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(54) **A MACHINE FOR MULTIPLE DRAG FINISHING**

(57) A machine (10) for drag finishing of mechanical workpieces comprising a main rotary head (12), the main rotary head (12) having an axis of rotation (A-A) and carrying a plurality of rotating workpiece holding elements (16) arranged along a circumference around the axis of rotation (A-A) and wherein each rotating workpiece holding element (16) is adapted to support at least one work-

piece to be finished, wherein the machine further comprises at least two vats (50,52,54,56) for the containment of finishing media, positioned around the axis of rotation (A-A) of the main rotary head (12) and in that the machine further comprises a single loading and unloading station configured to be assisted by a robot.

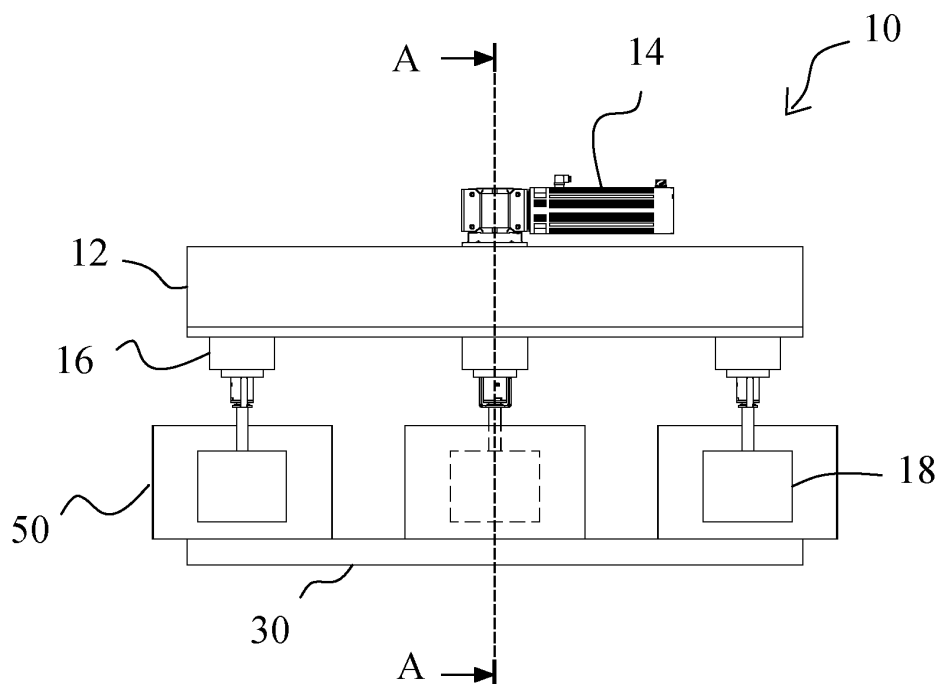


FIG.1

Description

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

[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, workpieces are fixed to suitable supporting devices such as carrying pieces mandrels.

[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.

[0005] Processing is done usually at high speed (at adjustable intensity) giving place to a certain contact pressure between the workpiece and processing media which leads to the desired result.

[0006] More in particular, in some known machines, the pieces are mounted on a rotating head that has a plurality of piece-holder groups each consisting of a spindle that is able, in turn, to accommodate a plurality of pieces placed along a circumference.

[0007] By way of example, a machine of the type described may be provided with a rotary head provided with three spindles holding pieces, each of which is adapted to support 12 pieces.

[0008] The machine can be set in motion by rotating the rotary head in a direction of rotation, while the spindles holding pieces may be made to rotate in an opposite direction.

[0009] A control panel allows the setting of the various operating parameters of the machine.

[0010] A first problem of the prior art is given by the fact that, in case that a piece has to be subjected to two or more finishing media such as, for example, one for roughing, one for smoothing and one for polishing, if a single machine with a single vat is provided, it becomes necessary to replace the media for roughing with the one for smoothing, subsequently, the one for smoothing with the one for polishing, which results in an increase of time and costs.

[0011] A further problem is given by the fact that machines for multiple finishing operations can have large dimensions, which involves high transport costs and sensible occupation of space inside the plants in which these are installed.

[0012] An object of the present invention is to overcome the above mentioned drawbacks, by providing a machine for the finishing of surfaces that allows to couple versatility of use, rapidity of execution with reduced costs and bulk.

[0013] Another purpose is to achieve said result in a practical and economical way.

[0014] These objects are attained by a machine for drag finishing of mechanical workpieces comprising a main rotary head, the main rotary head having an axis of rotation and carrying a plurality of rotating workpiece holding elements arranged along a circumference around the axis of rotation and wherein each rotating workpiece holding element is adapted to support at least one workpiece to be finished, characterized in that the machine further comprises at least two vats for the containment of finishing media, positioned around the axis of rotation of the main rotary head and in that the machine further comprises a single loading and unloading station configured to be assisted by a robot.

[0015] The invention offers numerous advantages, among which for example, the fact of being able to perform multiple machining processes, namely processes articulated over multiple passages of the workpieces within different types of media, wherein each of the media is contained in a respective containment vat.

[0016] For example, the machine according to an aspect of the invention can operate a deburring process, followed by a smoothing process, followed by a polishing process.

[0017] Other examples will be discussed below in the present description. Not less important are the following advantages:

- compact design compared to other existing standards;
- highly automated processes to manage multi stage processes;
- possibility of robot-assisted loading and unloading.

[0018] The invention provides also a method for drag finishing of mechanical pieces using a machine according to the preceding claims, the method comprising the following steps:

- loading of at least one rotating workpiece holding element from a loading and unloading station;
- immersing the workpieces loaded on the rotating workpiece holding elements in a first vat containing a first finishing media;
- performing a first finishing operation within the first vat;
- extracting the workpieces loaded on the rotating workpiece holding element from the first vat;
- rotating the main rotary head of the machine to bring the rotating workpiece holding element above a second vat containing a second finishing media;
- immersing the workpieces loaded on the rotating workpiece holding element in the second vat and performing a second finishing operation;
- extracting the workpieces loaded on the rotating workpiece holding element from the second vat;
- unloading the rotating workpiece holding element in correspondence of the loading and unloading station.

[0019] Further characteristics of the invention can be deduced from the dependent claims.

[0020] 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 is a side view of an embodiment of the machine of the invention;

Figure 2 is an axonometric view of the machine of Figure 1;

Figure 3 is a top view of an embodiment of the machine of the invention;

Figure 4 illustrates two different operating steps of the machine of Figure 3;

Figure 5 is a top view of the machine of Figure 3, in a different operating position;

Figure 6 illustrates two different operating phases of the machine of Figure 5;

Figures 7-9 illustrate some operating phases of a machine according to a further embodiment of the invention;

Figures 10-11 illustrate some operating phases of a machine according to still another embodiment of the invention;

Figures 12-14 illustrate some operating phases of a machine according to another embodiment of the invention; and

Figures 15 and 16 illustrate further embodiments of machines according to the invention.

[0021] In particular in figure 1, a machine for surface treatment of mechanical pieces, according to the present invention, globally indicated by the reference number 10, is shown.

[0022] The machine 10 comprises a main rotary head 12 which can be set in rotation, for example, by means of a geared motor unit 14 which sets in rotation the rotary head main 12 about an axis of rotation A-A (shown in Figures 1-2) and that, in most applications, is a vertical axis.

[0023] The motorized rotary head 12 carries a plurality of rotating workpiece elements 16, each rotating workpiece element 16 being adapted to support at least one workpiece to be machined and set in rotation by a relative geared motor unit 14.

[0024] The machine 100 can be set in motion by rotating the rotary head 12 in a direction of rotation, while the rotating workpiece elements 16 can be rotated in the opposite direction.

[0025] In many applications, each rotating workpiece element 16, instead of carrying a single work piece, carries a multi-spindle head, where each multi-spindle head carries a plurality of satellite spindles.

[0026] These multi-spindle heads 18 (schematically indicated in the drawings), are such that each multi-spindle head 18 carries a plurality of satellite spindles.

[0027] In this case, the dynamics of the rotary machines equipped with a plurality of multi-spindle heads 18, which is in itself known for this type of machine, is as follows.

[0028] The main head 12 rotates according to a determined direction of rotation (in the attached drawings clockwise when viewed from above), the multi-spindle heads 18 rotate in the opposite direction (e.g.: counter-clockwise) and, finally, the single spindle of each head multi-spindle rotate in the direction opposite to that of rotation of the multi-spindle heads 18 (thus, for example, clockwise).

[0029] According to one aspect of the present invention, the machine 100 further comprises at least two vats 50,52,54,56 for the containment of finishing media.

[0030] More generally, the number of containment vats for the finishing media can be four, six or eight or even another number.

[0031] Exemplary embodiments will be detailed hereinafter.

[0032] Vats 50,52,54,56 for the containment of finishing media are positioned around the axis of rotation (A-A) of the motorized rotating head 12, for example assuming a corolla configuration such as the one illustrated in the various figures attached to this description.

[0033] Moreover the vats 50,52,54,56 for the containment of finishing media are positioned in such a way that the machine can immerse the piece carried by a respective holding element pieces 16 within the finishing media of a respective containment vat.

[0034] In the case in which multi-spindle satellite heads 18 are used, the vats 50,52,54,56 for containment of the finishing media are positioned in such a way that the machine can immerse the pieces carried by a specific multi-spindle satellite head 18 inside the finishing media.

[0035] The vats 50,52,54,56 for the containment of finishing media are adapted to receive a different finishing media, as best illustrated in the various embodiments discussed hereinafter.

[0036] In addition, the vats 50,52,54,56 are placed on a flat surface, such as a vat floor 30, which can be placed in relative motion with respect to the rotating head 12 along a vertical direction.

[0037] According to an embodiment of the invention, means are provided to raise and lower the vat floor 30 according to the directions indicated with arrows F1 and F2 in Figure 4, for example by use of a hydraulic platform for lifting and lowering of the vat floor 30.

[0038] Alternatively, for example in smaller machines, vat floor 30 may be fixed and the rotating head 12 can be provided with lifting and lowering means.

[0039] The vats 50,52,54,56 for containment of finishing media can, in turn, be set in rotation by known means or may be devoid of rotary movement, according to the different embodiments of the invention.

[0040] Each machine may comprise a loading station for the work pieces on the relative spindles pieces and a station/area or discharge portion of the machined parts.

The stations/areas or portions of the loading and unloading can be coincident, as in the case indicated with the reference numeral 20 in Figures 7-9, or placed in the same area of access to the machine or placed each in its own dedicated area.

[0041] In some embodiments of the invention loading and unloading of the pieces can be performed by using one or more anthropomorphic robot(s) (not shown for simplicity) adapted to pick pieces, whose surfaces are to be machined, by a counter, a technologic tray or from another parts storage and to mount them on the piece-carrying spindles.

[0042] In an embodiment, the anthropomorphic robot 19 is part of the machine, such as the loading and unloading station 20.

[0043] In operation of the machine according to the various embodiments of the present invention, the pieces to be subjected to finishing operations are loaded onto the respective piece-carrying spindles, for example by use of an anthropomorphic robot or by other known means.

[0044] The rotary head is rotated and the piece-carrying spindles are brought on the vertical of vat inside which the workpieces are to be immersed.

[0045] At this point, the vat floor 30 is raised (or alternatively the rotary head 12 is lowered) until the pieces are brought inside the media in the respective vats and the spindles are rotated for a predetermined time depending on the required processing.

[0046] Once this stage of processing is ended, the vat floor 30 is lowered (or alternatively the rotary head 12 is raised) and the rotary head 12 is free to rotate in order to bring the workpieces over other vats containing, in general, a different finishing media to make a further stage of processing.

[0047] This process ends when the pieces have undergone all processing steps envisaged and are brought from the rotating head 12 to the station/area or discharge portion therein and discharged from the machine.

[0048] Some exemplary embodiments further clarify the various possibilities offered by the invention.

[0049] Figures 7-9 illustrate some operating phases of a machine 100, according to a further embodiment of the invention.

[0050] The machine 100 has three multi-spindle rotating heads 18 and six vats containing finishing media, in particular subdivided into two sets of three vats each.

[0051] For example, in the first set of vats 50 a media for smoothing is provided and in the second set of vats 52 a media for polishing is provided.

[0052] The machine 100 is therefore able to perform machining processes in two phases, such as A) smoothing and B) polishing, quickly and in a very small space.

[0053] In Figures 7-9 the operative dynamics of the machine 100 is reproduced.

[0054] In figure 7 it is observed that, one at a time, the multi-spindle rotary heads 18 are shifted in such a way that the individual mandrels can be loaded and unloaded

from a single point (marked by arrow F3). This fact has the advantage of allowing to a robot 19 to carry out the loading and unloading of the machine.

[0055] In Figure 8, following a rotation of the rotary head 12 by 45° in a clockwise direction, the three multi-spindle rotary heads 18 are brought in correspondence with each of a smoothing vat 50 (indicated by dashed lines).

[0056] The vat floor 30 is raised and the pieces carried by multi-spindle heads 18 are immersed in the smoothing media and the machine performs the rotations required for the required processing.

[0057] Once the smoothing process is terminated, the vat floor 30 is lowered and a further rotation of the rotary head 12 by 45° clockwise, carries the three multi-spindle heads 18 over the polishing vats 52 (Figure 9).

[0058] Appropriate rotations of the rotating head 12 finally carry the multi-spindle heads 18 to the loading and unloading station 20 for the unloading of the finished parts.

[0059] Figures 10-11 illustrate some operating phases of a machine 110 according to still another embodiment of the invention.

[0060] The machine 110 is provided with four multi-spindle rotating heads 18 and eight vats containing finishing media, in particular subdivided into two sets of four vats each.

[0061] The machine 110 is also able to perform machining processes in two phases, such as A) smoothing and B) polishing, quickly and in a very small space.

[0062] In Figures 10-11 the operative dynamics of the machine 110 is reproduced.

[0063] In figure 10 it is observed that, one at a time, the multi-spindle heads 18 are shifted in such a way that the individual spindles can be loaded and unloaded from a single point. This fact has the advantage of allowing to a robot to carry out the loading and unloading of the machine. In the same figure 10, the multi-spindle rotary heads 18 are brought in correspondence with each of a smoothing vat 50.

[0064] Once the smoothing process is terminated, the vat floor 30 is lowered and a further rotation of the head 12 by 45° clockwise, carries the four multi-spindle heads 18 over polishing vats 52 (in this case indicated by dashed lines in Figure 11).

[0065] Figures 12-14 illustrate some operating phases of a machine 110' according to still another embodiment of the invention.

[0066] The machine 110' is provided with four multi-spindle rotating heads 18 and eight finishing vats, subdivided into two sets of two vats each and in a set of four vats.

[0067] For example, in the first set of two vats 50 a smoothing media is inserted and in the second set of two vats 52 a polishing media is inserted, while in the third set of four vats 54 a roughing media is inserted.

[0068] The machine 100' is able to perform processes in several stages, such as: A1) roughing, A2) roughing,

B) smoothing, and C) polishing, quickly and in a very small space.

[0069] At the beginning of the working cycle two multi-spindle heads at a time are loaded, then, in a continuous fashion, two multi-spindle heads at a time are discharged.

[0070] In order to better visualize the rotation of the machine 100' the four multi-spindle heads 18 have been indicated with Roman letters I-IV to distinguish between them.

[0071] A possible operation of the machine 100' is the following.

[0072] At first the multi-spindle heads I and II are loaded, by means of a 45° rotation of the head 12.

[0073] The multi-spindle heads I and II are then immersed in the roughing vats 54 for a first roughing operation. At the same time, the multi-spindle heads III and IV, previously loaded, are immersed in the smoothing vats 50 for the respective processing.

[0074] After this phase, the main head 12 is rotated by 45° clockwise when viewed from above (Figure 13) and the multi-spindle heads I and II are carried within other roughing vats 54 for a second roughing phase, while the multi-spindle heads III and IV are immersed in the polishing vats 52 to perform the respective phase.

[0075] Subsequently, since for the multi-spindle heads III and IV the polishing operation is, in this particular example case, the last phase, the main head 12 is progressively rotated to carry the pieces supported by the multi-spindle heads 18 in the position of loading/unloading and replace them with new workpieces.

[0076] The main head 12 is then rotated to carry the new work pieces supported by the multi-spindle heads III and IV, in the positions indicated in figure 14, namely for the first roughing step, while the pieces supported by the multi-spindle heads I and II are brought in correspondence of the polishing tanks 52 for the respective phase.

[0077] The situation shown in Figure 14 is therefore the same as the one in figure 12 with the only difference that different multi-spindle heads are employed for the various processes.

[0078] The described cycle can then be repeated any number of times, depending on the machining requirements.

[0079] Figure 15 illustrates a further embodiment of a machine according to the invention.

[0080] The machine 120 is provided with eight multi-spindle rotating heads 18 and eight finishing vats. In particular, in the embodiment depicted in Figure 15, two sets of vats are provided, each set comprising four vats each, namely four smoothing vats 50 and four polishing vats 52.

[0081] The machine 120 is therefore able to perform machining processes in two phases, such as A) smoothing and B) polishing quickly and in a very small space.

[0082] In Figure 15 the operative dynamics of the machine 120 is also reproduced.

[0083] Initially multi-spindle heads 18 are loaded at a time, then, in a continuous fashion, four multi-spindle heads 18 are unloaded at a time.

[0084] Moreover, initially four multi-spindle heads 18 are on smoothing vats 50 and the other four multi-spindle heads 18 are on the polishing vats 52.

[0085] After this stage, the vat floor 30 is lowered and the main head 12 is rotated, for example clockwise, to bring the new work pieces on the respective vats.

[0086] Figure 16 illustrates still another embodiment of a machine 130 according to the invention.

[0087] The machine 130 is also provided with eight multi-spindle rotating heads 18 and eight finishing vats. In particular, in the embodiment depicted in Figure 16, four sets of vats are provided, each set comprising two vats each, namely two smoothing vats 50, two polishing vats 52, two roughing vats 54 and two fine smoothing vats 56 for the respective operations.

[0088] For each working phase, two multi-spindle heads 18 are on the smoothing vats 50, two multi-spindle heads 18 are on the fine polishing vats 52, two multi-spindle heads 18 are on the roughing vats 54 and two multi-spindle heads 18 are on the polishing vats 50.

[0089] An embodiment of the invention provides to apply, to each piece carrying spindle, means for carrying said spindle in a working position inside the respective vat that is eccentric with respect to the center of the vat, according to the description of the patent applications ITMI2013A001616 and EP14185788, the teachings of which are herein incorporated.

[0090] For example a single spindle for each piece carrying element can be mounted on a frame which can move horizontally towards an eccentric position inside the respective vat.

[0091] Finally the vats 50,52,54,56 for containment of finishing media can be static and/or rotating and/or vibrating.

[0092] 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 for drag finishing of mechanical workpieces comprising a main rotary head (12), the main rotary head (12) having an axis of rotation (A-A) and carrying a plurality of rotating workpiece holding elements (16) arranged along a circumference around the axis of rotation (A-A) and wherein each rotating workpiece holding element (16) is adapted to support at least one workpiece to be finished, **characterized in that** the machine further comprises at least two vats (50,52,54,56) for the containment of finishing media, positioned around the axis of rotation (A-A) of the main rotary head (12) and **in that** the machine further comprises a single loading and unloading station configured to be assisted by a robot.
2. The machine according to claim 1, wherein each ro-

tating workpiece holding elements (16) comprises a multi-spindle head (18).

3. The machine according to claim 1, wherein the vats for the containment of finishing media are positioned as a corolla around the axis of the main rotary head (12). 5
4. The machine according to claim 1, wherein the vats (50,52,54,56) for the containment of finishing media are adapted to receive a different finishing media. 10
5. The machine according to claim 1, wherein means are provided for imparting to the vats (50,52,54,56) for the containment of finishing media and to the main rotary head (12) a relative movement towards and away from each other. 15
6. The machine according to claim 1, wherein each rotating workpiece holding element (16) is provided with means for bringing said rotating workpiece holding element (16) in a working position inside the respective vat, the working position being eccentric with respect to the center of the vat itself. 20
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7. The machine according to claim 1, wherein the vats (50,52,54,56) for the containment of finishing media can be static and/or rotating and/or vibrating.
8. A method for drag finishing of mechanical pieces using a machine according to the preceding claims, the method comprising the following steps: 30
 - loading of at least one rotating workpiece holding element (16); 35
 - immersing the workpieces loaded on the rotating workpiece holding elements (16) in a first vat containing a first finishing media;
 - performing a first finishing operation within the first vat; 40
 - extracting the workpieces loaded on the rotating workpiece holding element (16) from the first vat;
 - rotating the main rotary head (12) of the machine to bring the rotating workpiece holding element (16) above a second vat containing a second finishing media; 45
 - immersing the workpieces loaded on the rotating workpiece holding element (16) in the second vat and performing a second finishing operation; 50
 - extracting the workpieces loaded on the rotating workpiece holding element (16) from the second vat;
 - unloading the rotating workpiece holding element (16). 55

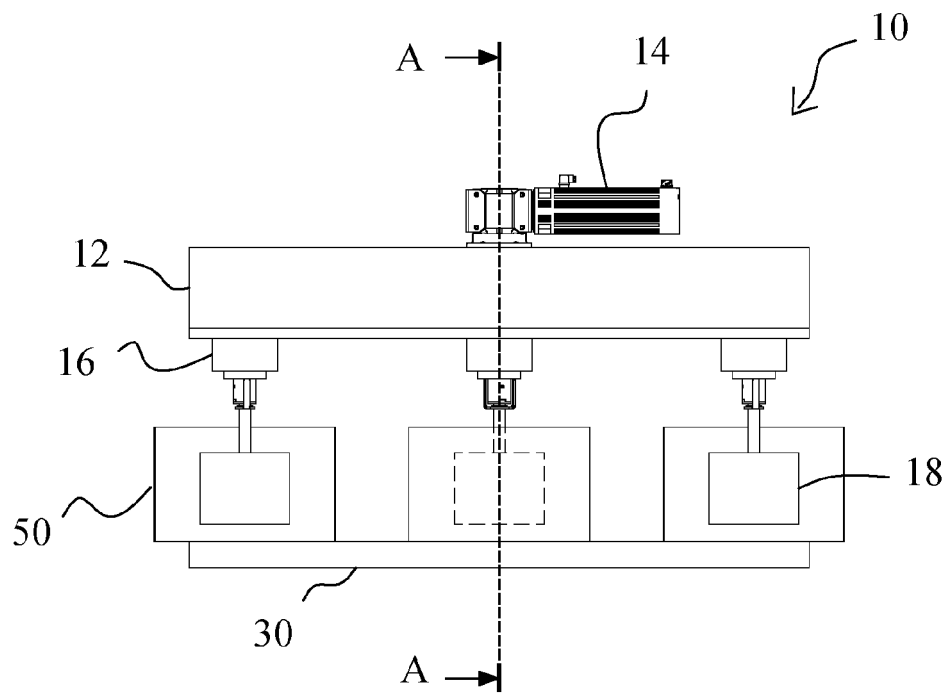


FIG.1

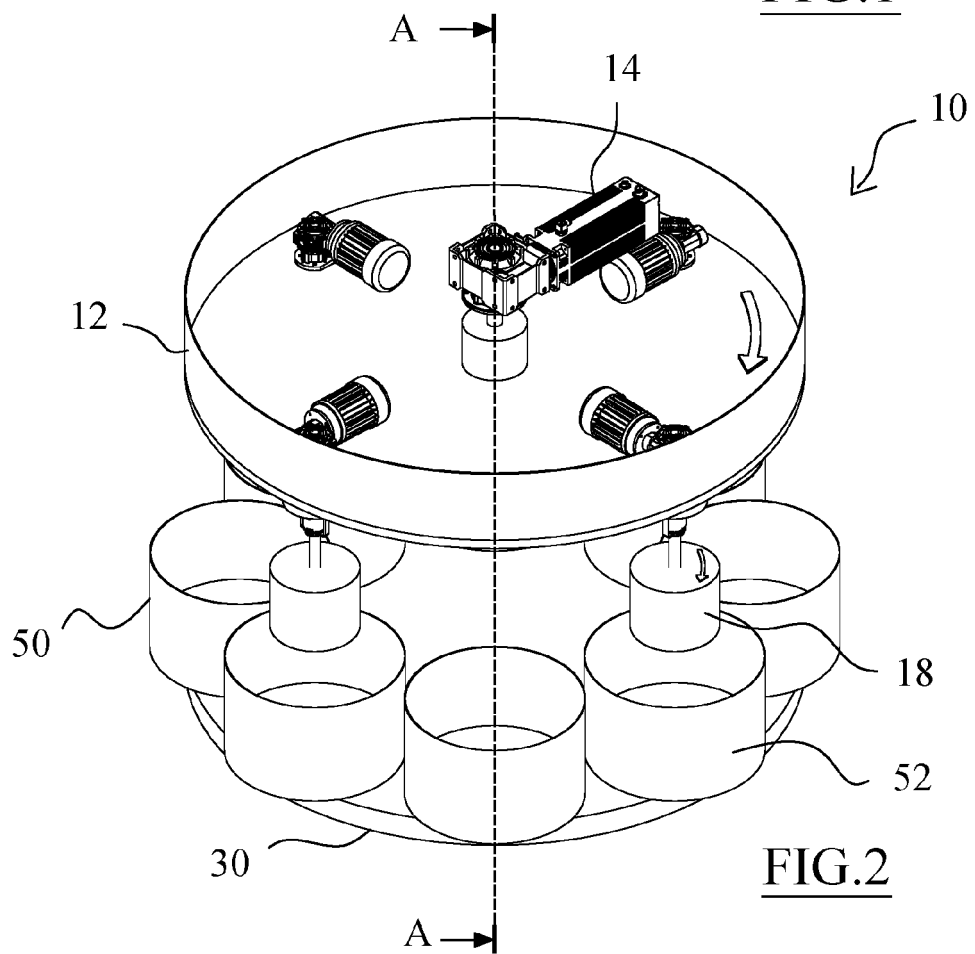


FIG.2

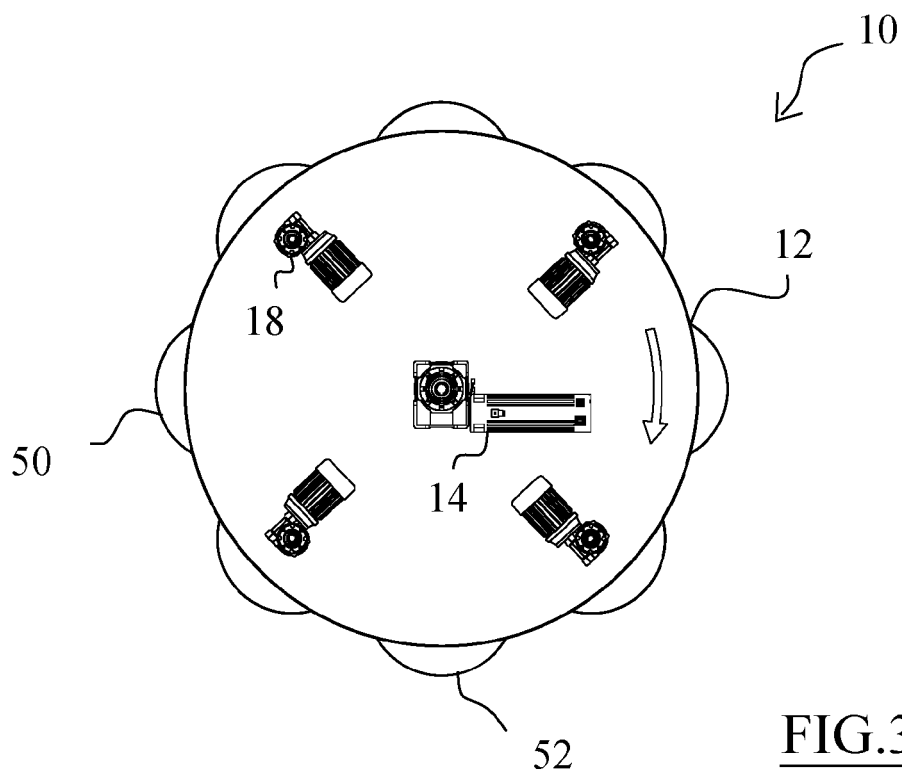


FIG.3

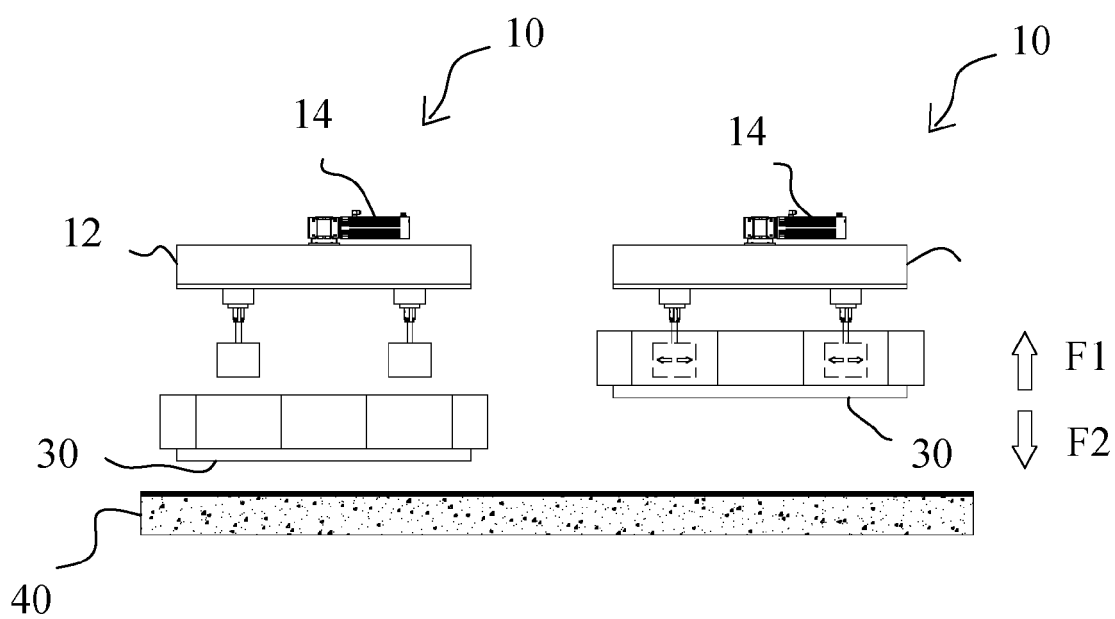


FIG.4

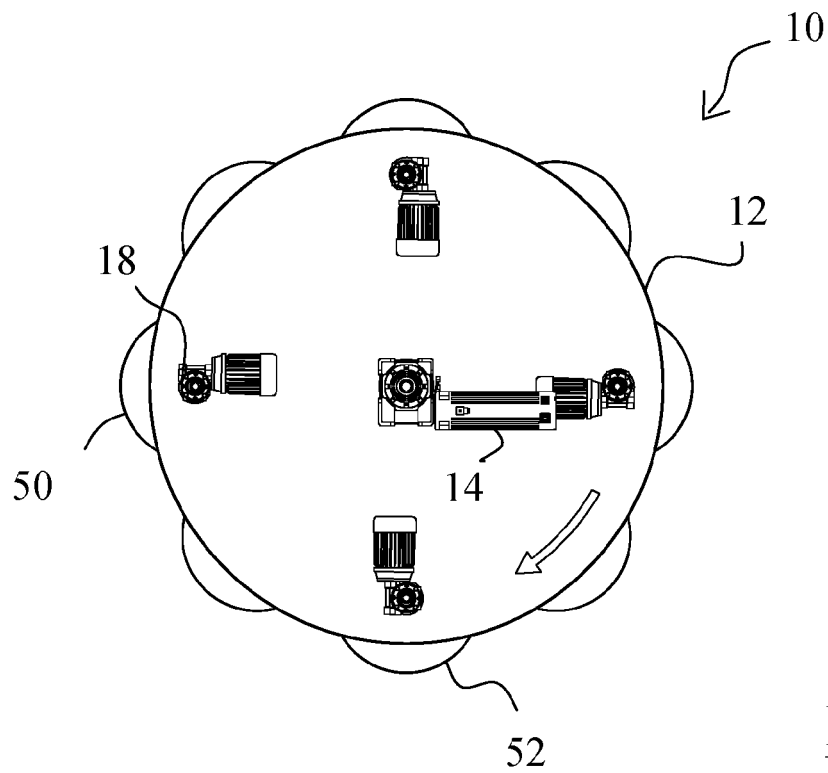


FIG. 5

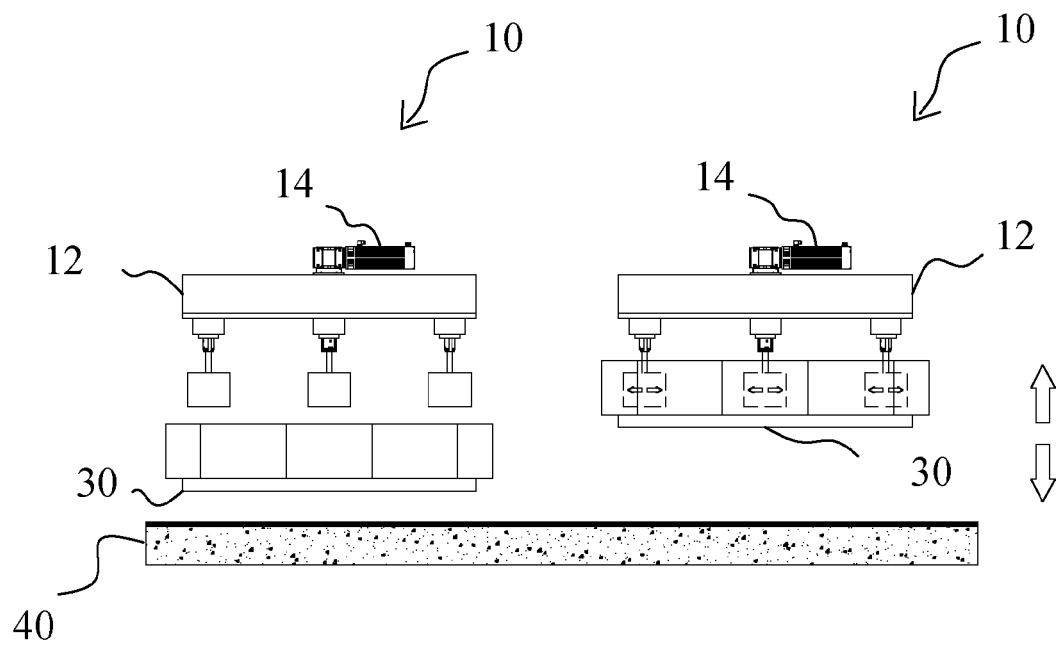


FIG. 6

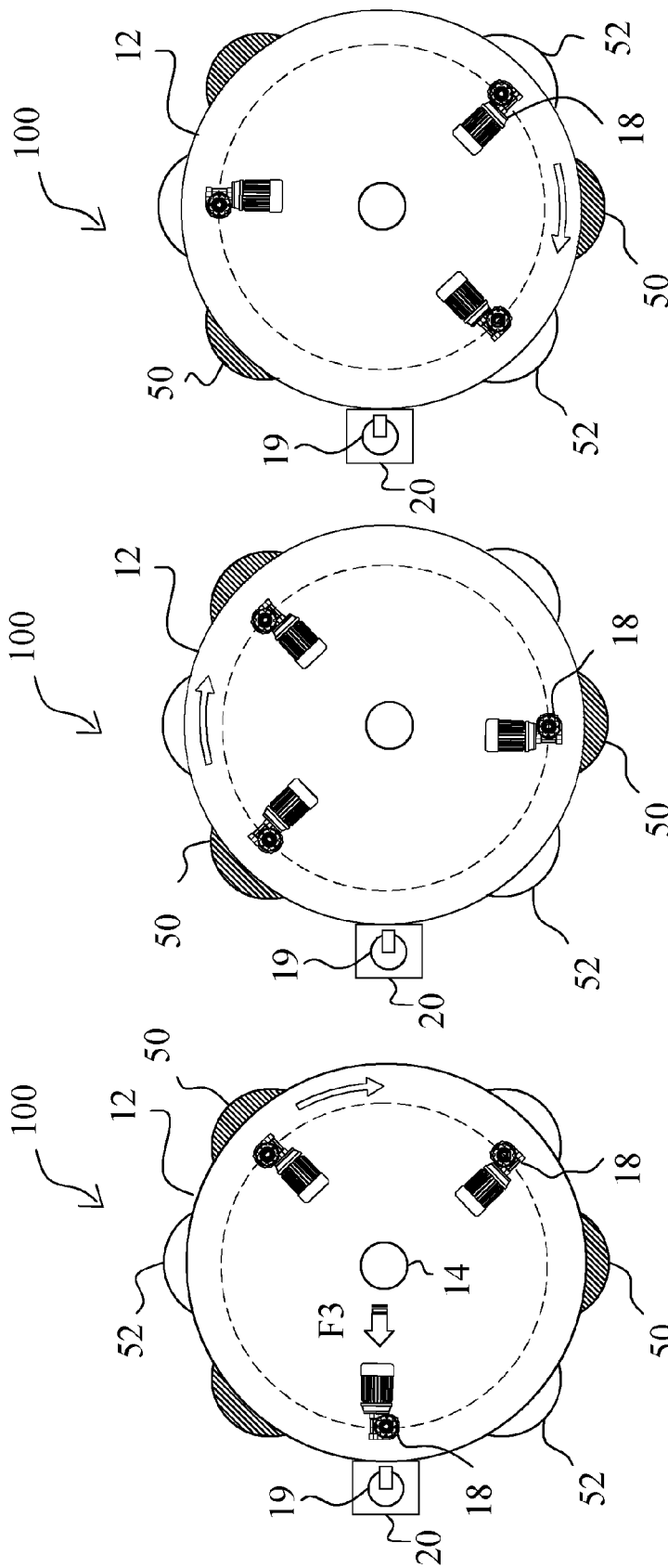


FIG.7

FIG.8

FIG.9

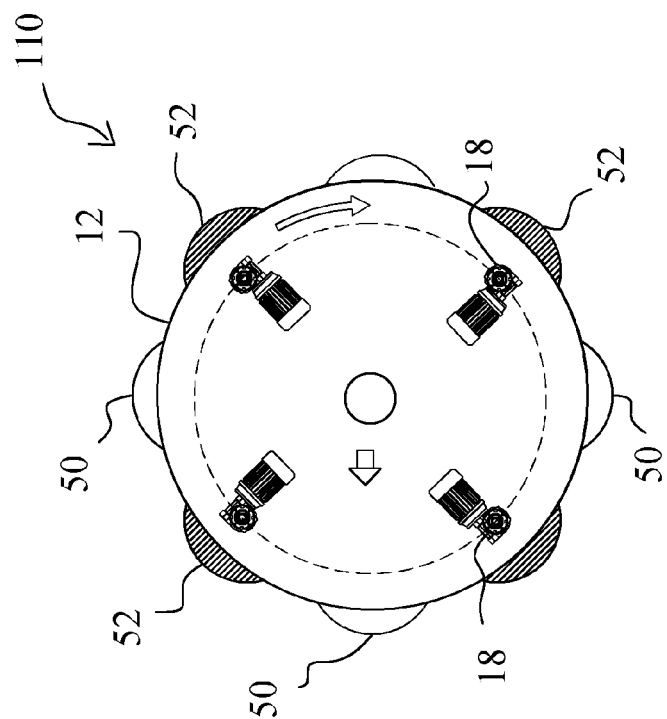


FIG.11

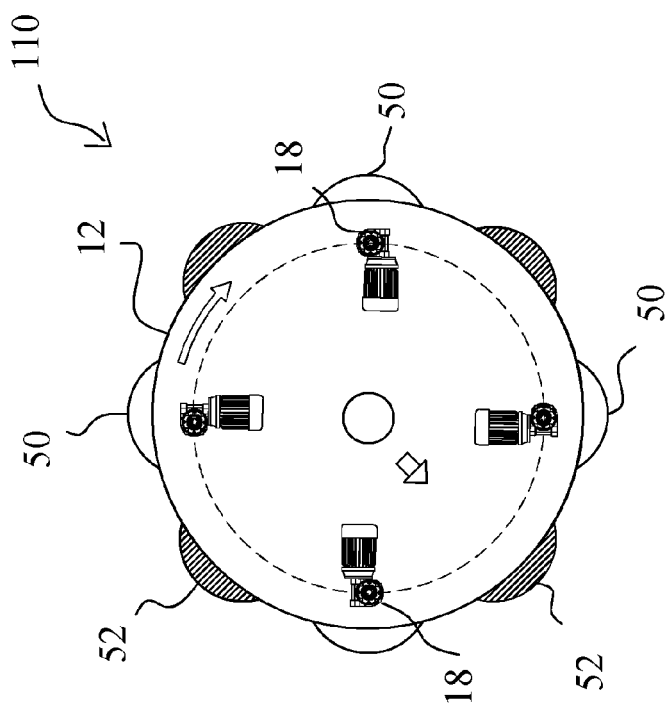


FIG.10

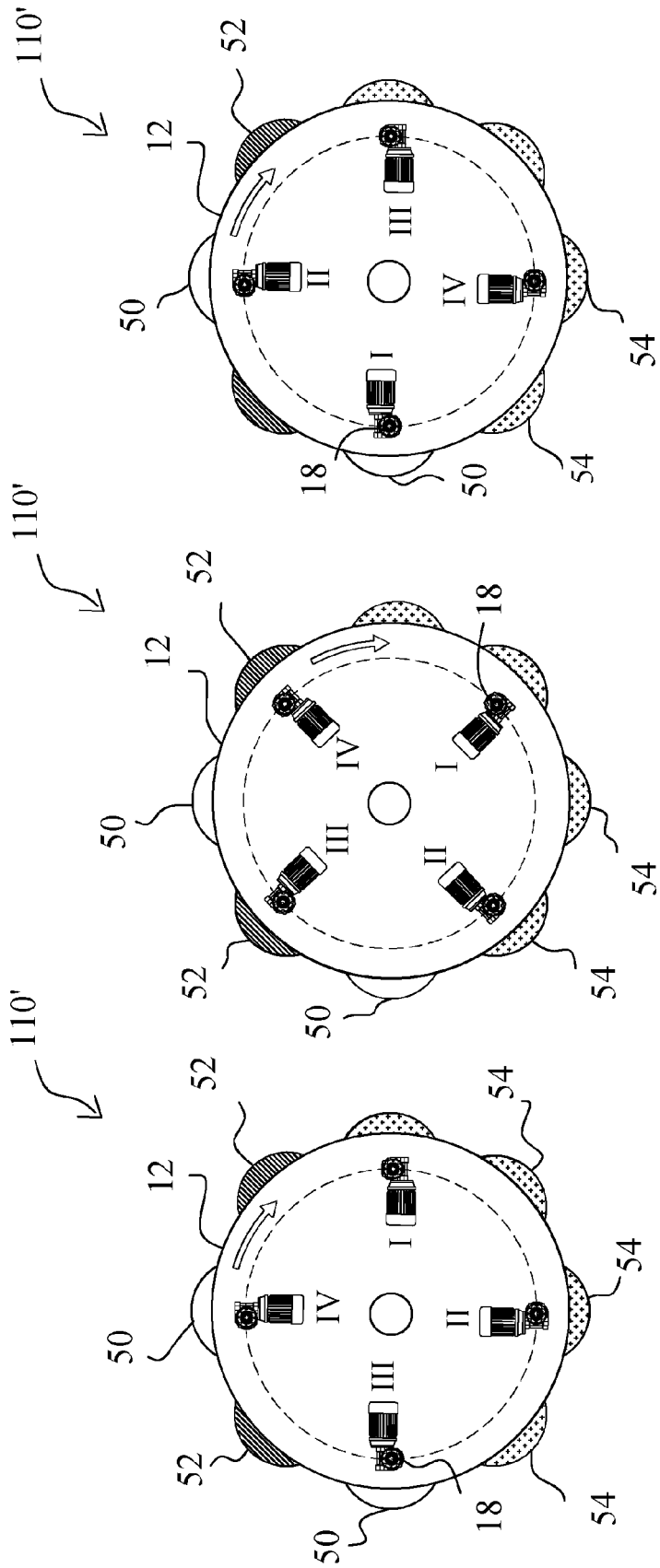


FIG.14

FIG.13

FIG.12

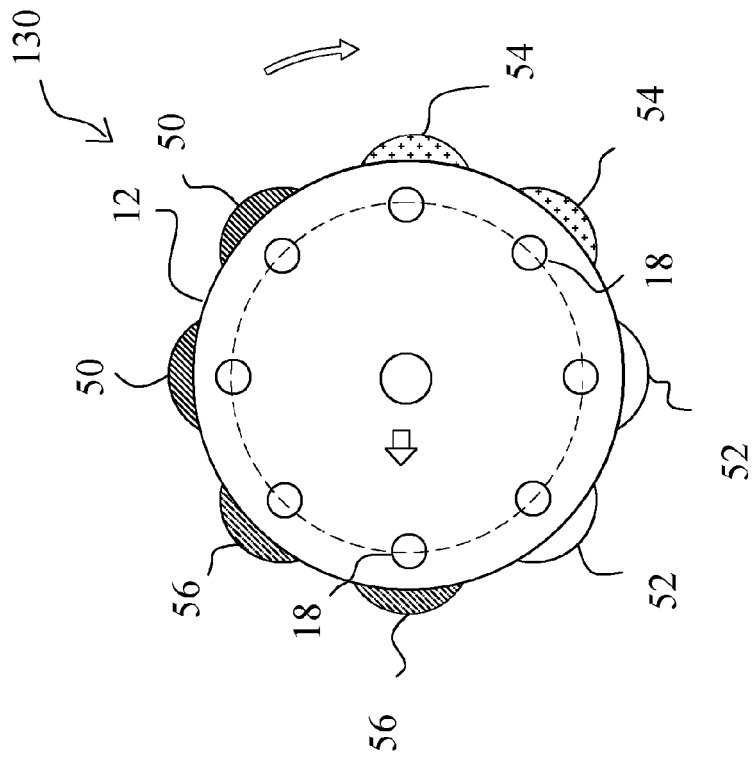


FIG.16

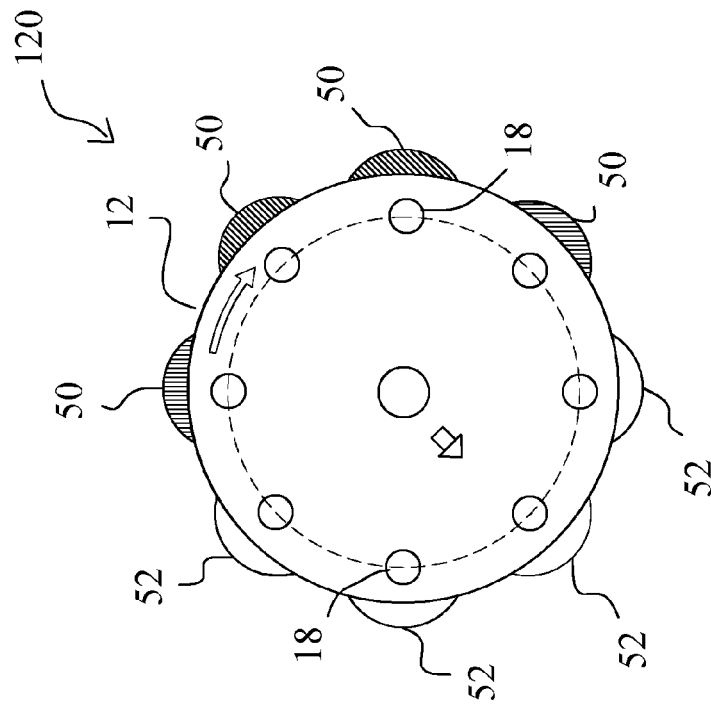


FIG.15



EUROPEAN SEARCH REPORT

Application Number
EP 15 19 0971

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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 Munich		Date of completion of the search 16 December 2015	Examiner Endres, Mirja
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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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