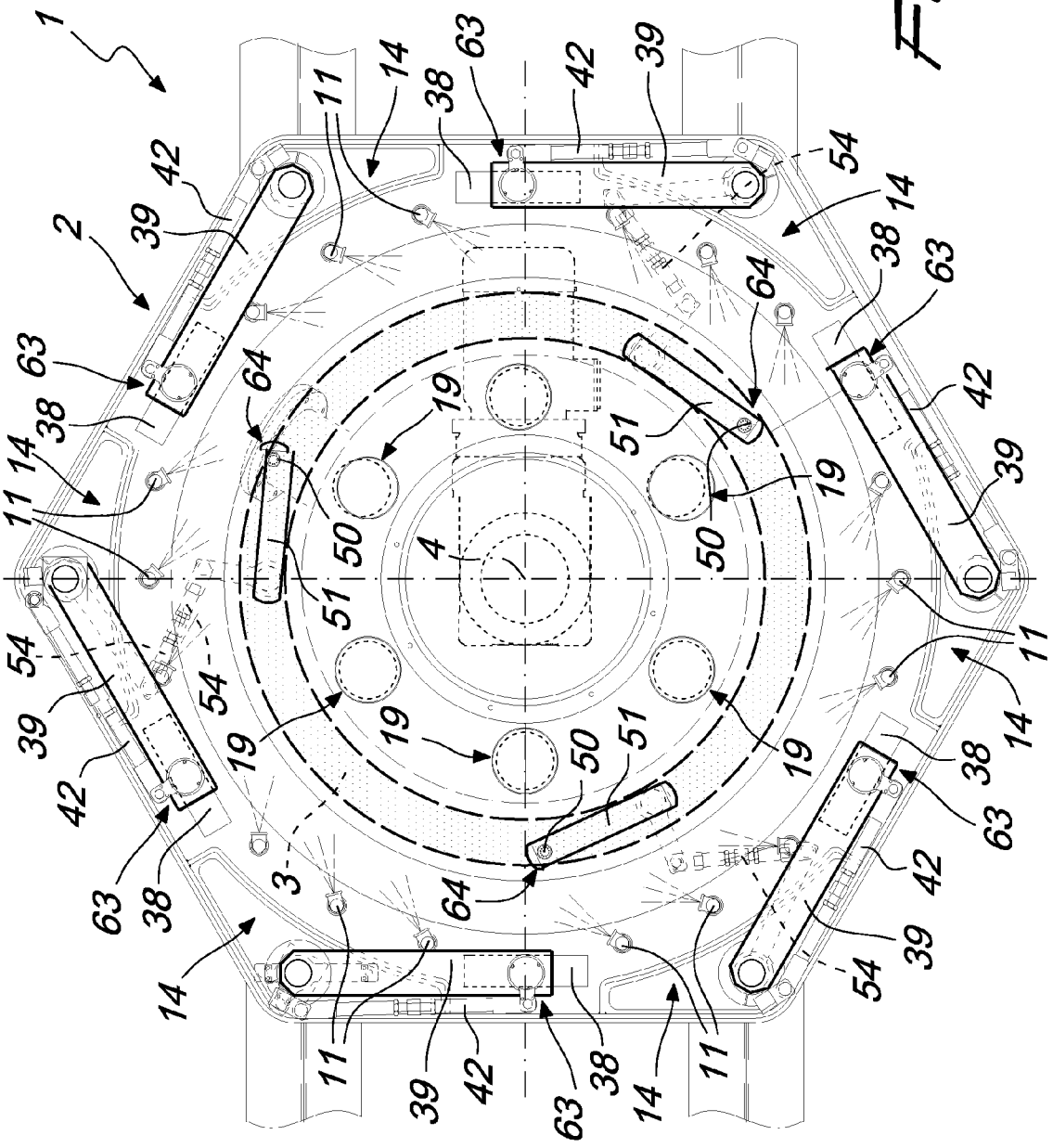


Fig. 7

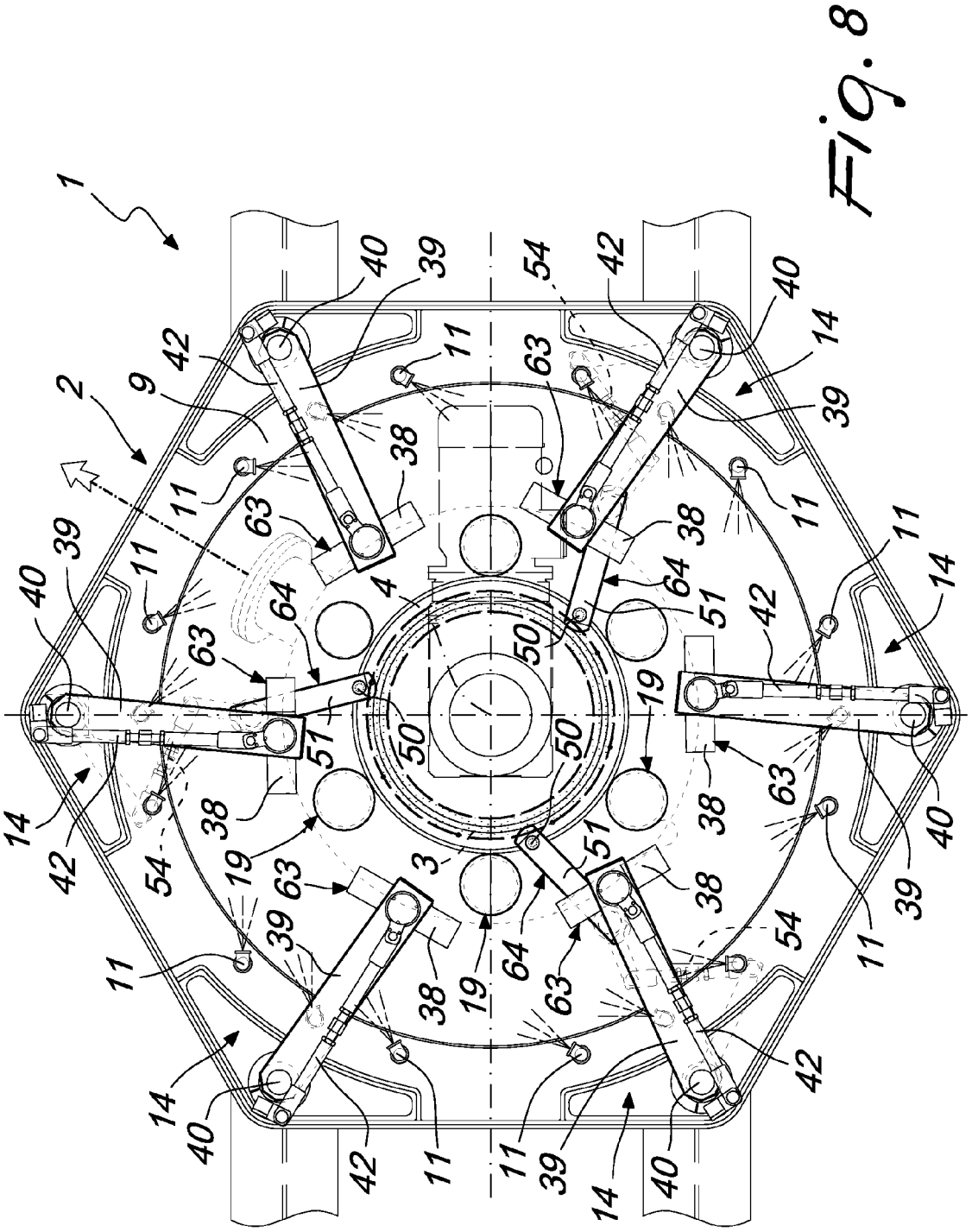


Fig. 8

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# EUROPEAN SEARCH REPORT

Application Number
EP 10 15 5890

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 11 May 2010 | Brown, Andrew |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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