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(54) **A MACHINE FOR DRAG FINISHING OF WORKPIECES**

(57) A machine (10,500) for drag finishing of workpieces comprises an outer frame (20) which houses a tub (100,630) for the containment of finishing media, an operative group (90,90') integrally connected to an independent frame (34), the operative group (90,90') comprising a geared motor (50) and a shaft (51) suitable to transmit a rotary motion to the workpieces, wherein the machine (10,500) comprises a base frame (31) which allows an approaching and distancing movement of the operative group (90,90') along a vertical axis (V) with respect to the tub (100,630), characterized in that the machine (10,500) comprises a guide rail frame (32) on which guides (40,41,42) are provided allowing a rotation of the independent frame (34) in order to carry said operative group (90,90') into a position inclined by an angle ( $\alpha$ ) with respect to the vertical axis (V) and viceversa.

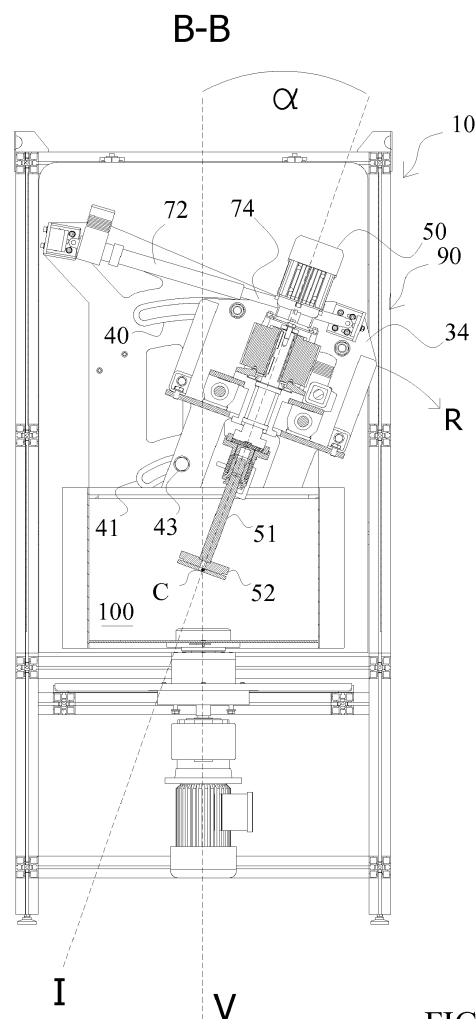


**FIG.12**

## Description

**[0001]** The present invention refers to a machine for drag finishing of workpieces.

**[0002]** As is known, mass finishing of metal (and non-metal) surfaces is based on the dynamics relating to the way in which the mass consisting of the finishing media and the pieces is placed in relative motion

**[0003]** In particular, in drag finishing operations, work pieces are fixed to suitable supporting devices such as mandrels carrying pieces.

**[0004]** The pieces are then dragged circularly, at a more or less high speed, inside a treatment vat in which a finishing media is present, which can be constituted by components such as, for example, abrasive granules of appropriate size and shape, polymer materials, ceramics, plastics, or materials having synthetic or natural origin. Processing is done usually at high speed, giving place to a certain contact pressure between the workpiece and processing media which leads to the desired result. Document DE 20 2009 008 070 discloses a workpiece holder connected to a rotating shaft from which it receives the rotation movement by means of a cardanic joint.

**[0005]** In turn, the rotating shaft is supported by a clamping device in such a way that the workpiece holder can be inclined by an angle ( $\alpha$ ) of between 5° and 35° with respect to the clamping device and fixed in that position by the application of a spacer. Another example is given by the machine described in document DE 10 2010 052 222 which comprises a plurality of workpiece holders provided with one or more rotary spindles put into rotation by a geared motor. The workpiece holders are disposed on a rotating head and can be brought from a working position to a raised position by means of lifting devices which slide vertically along guides.

**[0006]** The workpiece holders are fixed to the rotating head by means of plates with clamping screws that allow to tilt the workpiece holders by a certain fixed angle relatively to the vertical.

**[0007]** A first problem of the prior art is given by the fact that the workpiece holders can be inclined only in fixed positions thus allowing only a limited number of predetermined orientations.

**[0008]** A further problem of both known embodiments is the fact that, since the inclination of the workpiece holders is fixed, in order to vary it is necessary to stop the known machines.

**[0009]** Document US 6,406,356 describes a machine for finishing of motor vehicle wheels, which after the finishing operation will have to be subjected to a chrome plating.

**[0010]** The machine herein described comprises a rotating shaft which carries a plurality of supports connected to a cross structure, where each of the supports holds in a cantilevered fashion a wheel to be processed by immersion in a tub containing the finishing media.

**[0011]** Each wheel to be machined is fixed to its support

by means of a shaft coaxial to the axis of the respective wheel so that each wheel provides an outer face to the action of the media, or is positioned with an angle of attack  $\theta$  with respect to the action of the media.

**[0012]** To be able to vary the angle of attack  $\theta$  of the wheels it is provided to mount each wheel onto an horizontal adjustment plate provided with a semicircular groove.

**[0013]** The wheel can then be oriented about an axis that is perpendicular to the horizontal adjustment plate, axis that passes through the point on which the wheel is mounted, in such a way that the wheel assumes an angle  $\theta$  preferred for a particular process and then fixed in position by means of a passing screw which engages in the semicircular groove.

**[0014]** Also in this case, in order to vary the angle  $\theta$  it is necessary to stop the machine in order to disengage the passing screw from the semicircular groove.

**[0015]** An object of the present invention is to overcome the above mentioned drawbacks by providing a machine for the finishing of surfaces which enables adjustment of the orientation of the workpiece holders also during the finishing process.

**[0016]** Another object is to achieve said result in a practical and economical way.

**[0017]** Said objects are reached by means of a machine for drag finishing of workpieces, the machine comprising an outer frame which houses a tub for the containment of finishing media, an operative group integrally connected to an independent frame, the operative group comprising a geared motor and a shaft suitable to transmit a rotary motion to the workpieces, wherein the machine comprises a base frame which allows an approaching and distancing movement of the operative group along a vertical axis with respect to the tub, characterized in that the machine comprises a guide rail frame on which guides are provided allowing a rotation of the independent frame in order to carry said operative group into a position inclined by an angle with respect to the vertical axis and viceversa and wherein the arc shaped configuration of the guides allows to the operative group to rotate around a point that belongs to an axis around which the rotating movement of the workpieces occurs.

**[0018]** Among the advantages of the present invention it may be included the fact that it allows to tilt the work pieces by an angle at will with respect to the vertical axis passing through the center of the finishing tub in order to increase the efficiency of processing and to enable an optimum processing even for parts having complex surface morphologies and provided with undercuts or particularly difficult to work. A further advantage of the present invention consists in the fact that the adjustment of the angle of inclination of the operating group, and then the work pieces can be carried out at any time of the processing and in any configuration of the machine without having to stop the processing carried out by the machine

**[0019]** The adjustment can also be carried out, for ex-

ample, in a raised configuration for loading and unloading machine in pieces when the machine is stopped or in a working configuration inside the tub containing the finishing media.

**[0020]** Other examples will be discussed in the following present description.

**[0021]** The invention comprises also a method for drag finishing of workpieces using the machine according to the preceding claims, the method comprising the following steps:

- loading of the machine with the workpieces;
- performing a relative approaching movement between the operative group and the tub to insert the workpieces inside the tub containing the finishing media;
- inclining the operative group by an angle with respect to the vertical axis to configure the machine for a machining operation in which the operative group is in an inclined position with respect to the vertical axis.

**[0022]** This solution has advantages similar to those of the machine described above. Further characteristics of the invention can be deduced from the dependent claims. Further characteristics and advantages of the invention will become apparent from the following description provided as non-limitative examples, with the aid of the figures illustrated in the enclosed drawings, in which:

- figure 1 shows a top view of a first embodiment of the machine for surface treatment of mechanical pieces according to the present invention;
- figure 2 shows a lateral view of the machine for surface treatment of mechanical pieces of figure 1;
- figure 3 shows a sectional view of the machine of figure 1 according to the sectional plane B-B in a first configuration;
- figure 4 shows a sectional view of the machine of figure 1 according to the sectional plane B-B in a second configuration;
- figure 5 shows a sectional view of the machine according to the sectional plane A-A in the working configuration of figure 3;
- figure 6 represents schematically the reciprocal positions of a workpieces carrying frame and of the tub in the working configuration of the preceding figure;
- figure 7 shows a sectional view of the machine according to the sectional plane A-A in the working configuration of figure 4;
- figure 8 represents schematically the reciprocal positions of a workpieces carrying frame and of the tub in the working configuration of the preceding figure;
- figure 9 shows a sectional view of the machine for surface treatment of mechanical pieces according to the present invention along the sectional plane A-A in a third working configuration;
- figure 10 represents schematically the reciprocal positions of a workpieces carrying frame and of the tub

in the working configuration of the preceding figure;

- figure 11 shows a section of the machine along the sectional plane B-B wherein the movement of rotation R and the coincidence between the vertical axis V and the axis I is shown;
- figure 12 shows a sectional view of the machine according to the sectional plane B
- B in a working configuration with the vertical axis V and the inclined axis I being separated by an angle  $\alpha$ ;
- figure 13 shows a sectional view of the machine according to the sectional plane A-A in the working configuration of figure 12;
- figure 14 represents schematically the reciprocal positions of a workpieces carrying frame and of the tub in the working configuration of the preceding figure;
- figure 15 shows a top view of a second embodiment of the machine for surface treatment of mechanical pieces according to the present invention;
- figure 16 shows a lateral view of the machine for surface treatment of mechanical pieces of figure 15;
- figure 17 shows a partially sectional view of the machine of figure 15 according to the sectional plane C-C in a first configuration;
- figure 18 represents schematically a tub in the working configuration of the preceding figure;
- figure 19 shows a partially sectional view of the machine of figure 15 according to the sectional plane C-C in a second configuration;
- figure 20 represents schematically the reciprocal positions of a workpieces carrying frame and of the tub in the working configuration of the preceding figure;
- figure 21 shows a partially sectional view of the machine of figure 15 according to the sectional plane C-C in a third configuration;
- figure 22 represents schematically the reciprocal positions of a workpieces carrying frame and of the tub in the working configuration of the preceding figure; and
- figure 23 is a plan view that represents a further application of the present invention.

**[0023]** In figure 1 it is shown a top view of a first embodiment of a machine for drag finishing of mechanical pieces, according to the present invention, globally designated by the reference number 10.

**[0024]** In figure 1 there are shown the section plane A-A used to highlight the components and the operating mechanisms of the machine 10 of figures 5,7,9,13 and the sectional plane B-B used to highlight the components and functioning mechanisms the machine 10 of figures 3,4,11,12.

**[0025]** In figure 2 it is shown a side view parallel to the sectional plane B-B of the machine 10 where it is highlighted the sectional plane A-A.

**[0026]** As shown in Figure 3 the machine 10 is provided with an external frame 20 which houses a tank 100 for the containment of finishing media.

**[0027]** The tub 100 can be set in rotation by a geared

motor 110 dedicated and placed under it or, in some embodiments of the invention, can remain fixed.

**[0028]** The machine 10 comprises a geared motor 50 and a shaft 51 suitable to transmit a rotating motion to the working pieces.

**[0029]** In particular, the shaft 51 is connected to the geared motor 50 by means of a fitting 62 which fits in a respective mandrel 60, wherein said shaft 51 supports a workpiece carrier frame 53.

**[0030]** The complex of elements comprising the gear motor 50, the shaft 51 and a workpiece carrier frame 53 form a single operating unit 90 and is housed on a support plate 38 which is in turn integrally attached perpendicularly to an independent frame 34. Furthermore, in the machine 10, above the tub 100 there is a base frame 31 which supports a guide rail frame 32.

**[0031]** The guide rail frame 32 is provided with an upper arc guide 40, an intermediate arc guide 41 and to a lower arc guide 42. Preferably, the arc guides 40, 41, 42 have different lengths and different radii of curvature. In particular the upper arch guide 40 has the greater length and the greater radius of curvature R1 while the lower arc guide 42 has the smallest radius of curvature R3 and the shorter length.

**[0032]** The intermediate arc 41 has an intermediate length comprised between the length of the upper arch 40 and the length of the lower arc guide 42.

**[0033]** The intermediate arc guide 41 has a radius of curvature R2 that is intermediate between the radius of curvature of the upper arc guide 40 and the radius of curvature of the lower arc guide 42.

**[0034]** In arc guide 40 a first upper pin 45 and a second upper pin 46 slide, whereas in arc guide 41 an intermediate pin 43 slides and in the arc guide 42 a lower pin 44 slides. The pins 43, 44, 45, 46 are integrally connected to the independent frame 34 and by virtue of their engagement with said arched guides allow a relative movement between the independent frame 34 and the guide rail frame 32.

**[0035]** Furthermore, the relative movement between the independent frame 34 and the guide rail frame 32 allows a similar movement of the operating group 90 which is integral with the independent frame 34.

**[0036]** The independent movement of the frame 34 with respect to the guide rail frame 32 is produced by means of a movement unit 70.

**[0037]** The movement unit 70 comprises a double-acting cylinder 72 provided with a stem 74.

**[0038]** The double-acting cylinder 72 effect is connected to a first end with the frame guide rail 32 by means of a first fixed flange 33 and to a second end with the independent frame 34 by means of a second movable flange 39.

**[0039]** In the machine 10, it is also provided a horizontal support plate 38 for supporting the operating group 90 and that is engaged perpendicularly and integrally with the independent frame 34.

**[0040]** The support plate 38 also has a slot 37 through

which the rotation shaft 90 of the operating group can pass.

**[0041]** The support plate 38 is further provided with translation guides 35, 36 which allow scrolling in the horizontal direction of the operating group 90.

**[0042]** The base frame 31 can move vertically along the direction Tv as shown in figures 4, 5, 7. The vertical translation Tv of the base frame 31 allows to bring the pieces mounted on the spindles of the frame workpiece holder 53 from a raised position shown in Figures 3 and 5 to a working position inside the tub 100 shown in Figures 4 and 7 and vice versa. The vertical translation Tv of the base frame 31 can be performed, for example, by the action of a motor not shown for simplicity in the figures, or by means of another moving body.

**[0043]** Figures 6 and 8 represent schematically the respective positions of the workpiece carrier frame 53 and of the tub 100 in a raised position respectively and in a working position.

**[0044]** Note that, by means of the translation guides 35, 36 of the workpiece holder frame 53 of the operating assembly 90 can translate along a horizontal axis (X) towards an eccentric working position with respect to the center of the tub 100 as shown in Figures 9-10.

**[0045]** The horizontal translation To of the operating group along guides is 35, 36 is shown in Figures 7 and 9.

**[0046]** The horizontal translation To of the shaft 51 takes place inside the slot 37 present in the support plate 38 on which the translation guides 35, 36 are housed.

**[0047]** Figure 8 schematically shows the eccentric position taken by the workpiece holder frame 53 with respect to the center of the tub 100 as a consequence of the horizontal translation To the operating group 90 along the translation guides 35, 36.

**[0048]** This variant of the invention is also based on what is described in the patent applications ITMI2013A001616 and EP14185788, the teachings of which are hereby incorporated.

**[0049]** As shown in Figures 11-12, the operating group 90 can rotate integrally with the independent frame 34 to which it is connected.

**[0050]** The rotation R of the independent frame 34 and of the operative group 90 is caused by the movement unit 70. The elongation of the rod 74 of the double acting cylinder 72 carries the independent frame 34 to slide along the path described by the arched guides by means of the pins.

**[0051]** The arched shape of the guides bring the independent frame 34 and consequently the operating group 90 to rotate about a point C shown, for example, in Figure 3.

**[0052]** The point C is therefore the center of instantaneous rotation of the operating group 90 for the rotation caused by the movement unit 70 and it is placed on the axis I, namely the axis around which the rotary motion transmitted to the workpieces by the shaft 51 driven by the motor 50 of the operative group 90 occurs.

**[0053]** The rotation R of the operating group 90 is such

that the axis I passing through the motor shaft 51 and the gear motor 50 is inclined by an angle  $\alpha$  with respect to the vertical axis V passing through the center of the tub 100.

**[0054]** Increasing the elongation of the stem 74 of the double effect cylinder 72, increases the rotation of the operating group 90 and consequently increases the angle  $\alpha$  spaced between the inclined axis I and the vertical axis V.

**[0055]** The width of the angle  $\alpha$  may vary between  $0^\circ$  and  $\alpha_{\max}$ .

**[0056]** The value of  $\alpha_{\max}$  can be for example of  $30^\circ$ , but also other values are possible.

**[0057]** The adjustment of the angle  $\alpha$  can then be finely controlled by the movement unit 70 during the working process of the pieces by means of an appropriate elongation of the stem 74.

**[0058]** In the configuration with  $\alpha = 0^\circ$  represented in figure 11, the I axis I and the vertical axis V coincide and the operating group 90 is in a non inclined vertical position.

**[0059]** In the configuration with  $0^\circ < \alpha < \alpha_{\max}$  represented in figure 12, the operating group 90 is located in an inclined position.

**[0060]** The vertical translation  $T_v$  of the base frame 31, the horizontal translation  $T_o$  and the rotation R with respect to the axis V of the operative group 90 can be controlled by programming of a programmable logic controller (PLC) 450, or other similar programmable electronic device, connected to a memory system 460 as shown, for simplicity, only in figure 2

**[0061]** In figure 13 there are indicated by means of arrows the movement of rotation P1 of the tub 100, the rotational movement of the frame P2 workpiece holder 53, the vertical translational movement  $T_v$  of the base frame 31, the rotation R and the horizontal translation  $T_o$  of the independent frame 34 and of the operating group 90. Figure 14 schematically shows the reciprocal positions of the workpiece carrier frame 53 and of the tub 100 in the configuration of the machine 10 represented in Figure 13 in which the operating group 90 has been lowered into the working configuration, shifted in an eccentric position with respect to the center of the tub 100 and inclined by a certain angle  $\alpha$ . In the same figure are also indicated, by means of arrows, the directions of rotation of the tub 100 and the workpiece carrier frame 53.

**[0062]** The operation of the machine 10 of the present invention is therefore based on the following.

**[0063]** The operating group 90 can be maintained in a raised position so as to allow the positioning of the workpieces on the spindles on the workpiece carrier frame 53.

**[0064]** By means of the vertical translational movement  $T_v$  the operating group 90 descends vertically so as to bring the workpieces inside the tub 100 containing the finishing media.

**[0065]** The tub 100 and the frame workpiece holder 53 may then be placed in rotation to perform the finishing of the pieces.

**[0066]** Preferably the tub 100 and the workpiece carrier frame 53 rotate in the opposite direction but can also rotate in the same direction.

**[0067]** By varying the elongation of the rod of the double effect cylinder 72 the operating group 90 can be inclined by an angle  $\alpha$ .

**[0068]** The rotation R of the operating group 90 can also be performed in the raised configuration with the operating group 90 outside the tub 100.

**[0069]** Alternatively, the rotation R of the operating group can be carried out at any height between the raised configuration and the working configuration.

**[0070]** Furthermore, the operating group 90 can be moved horizontally along the guides 35,36 in order to bring the workpiece carrier frame 53 in a position eccentric with respect to the center of the tub 100.

**[0071]** In particular, the increase of horizontal translation  $T_o$  to the operating group 90 increases the distance between the workpiece carrier frame 53 and the center of the tub 100 containing the finishing media.

**[0072]** The movements of horizontal translation  $T_o$  and of rotation R of the operating group 90 can be combined in order to simultaneously tilt and carry into an eccentric position of the workpiece carrier frame 53 (figure 13).

**[0073]** The vertical translation  $T_v$ , the horizontal translation  $T_o$  and the rotation R of the operating group 90 can be performed according to the order described but may also be performed in different sequences or simultaneously.

**[0074]** In Figure 15 it is shown a top view of a second embodiment of a drag finishing machine for mechanical parts, according to the present invention, generally designated by the reference number 500 and where the respective operating group is indicated with the reference number 90'.

**[0075]** In figure 15 it is shown the sectional plane C-C used to highlight the components and the operation of the machine mechanisms 500 in figures 17,19,21.

**[0076]** Figure 16 shows a side view parallel to the sectional plane C-C of the machine 500 in which a rotating head 52 comprises multiple spindles 510 to accommodate the devices or workpiece holder frames.

**[0077]** The group of elements comprising the gear motor 50, the motor shaft (not visible in the figure) and the rotating head 52 form the operating unit 90' which is coupled integrally to the independent frame 34.

**[0078]** The guide rail frame 32 includes the upper arc guide 40 within which the first upper pin 45 and the second upper pin 46 slide, the intermediate arc guide 41 inside which the intermediate pin 43 slides and the bottom arc guide 42 inside which the lower pin 44 slides.

**[0079]** The pins are integrally connected to the independent frame 34, and by virtue of their engagement with said arc guides, they allow a relative movement between the independent frame 34 and the frame guide rail 32

**[0080]** The independent movement of the frame 34 with respect to the guide rail frame 32 is produced by the movement unit 70.

**[0081]** As shown in Figure 17, the operating group 90' may be maintained in a raised position so as to allow the positioning by means of an insert connection of the devices or workpiece holder frames to be machined, on the mandrels 510 present on the rotating head 52.

**[0082]** The mandrels workpiece holder 510 are engaged by an epicyclic gear train having a sun gear 520. The epicyclic gear train includes planetary gears connected to the spindle and workpiece holder 510 and meshing with the sun gear 520 fixed on the motor shaft. The pieces mounted on the spindles 510 rotate by the driving torque produced by the geared motor 50 and transferred to them by the solar gear 520.

**[0083]** As shown in figure 18, in the raised configuration the mandrels 510 are not located within the tub 100.

**[0084]** Figure 19 shows how by means of a vertical translational movement  $T_v$  the operating unit 90' descends vertically so as to bring the workpieces inside the tub 100.

**[0085]** The relative motion between the parts mounted on the workpiece -holder 510 and the finishing media contained in the tank 100 can be achieved by rotating both the tub 100 and the rotating head 52 and the workpiece holder 510 or by rotating only the rotating head 52 and the workpiece holder 510 maintaining the tub 100 still.

**[0086]** Figure 20 schematically represents the reciprocal position of the workpiece holders 510 of the rotating head 52 with respect to the tub 100 when the machine 500 is in a working position with the operating group 90' in a vertical position. In the working configuration shown in figure 20 the direction of rotation of the workpiece holder of the rotating head 52 is opposite to that of the tub 100.

**[0087]** In figure 21 it can be observed how varying the elongation of the rod 74 of the double effect cylinder 72, the independent frame 34 and consequently the operating group 90' integral with it, can be rotated with respect to the guide rail frame 32. The rotation  $R$  of the operating group 90' is such that the axis  $I$  passing through the center of the rotating head 52, through the motor and the geared motor 50 tilts by an angle  $\alpha$  with respect to the vertical axis  $V$  passing through the center of the tub 100. Figure 22 schematically represents the reciprocal position of the workpiece carrier 510 and of the rotary head 52 when the machine 500 is in a working position with the operating group 90' in an inclined position with the  $I$  axis rotated by an angle  $\alpha$  relative to the vertical  $V$  passing through the center of the tub 100.

**[0088]** The angle  $\alpha$  can be finely adjusted by means of the movement unit 70 during the machining of the pieces process by appropriate lengthening of the stem 74.

**[0089]** The vertical translation  $T_v$  and rotation  $R$  of the operating group 90' can be programmed through the use of programmable logic controller (PLC) 450. Although not explicit in the drawings it is obvious how the machine 500 can be designed in a way altogether similar to the first embodiment in such a way as to allow the horizontal translation  $T_o$  of the rotating head 52.

**[0090]** A further embodiment of the invention, not represented for simplicity in the figures, plans to build the machines 10 and 500 described above with the arc guides shaped in such a way as to allow, under the action of the handling unit 70, the rotation of the operating groups 90,90' in both directions (clockwise and counter-clockwise).

**[0091]** The axis  $I$  passing through the geared motor 50, the motor shaft and the rotating head 52 can then be inclined with respect to the vertical axis  $V$  of the tub by an angle  $0^\circ < \alpha < \alpha_{\max}$ , visible, or by an angle of  $0^\circ < \alpha < -\alpha_{\max}$ .

**[0092]** A further application of the invention is represented in figure 23.

**[0093]** In this figure it is represented a system 600 for drag finishing of surfaces, the plant comprising a rotating tub 630 for the containment of finishing media and a movement unit comprising at least one mechanical arm for handling workpieces which in the specific case it is constituted by an anthropomorphic robot 610 adapted to take workpieces from a counter 615.

**[0094]** In particular, the tub 630 comprises two separate sectors 640,650, formed by concentric circular crowns.

**[0095]** Preferably each of the separate sectors 640,650 of the rotating tub 630 is adapted to receive a different finishing media.

**[0096]** In other embodiments (not shown for simplicity), the separate sectors of the rotating tub can also be more than two.

**[0097]** This configuration is illustrated in more detail for example in the patents IT 1409152 and EP 2747940 which are incorporated herein by reference and to whose description reference is made for further details.

**[0098]** Suffice it here to say that this plant makes it possible, within the same machine, for example to perform a first finishing operation with a first media in the most outer circular sector 640, and immediately after that performing a second processing with a second finishing media in the internal circular sector 650.

**[0099]** In the case there are provided more sectors, further finishing with different finishing media may be made.

**[0100]** A machine 10,500 according to the various embodiments of the invention described above can be used in the plant 600.

**[0101]** As seen above this machine can allow the rotation of the operative group 90,90' so as to bring it into a position inclined by an angle  $\alpha$  with respect to the vertical axis  $V$  and vice versa.

**[0102]** Moreover, as indicated above, in said machine there can be provided translation guides 35,36 to move the operating group 90,90' along a horizontal axis  $X$  towards a working position that is eccentric relatively to the center of the tub 630 and vice versa.

**[0103]** In this way the different sectors 640,650 of the tub 630 may be used in succession so as to allow considerable advantages in terms of cost, space, versatility

and speed of execution of the processing.

**[0104]** Obviously, to the invention as described changes or improvements dictated by contingent or specific motives may be introduced, without thereby departing from the scope of the invention as claimed.

## Claims

1. A machine (10,500) for drag finishing of workpieces, the machine (10,500) comprising an outer frame (20) which houses a tub (100,630) for the containment of finishing media, an operative group (90,90') integral-ly connected to an independent frame (34), the op-erative group (90,90') comprising a geared motor (50) and a shaft (51) suitable to transmit a rotary motion to the workpieces, wherein the machine (10,500) comprises a base frame (31) which allows an approaching and distancing movement of the op-erative group (90,90') along a vertical axis (V) with respect to the tub (100,630), **characterized in that** the machine (10,500) comprises a guide rail frame (32) on which guides (40,41,42) are provided allow-ing a rotation of the independent frame (34) in order to carry said operative group (90,90') into a position inclined by an angle ( $\alpha$ ) with respect to the vertical axis (V) and viceversa, and wherein the arc shaped configuration of the guides (40,41,42) allows to the operative group (90,90') to rotate around a point (C) that belongs to an axis (I) around which the rotating movement of the workpieces occurs.
2. The machine (10,500) according to claim 1, in which the guide rail frame (32) is supported by the base frame (31), the base frame (31) being able to move vertically along the vertical axis (V) so as to bring the workpieces supported by the operative group (90,90') from a raised position to a working position inside the tub (100,630) and viceversa.
3. The machine (10,500) according to claim 1, in which in the arc shaped guides (40,41,42) guides (40,41,42) which allow the rotation of the independ-ent frame (34) of the operative group (90,90') respec-tive pins (43,44) are engaged, the pins (43,44) being rigidly connected to the independent frame (34) of the operative group (90,90').
4. The machine (10,500) according to claim 3, wherein the arched guides comprise an upper arc guide (40), an intermediate arc guide (41) and a lower arc guide (42), wherein the upper arc guide (40) has a radius of curvature (R1) greater than the radii of curvature of the other guides, the lower arc guide (42) having a radius of curvature (R3) smaller than the radii of curvature of the other guides, and the intermediate arc guide (41) having a radius of curvature (R2) in-termediate between the radius of curvature of the upper arc guide (40) and the radius of curvature of the lower arc guide (42).
5. The machine (10,500) according to claim 4, wherein the rotation of the independent frame (34) to which the operative group (90,90') is connected is actuated by means of a movement unit (70) that allows a rel-ative movement between the independent frame (34) and the frame guide rail (32), wherein the move-ment unit (70) acts upon the independent frame (34) in order to finely adjust the angle ( $\alpha$ ).
6. The machine (10,500) according to claim 5, wherein the movement unit (70) comprises a double-acting cylinder (72) provided with a stem (74) the elongation of which carries the independent frame (34) along a path described by the arched guides (40,41,42) by engagement of the respective pins (43,44), in such a way that an axis (I) passing through the shaft (51) and through the geared motor (50) is inclined by an angle ( $\alpha$ ) with respect to the vertical axis (V).
7. The machine (10,500) according to claim 1, wherein translation guides (35,36) are provided to move the operative group (90,90') along a horizontal axis (X) towards a working position that is eccentric with re-spect to the center of the tub (100,630) and vice ver-sa.
8. The machine (10,500) according to claim 1, wherein the shaft (51) is connected to the geared motor (50) by means of a connecting element (62) that can be inserted in a respective mandrel (60), wherein said shaft (51) supports a workpieces carrying frame (53).
9. The machine (10,500) according to claim 1, wherein the shaft (51) is connected to the geared motor (50) and acts upon a plurality of mandrels (510) put into rotation by a solar gear (520) connected to the shaft (51).
10. The machine (10,500) according to claim 1, wherein the tub (630) comprises at least two separate sectors (640,640) formed by concentric circular crowns for the containment of finishing media.
11. A method for drag finishing of workpieces using the machine (10,500) according to the preceding claims, the method comprising the following steps:
  - loading of the machine (10,500) with the work-pieces;
  - performing a relatively approaching movement between the operative group (90,90') and the tub (100,630) to insert the workpieces inside the tub (100,630) containing the finishing media;
  - inclining the operative group (90,90') by an an-gle ( $\alpha$ ) with respect to the vertical axis (V) to

configure the machine (10,500) for a machining operation in which the operative group (90,90') is in an inclined position with respect to the vertical axis (V).

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12. The method according to claim 11, further comprising a step of horizontal translation of the operating group (90,90') along the horizontal axis (X) to bring the machine (10,500) in a working configuration within the tub (100,630) in an eccentric position with respect to the center of the tub (100,630).

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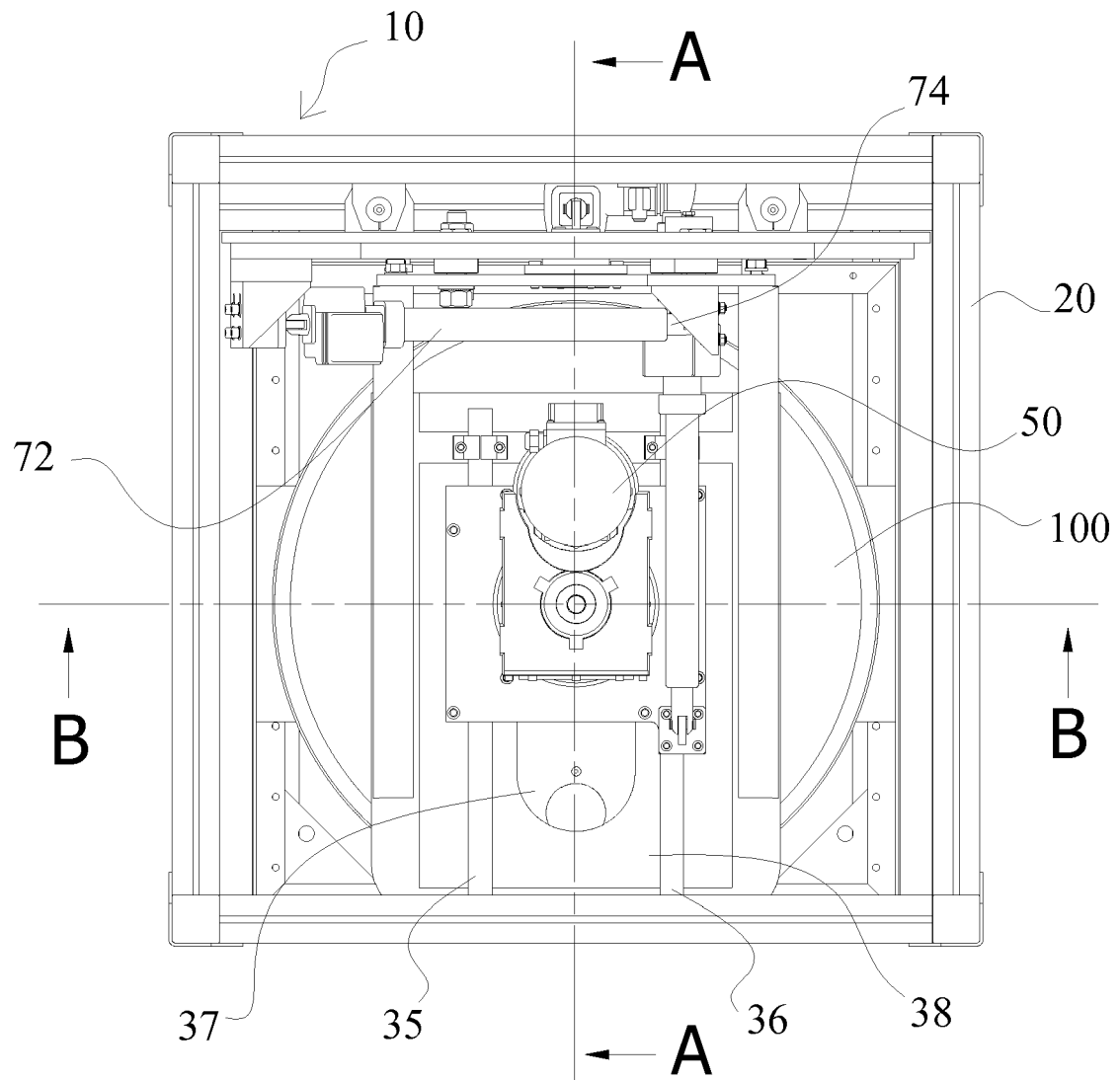


FIG.1

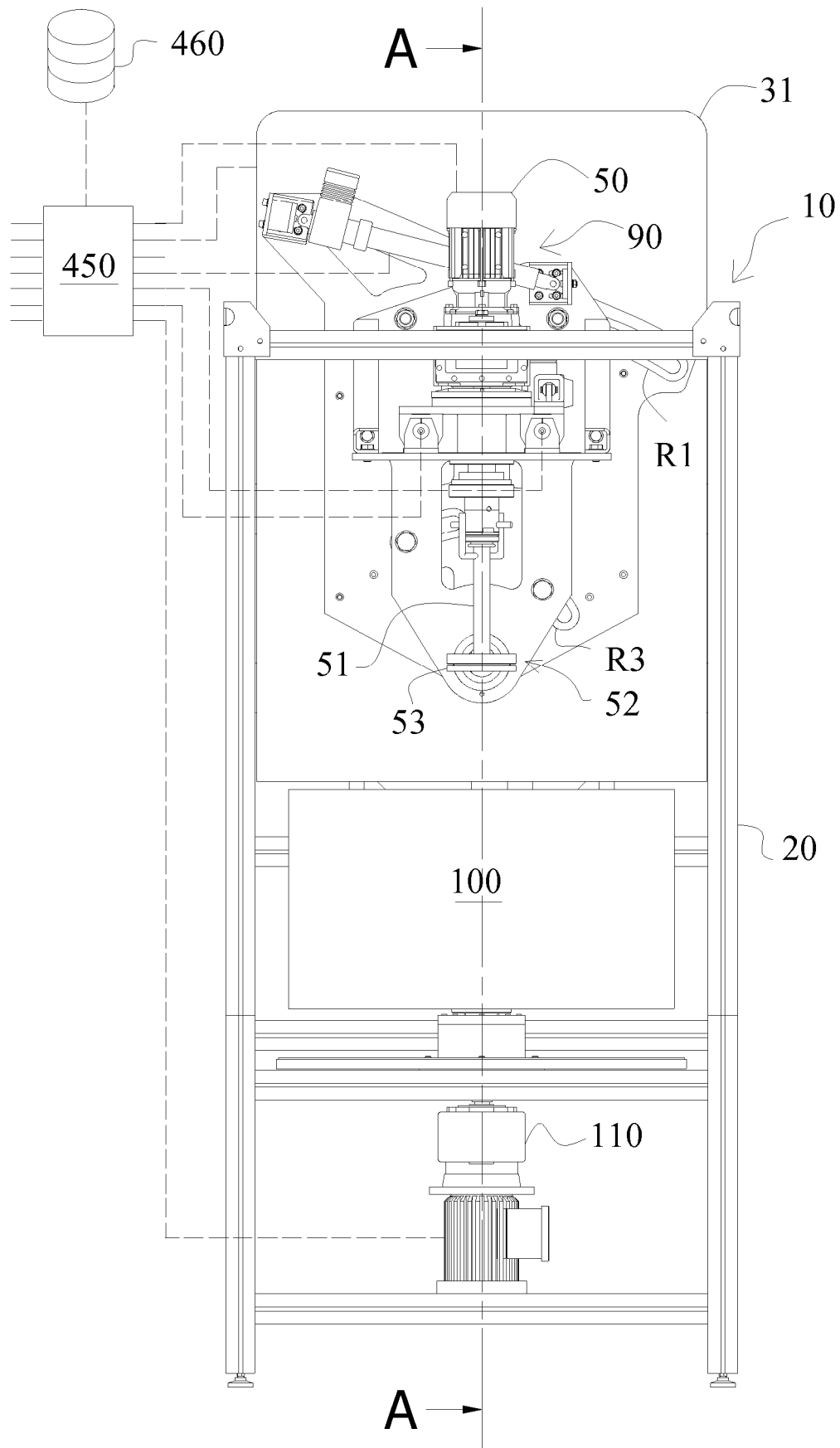


FIG.2

B-B

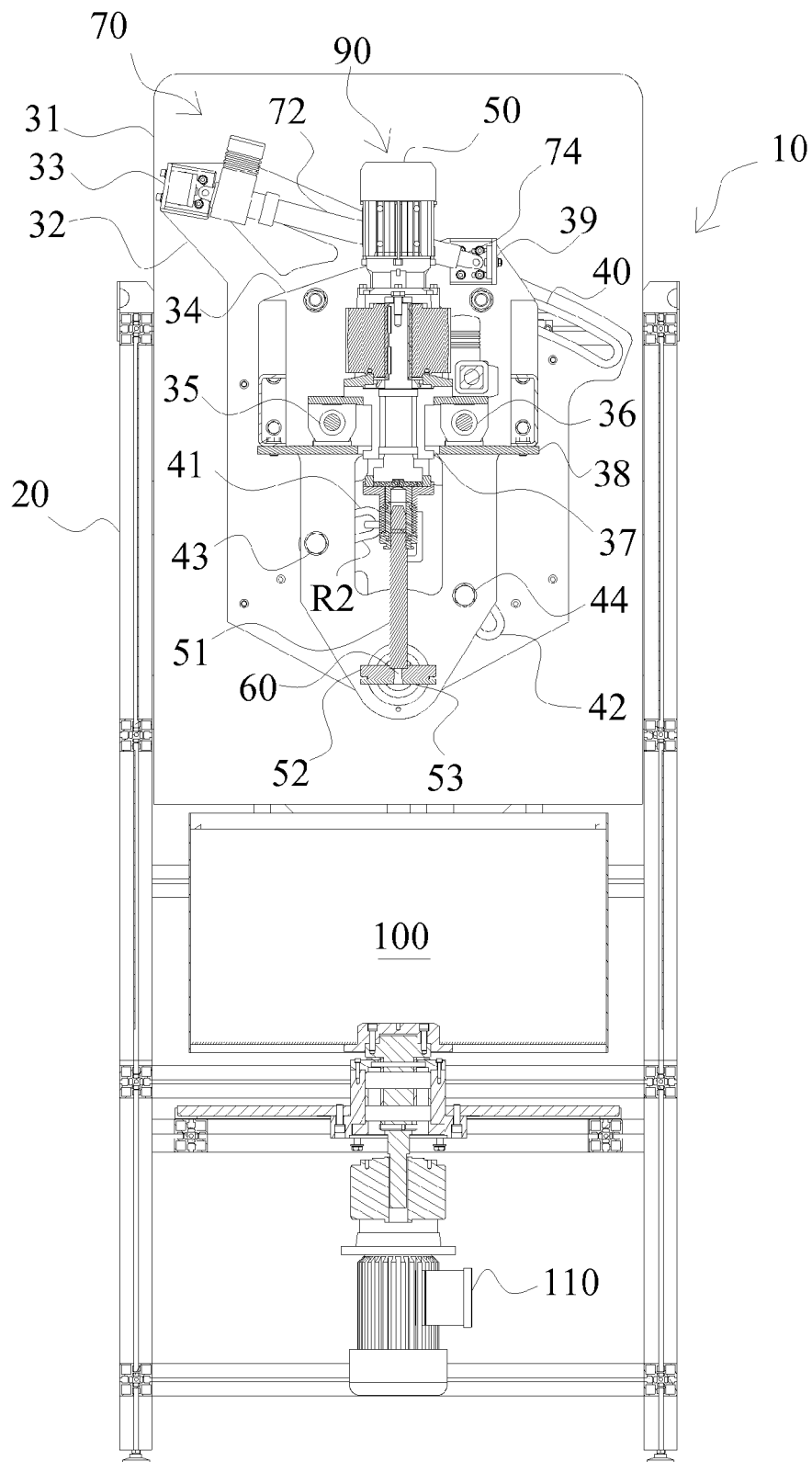


FIG.3

B-B

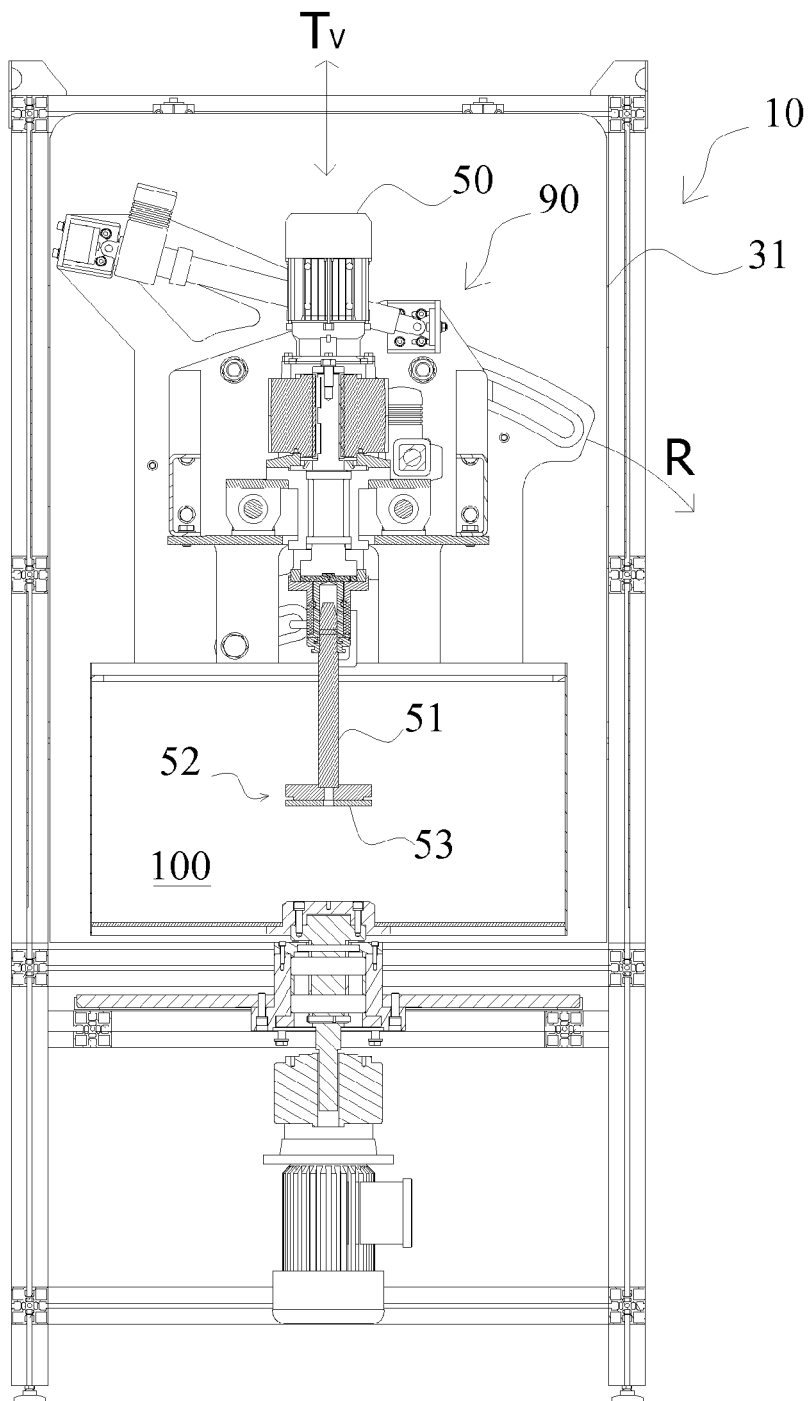


FIG.4

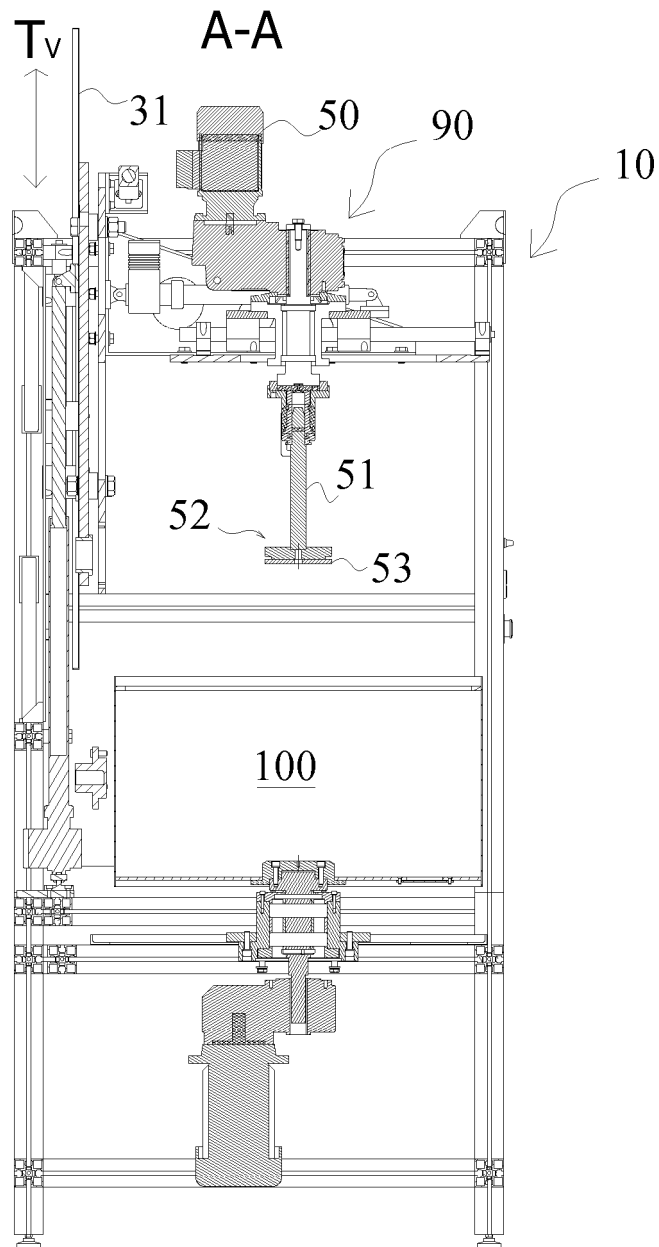


FIG.5

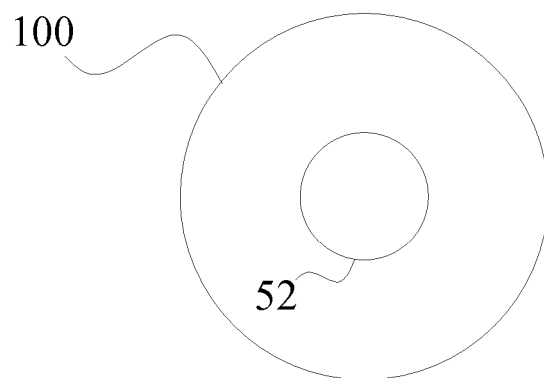


FIG.6

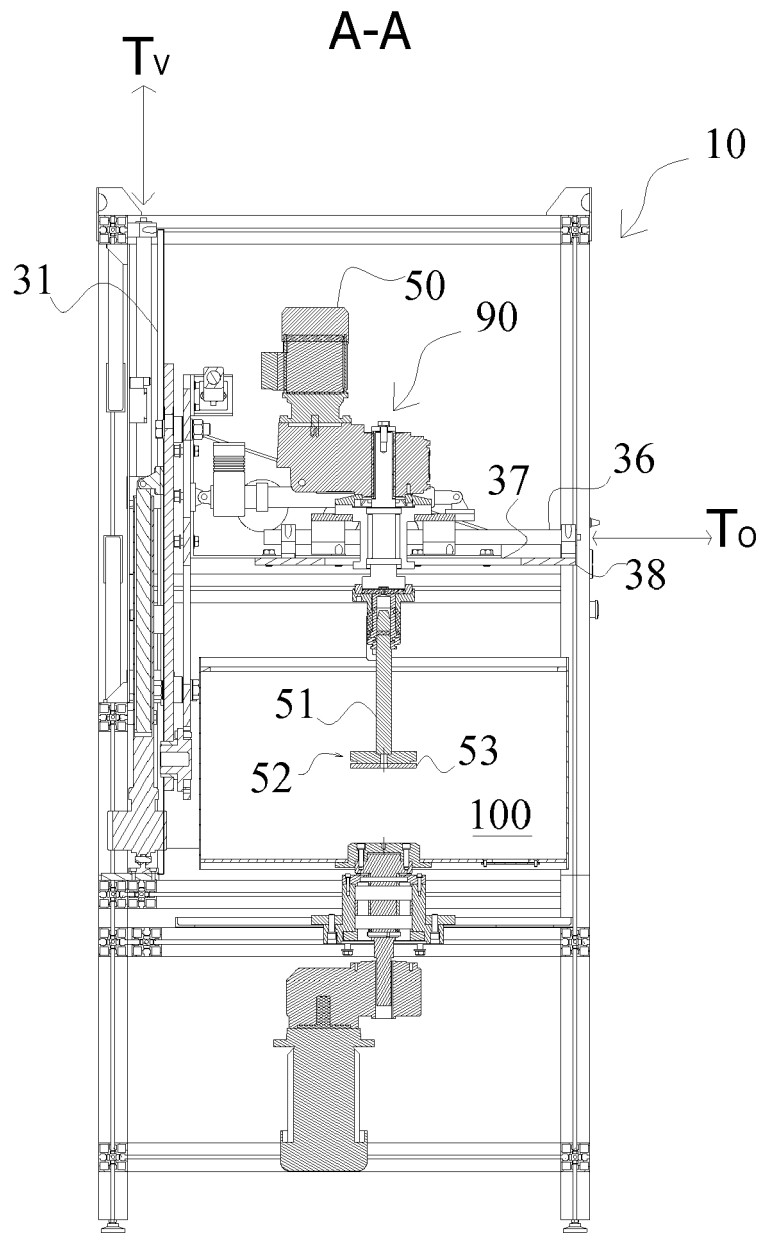


FIG.7

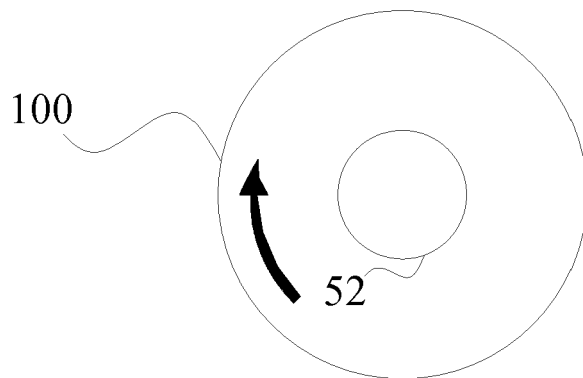


FIG.8

A-A

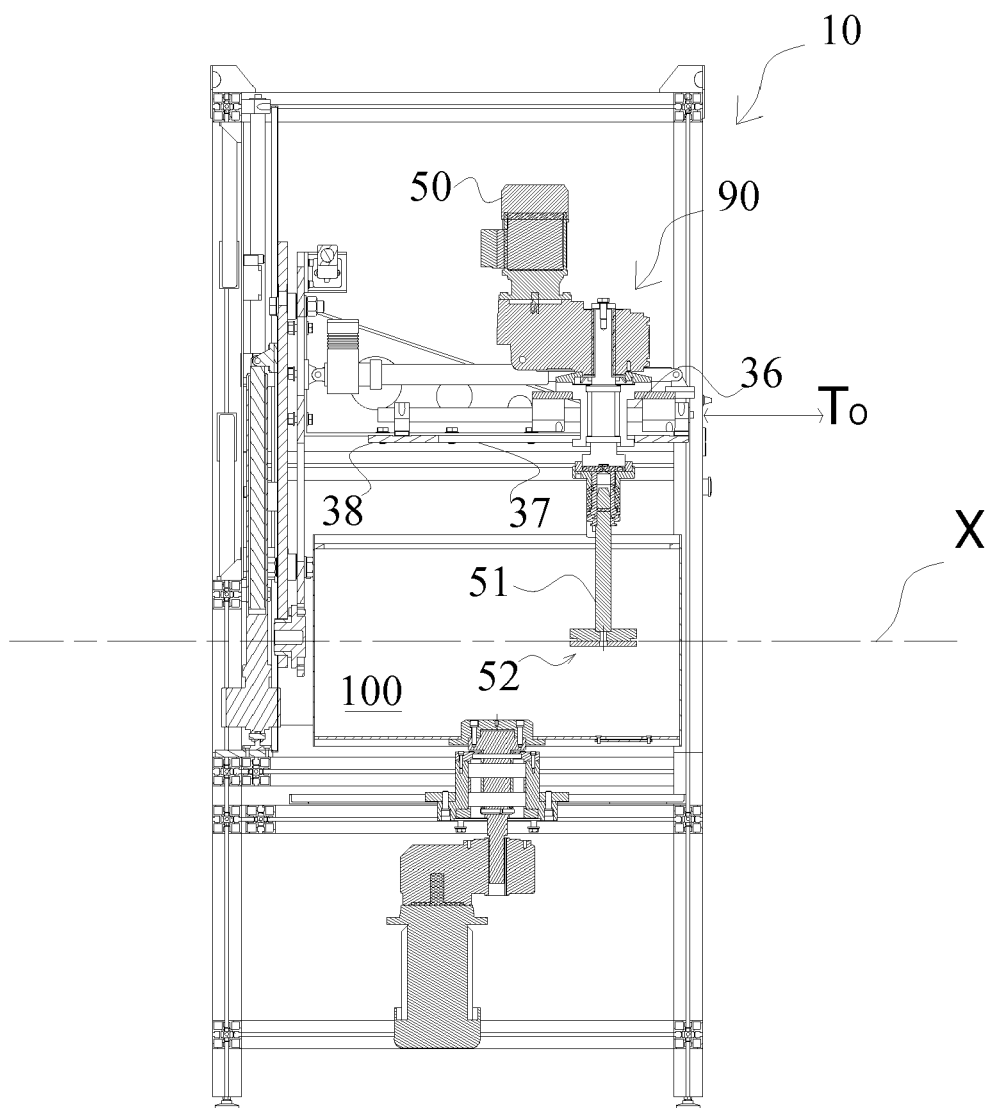


FIG.9

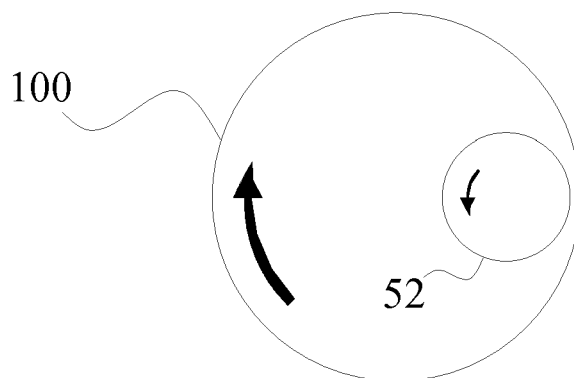
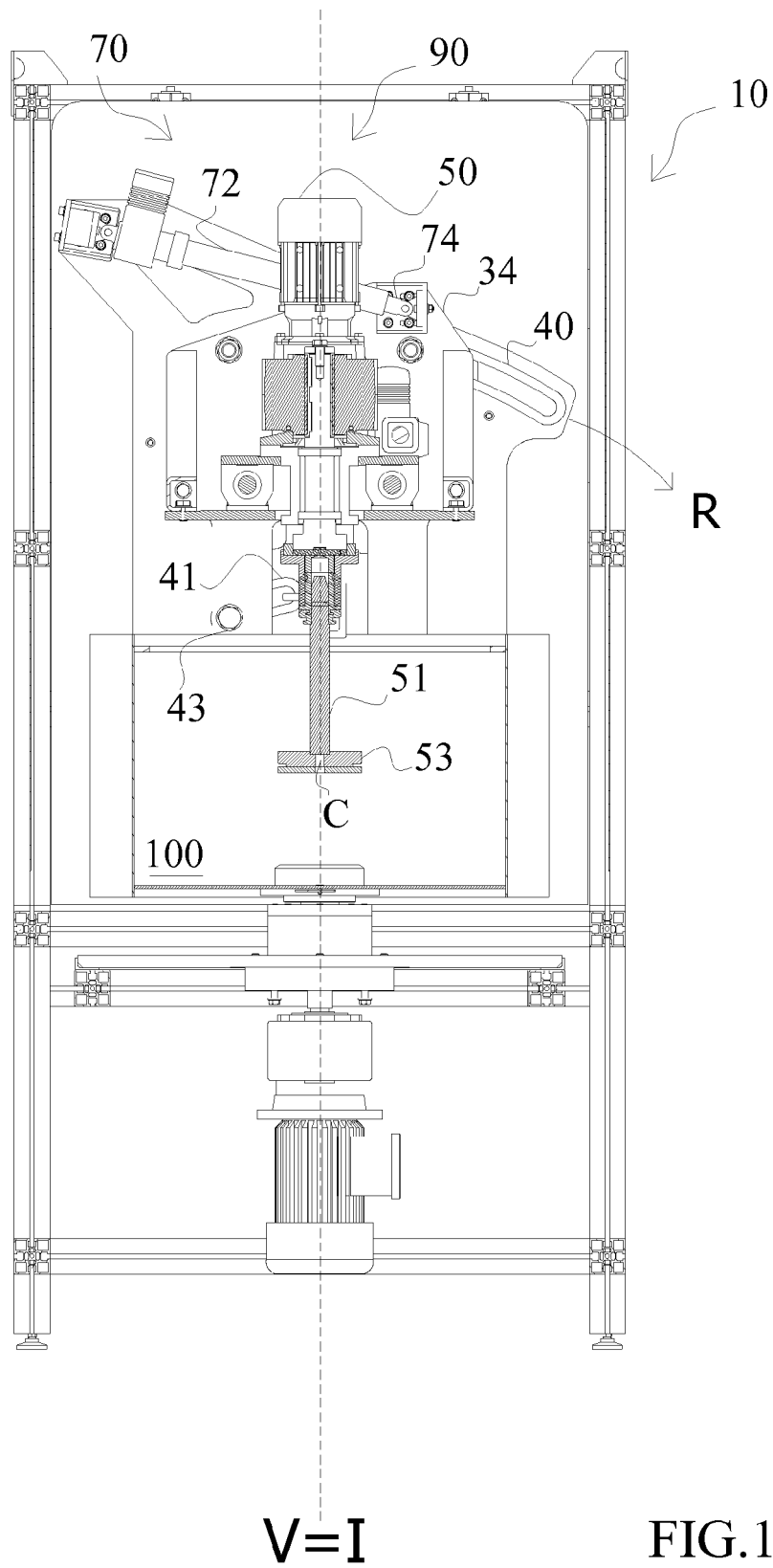


FIG.10

B-B



B-B

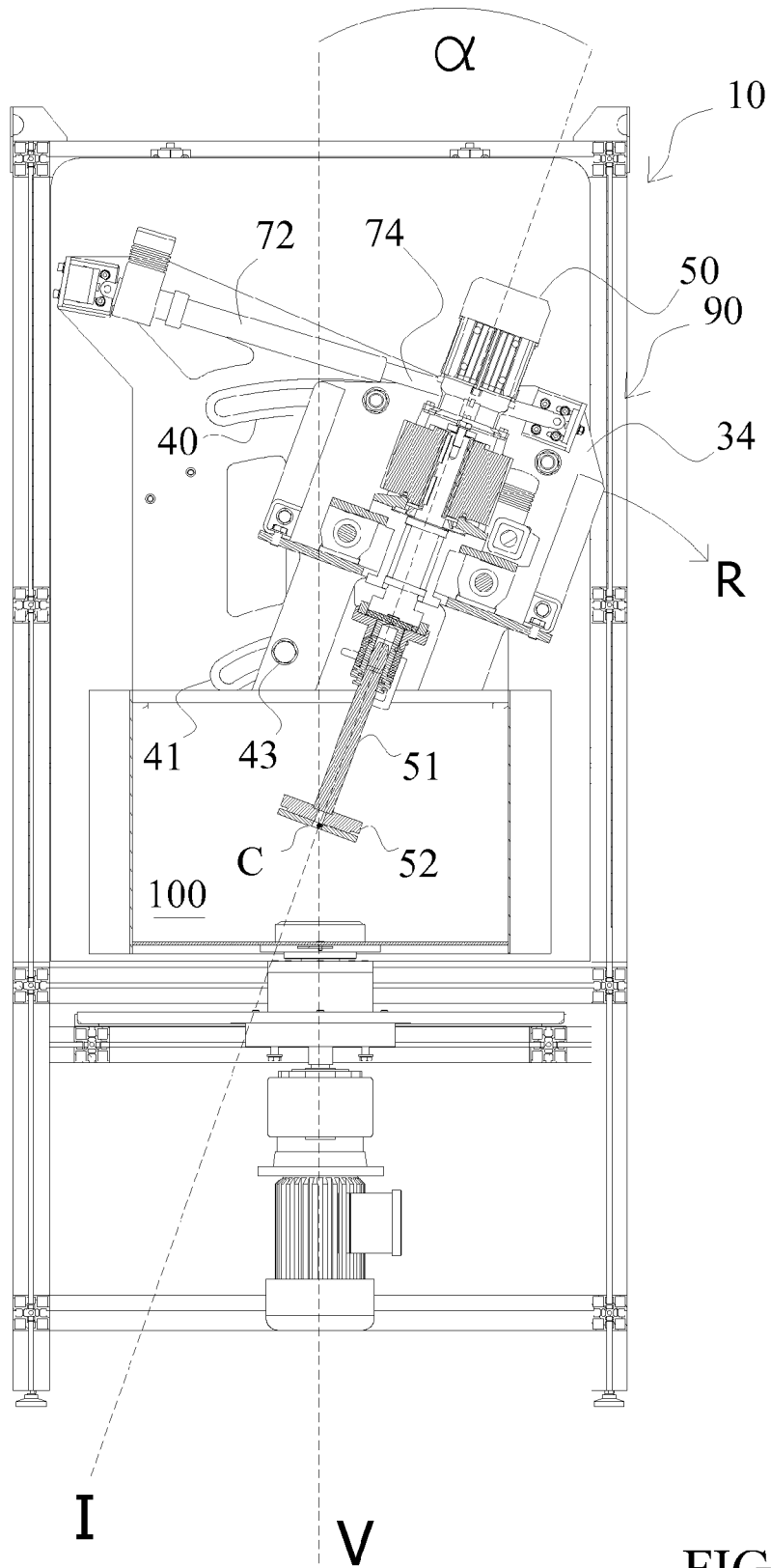


FIG.12

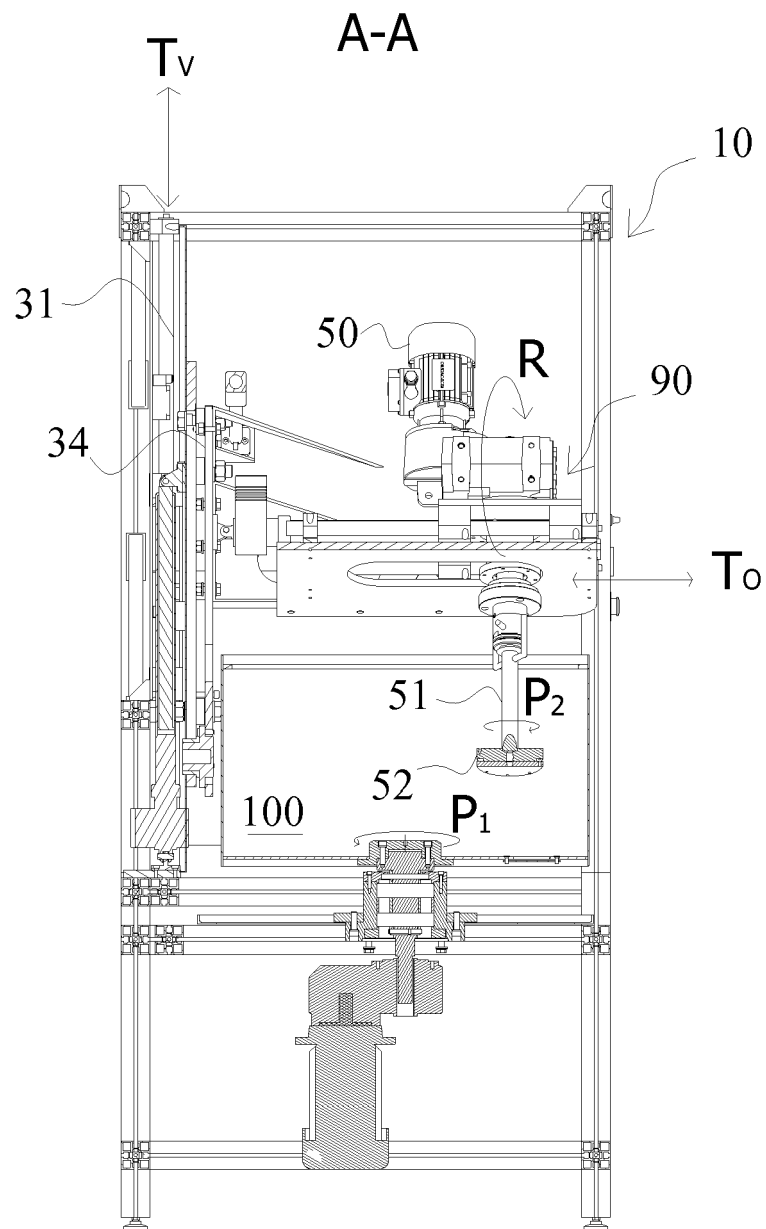


FIG.13

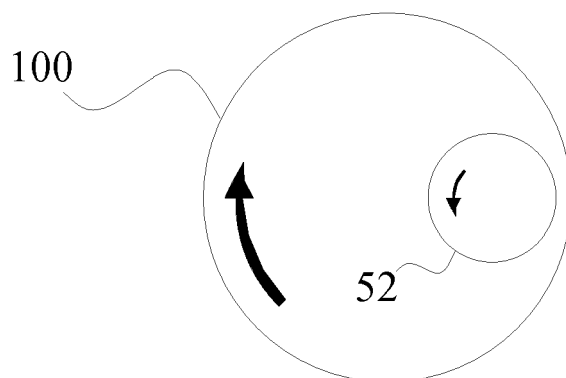


FIG.14

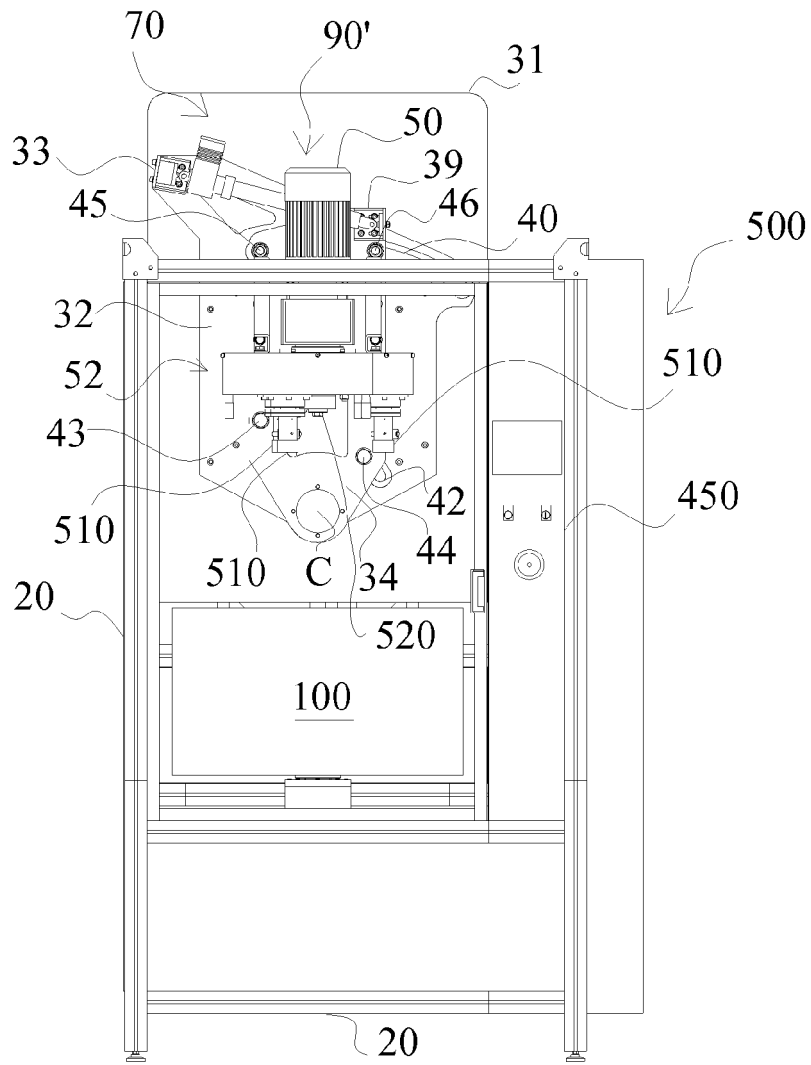


FIG. 16

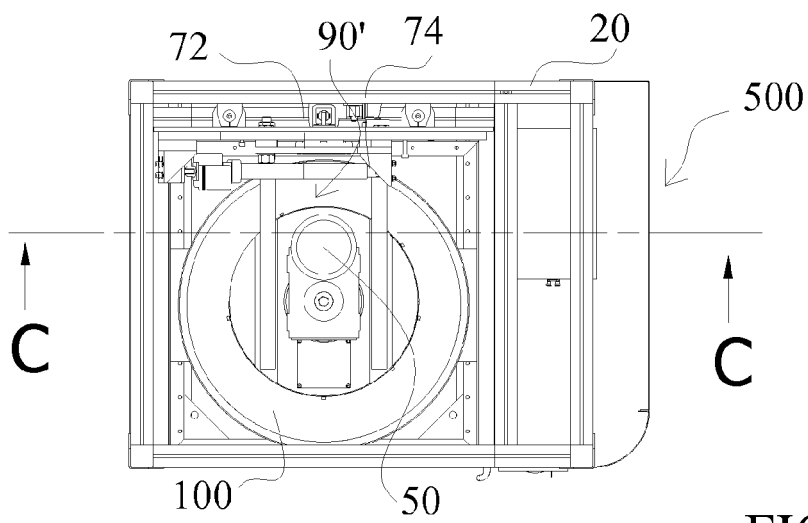
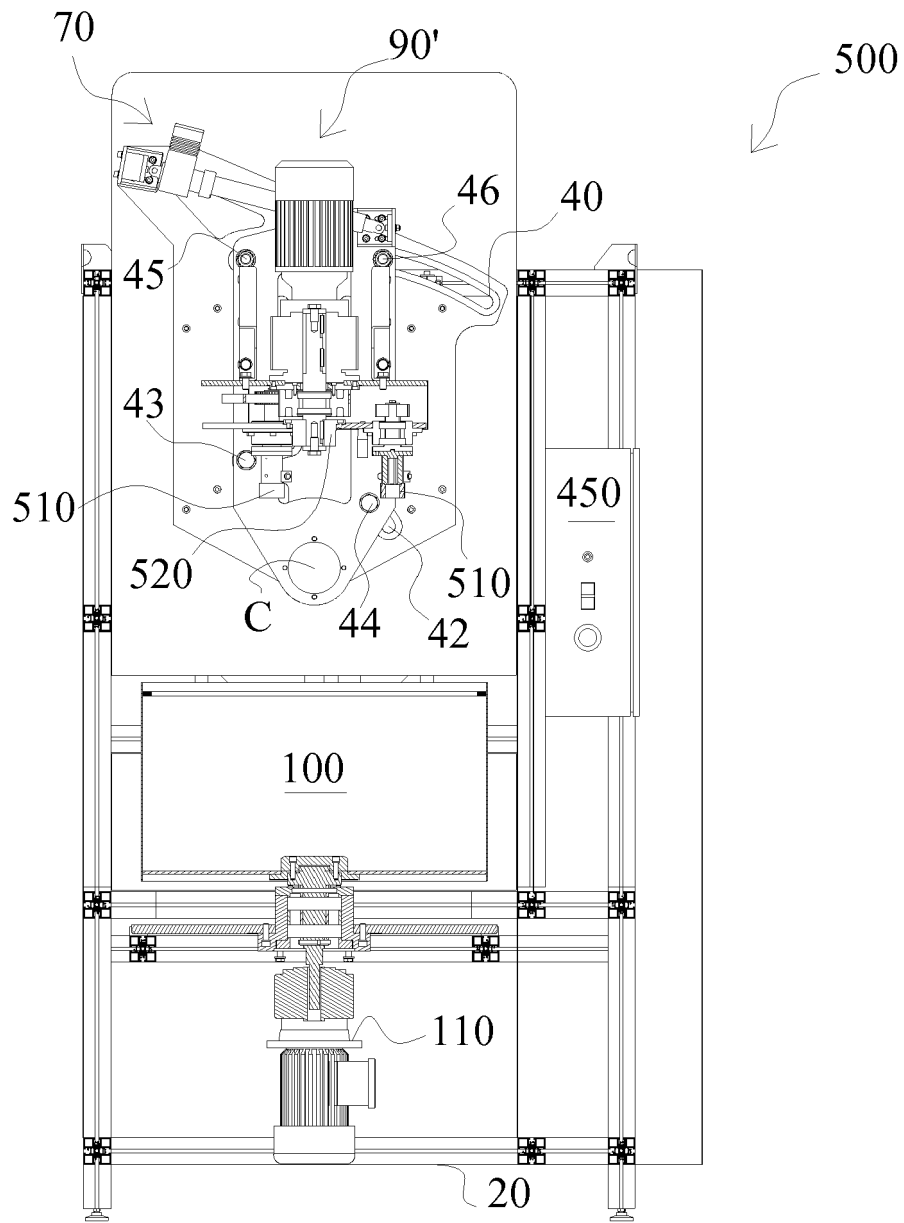


FIG. 15



C-C

FIG.17

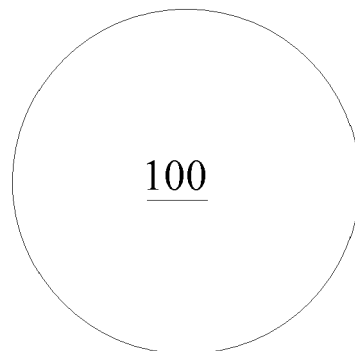
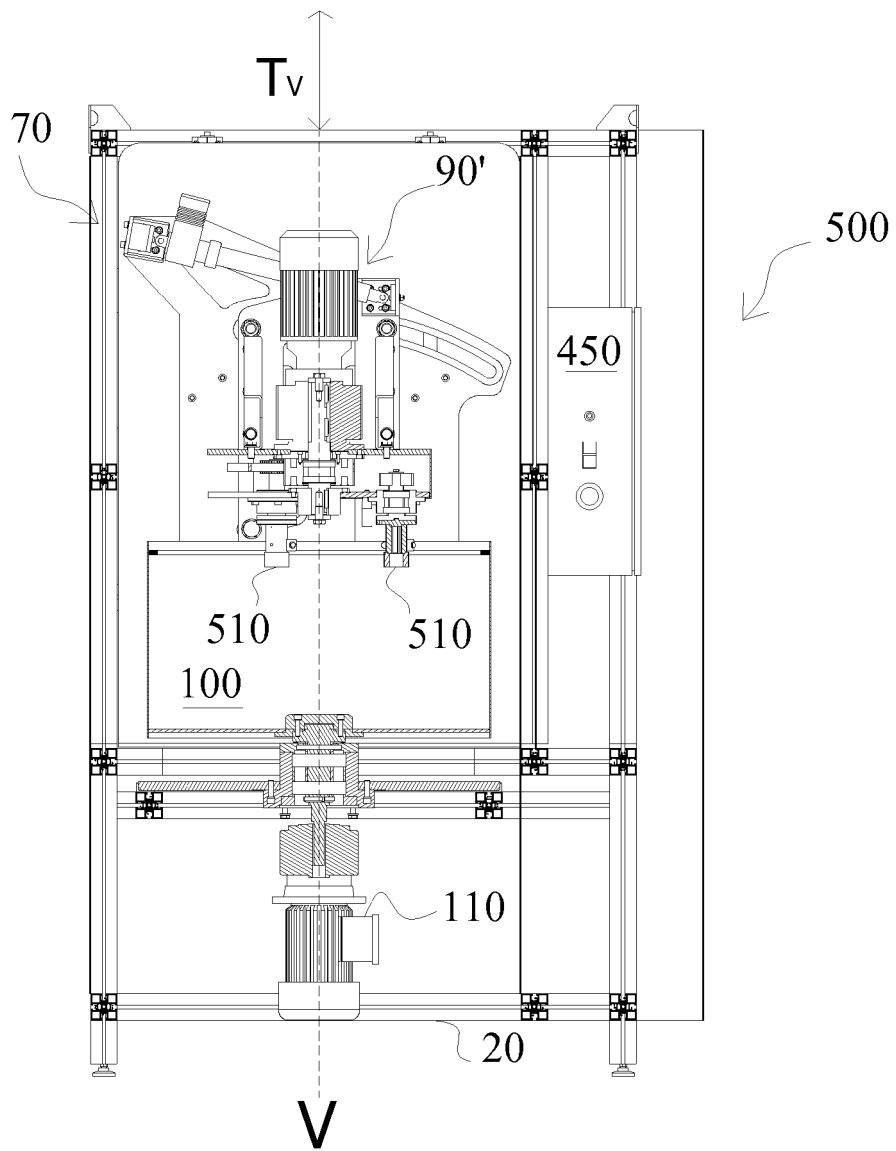


FIG.18



C-C

FIG. 19

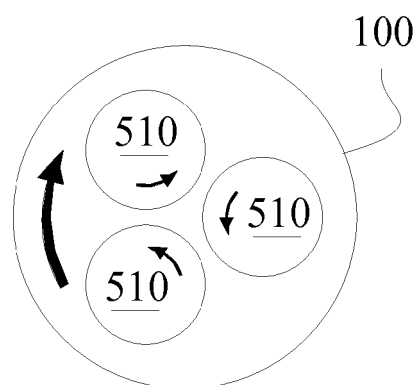


FIG. 20

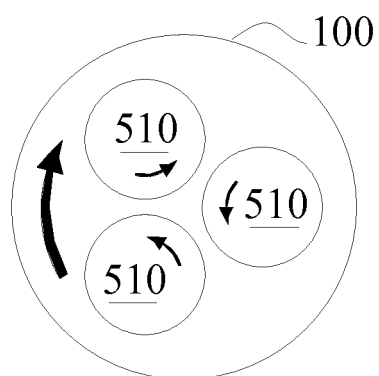
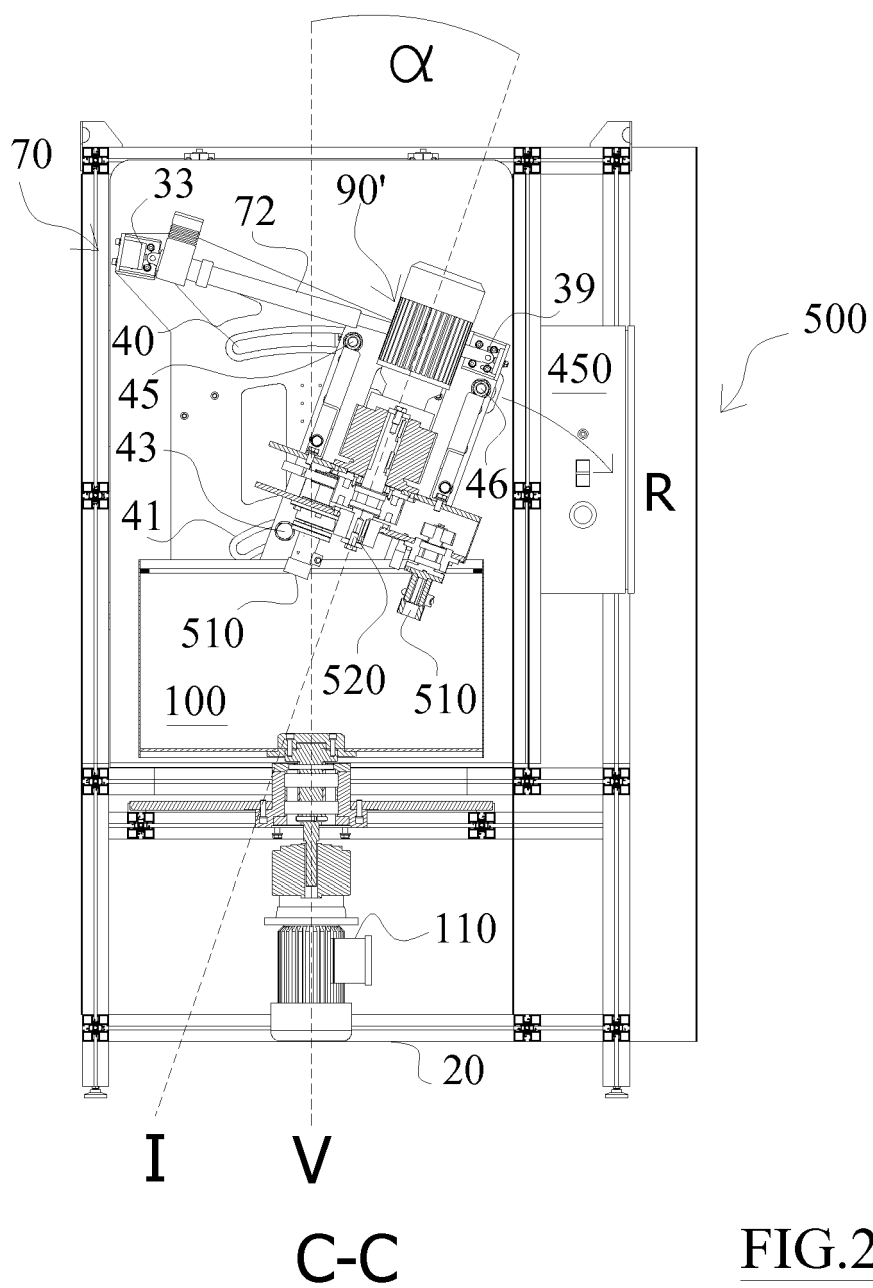


FIG.22

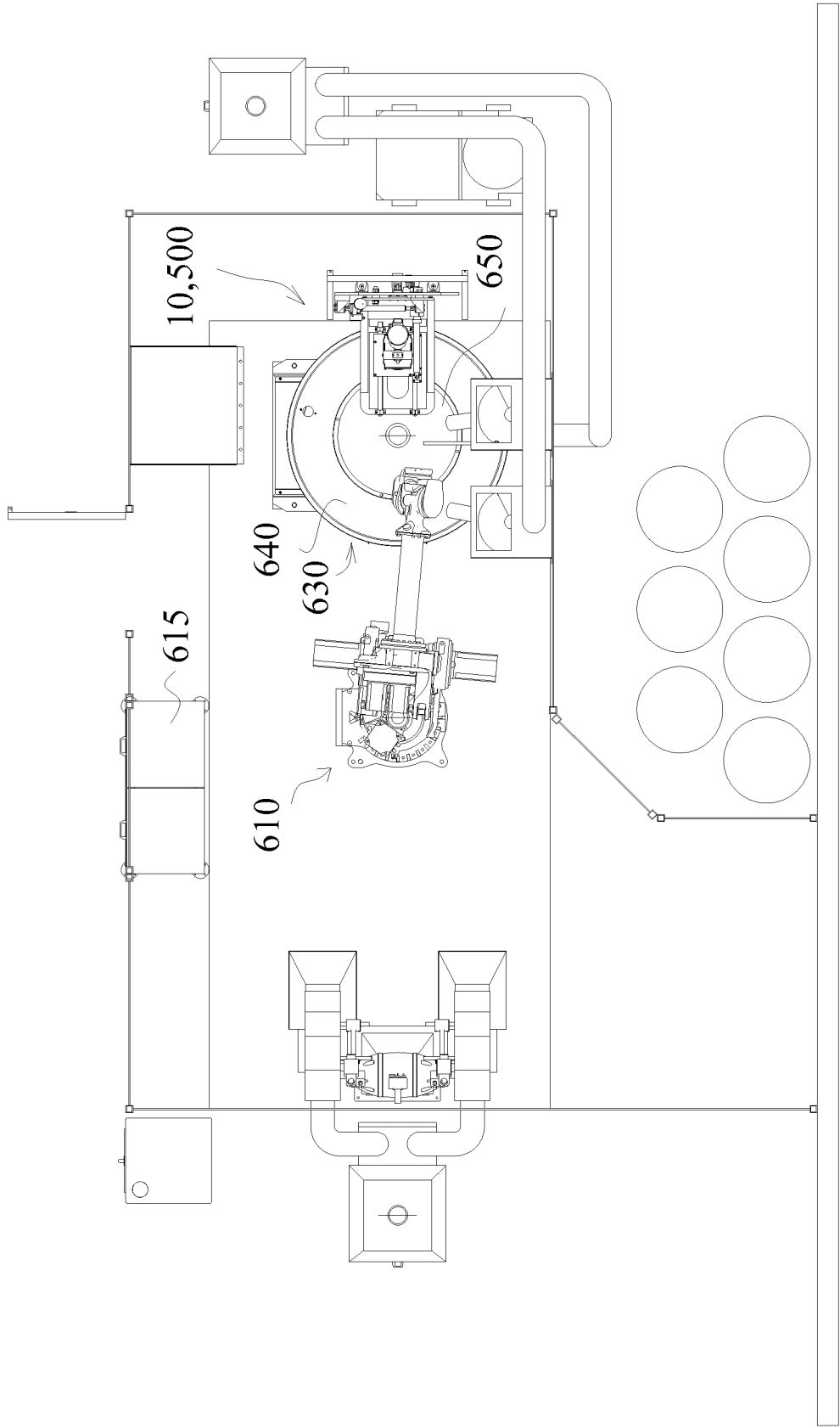


FIG.23



## EUROPEAN SEARCH REPORT

Application Number  
EP 17 15 5884

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                 |                                                         |                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------|
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                 |                                                         | B24B                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                 |                                                         |                                         |
| Place of search<br><b>Munich</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                 | Date of completion of the search<br><b>11 July 2017</b> | Examiner<br><b>Koller, Stefan</b>       |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                 |                                                         |                                         |

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

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