A grinding or polishing apparatus and method for grinding or polishing at least one workpiece, in particular having a ferromagnetic property, by way of barrel finishing, having at least one pot-like treatment container, mounted so as to be able to oscillate, for receiving one or more workpieces and grinding or polishing elements, also having at least one workpiece anchoring device for disposing one or more workpieces within the treatment container and for connecting the workpieces to the treatment container in a releasably secured manner, and also having at least one oscillation exciter, by means of which the treatment container can be oscillated, and in that the workpiece anchoring device comprises at least one switchable clamping plate, in particular at least one clamping plate having one or more permanent electromagnets, which is adapted such that a magnetic field emanating outwardly from a clamping surface of the clamping plate can be selectively activated or deactivated.
GRINDING OR POLISHING APPARATUS AND METHOD FOR OPERATING IT

CROSS-REFERENCE TO RELATED APPLICATIONS


FIELD OF THE INVENTION

[0002] The present invention relates to a grinding or polishing apparatus, preferably a circular vibrator, for grinding or polishing at least one, or simultaneously more than one, workpiece, preferably a workpiece having ferromagnetic properties, by way of barrel finishing, having at least one pot-like treatment container, mounted so as to be able to oscillate (for example spring-mounted), for receiving one or more workpieces and grinding or polishing elements, also having at least one workpiece anchoring device for disposing one or more workpieces within the treatment container and at the same time for connecting the workpiece or workpieces to the treatment container in a releasably secured manner, and also having at least one oscillation exciter, by means of which at least one oscillation component can be imparted to the treatment container.

BACKGROUND OF THE INVENTION

[0003] A grinding or polishing apparatus of this type is known in the prior art from the applicant’s German laid-open application DE 10 2005 047 303 A1. In order to grind or polish the surface of a workpiece or simultaneously more than one workpiece, the workpiece or workpieces is or are fixed in place inside the treatment container. DE 10 2005 047 303 A1 proposes for this purpose securely screwing an aluminum rim as a workpiece to a holding pin extending from the bottom of the container. Only after this mechanical attachment is a quantity of finely divided, pourable grinding or polishing elements with an effect on the workpiece filled into the treatment container, the quantity being set such that the workpiece is preferably completely embedded or submerged in the fill. In the case of the known apparatus, the oscillation exciter or exciters is or are then switched on, whereby the treatment container with the workpiece secured therein is made to oscillate. The grinding or polishing elements are also made to undergo small oscillations, but also thereby perform small movements in relation to the surface of the workpiece, by which the barrel finishing takes place and the desired grinding or polishing effect is produced. As explained in DE 10 2005 047 303 A1, this known grinding or polishing apparatus may preferably be used for multistage treatments. For example, abrasive grinding elements can be first filled into the treatment container and used for subjecting workpieces to a grinding treatment. Then the grinding elements can be exchanged, for example for polishing elements, and these can be used for polishing the already ground workpieces. To this extent, depending on the desired use, the generic grinding or polishing apparatus, and consequently the grinding or polishing apparatus according to the invention, can also be referred to as a grinding apparatus or a polishing apparatus and the elements can correspondingly be referred to as grinding elements or polishing elements. Although the apparatus known from DE 10 2005 047 303 A1 offers advantages, particularly with regard to how it can be used for a wide variety of workpieces, it is perceived to be restricted by the fact that a certain effort is required for changing workpieces, in particular since measures have to be taken against unintentional detachment of the workpiece during the oscillatory or vibratory drive, whereby it may also be necessary, depending on the type of mechanical attachment, for a corresponding tool to be provided. In addition to this there is the time that is necessary, when changing the workpiece, for the prior emptying of the grinding or polishing elements out of the treatment container and the subsequent filling, resulting in undesired downtimes of the known apparatus.

[0004] Against this background, it is an object of the present invention to develop an apparatus of the type mentioned at the beginning, advantageously such that, in particular, the restrictions mentioned can be avoided as far as possible.

SUMMARY OF THE INVENTION

[0005] This object is achieved according to the invention first and foremost in conjunction with the features that the workpiece anchoring device comprises at least one switchable clamping plate, in particular at least one clamping plate having one or more permanent electromagnets, which is adapted such that a magnetic field emanating outwardly from a clamping surface of the clamping plate can be selectively activated or deactivated. Said at least one clamping plate may therefore preferably have one or more permanent electromagnets, although this is not necessary. It has surprisingly been found that, in spite of the oscillations and vibrations occurring during the grinding or polishing, under some circumstances over a relatively long processing time of many hours or days, it is possible to connect the workpiece or workpieces so securely and reliably to a clamping plate of this type (i.e. to “clamp” it or them), either directly or by means of a workpiece holder, that the workpiece or workpieces are held fixed in place inside the treatment container. Since the clamping or fixing on the clamping plate is preferably possible solely by means of the effect of a magnetic force action that can be alternately changed in polarity, or as a result can be switched on and off, the clamping and releasing, or the exchange of workpieces or of workpiece holders with workpieces secured thereto, for example in groups, only requires a small amount of time and can also be advantageously performed with respect to the clamping plate without any tools. An additional advantage is that workpieces with different geometries can generally be clamped on the magnetic clamping plate (also dependent on the configuration of the latter). The clamping plate for its part can be securely or fixedly connected to the treatment container in virtually any desired manner. A fixed connection of this type may be made either permanently or releasably (for example by means of screw connections). The grinding or polishing apparatus may have a control device, by means of which a magnetic field can be alternately switched on and off, at least in a receiving region for a workpiece or a workpiece holder lying in front of or outside the clamping surface and adjacent thereto. As the following description illustrates, this does not necessarily mean that the electrically controllable magnets are deactivated in a switching state of the clamping plate in which the magnetic field emanating outwardly beyond the clamping surface is deactivated. Instead, it is preferred within the scope of the invention that the clamping plate comprises two or more magnetizing devices, and more preferably an even number thereof, neighboring one another in a plane defined by the clamping surface,
each magnetizing device being made up of different types of magnet, only the polarity or the magnetic “north-south direction” of individual magnets being changed between the different switching states. This makes it possible for the resultant magnetic field in the activated switching state of the clamping plate to extend outwardly beyond the clamping surface of said plate, while on the other hand, it is possible in the deactivated switching state to restrict the then different resultant magnetic field to the region behind the clamping surface or within the clamping plate. It is preferably provided that the magnetizing devices each have a permanent electromagnet which has a permanent magnet that can be changed in polarity (or is reversible) and a coil surrounding the permanent magnet, which coil is connected to a source of direct current or direct voltage with a switchable direction of the current or voltage. Such a reversible permanent magnet may preferably be produced from a magnetically hard material. For example, it may be an AlNiCo magnet. As a result of a flow of current through the coil, a permanent electromagnet of this type is given a magnetization, the polarity or “north-south direction” of which depends on the direction of flow of the current or the electric voltage applied, and also maintains this magnetization after the voltage or current is switched off, whereby just a short time of for example a few seconds (for example three to four seconds) may be sufficient for the magnetization. As and when required, the polarity can be reversed, that is to say the polarity of the permanent electromagnet can be changed, by applying a reversed voltage to the coil or by making a current flow through the coil in the opposite direction. To this extent, in this context voltage means a direct voltage and current means a direct current. The supplying or switching function may be performed by means of a direct-voltage or direct-current generator and a suitable control. It is preferably provided that the geometrical center axis of the coil is in this case oriented perpendicularly to the clamping surface that extends over the plurality of magnetizing devices. It is also preferred that each individual magnetizing device has a magnetizing element which is facing the clamping surface and in particular comprises mild steel or a comparable material, behind which the permanent electromagnet is disposed, preferably adjacent or in contact. The surface of the magnetizing element that is directed away from the permanent electromagnet may be a free magnet pole face, which forms a component part of the clamping surface. The permanent electromagnet brings about a certain magnetization of the magnetizing element. If the polarity of the permanent electromagnet is changed, the magnetization of the magnetizing element also changes as a result. It is considered to be a suitable development that, in a plane parallel to the clamping surface, some or all of the magnetizing devices or magnetizing elements (specifically the exposed magnet pole faces thereof) are disposed in such a way that they are distributed in a matrix-like or linear manner and preferably have a square or rectangular cross-section, and that permanent magnets are disposed at the side edges, preferably at all the side edges, of the magnetizing elements, so that the magnetic pole axes of said permanent magnets run parallel to the clamping surface, wherein, for each magnetizing element, the pole axes of all the permanent magnets neighboring a specific magnetizing element point with the same polarity toward this magnetizing element. This overall array in the manner of a row or matrix may preferably be disposed in a clamping plate frame or housing of ferromagnetic material. The permanent magnets laterally adjacent to a magnetizing element likewise bring about a specific magnetization of this element. If the switchable permanent electromagnets described are initially excluded from the consideration, a lateral disposition of in each case a permanent magnet, respectively between a magnetizing element at the periphery in the overall array and the clamping plate housing and between neighboring magnetizing elements, will bring about the effect that magnetizing elements that are respectively neighboring one another are given magnetizations with opposite polarity in relation to one another. Within a row-like arrangement or within a row or column of a matrix array, the free magnet pole faces form alternating magnetic north and south poles. If the switchable permanent electromagnets are additionally taken into consideration, the resultant magnetization of a magnetizing element is influenced both by the permanent or unchangeable magnetizing influence of the permanent magnets to the sides of it and also by the superposed switchable magnetizing influence of the permanent electromagnet located under it. It is preferably provided that the magnetic flux jointly produced by the lateral permanent magnets corresponds in terms of magnitude to the magnetic flux produced by the permanent electromagnet. This makes it possible for the magnetic field lines of the resultant or superposed magnetic field in the one switching state in which the two magnetizations reinforce one another to extend beyond the clamping surface from the north poles to the neighboring south poles, while the magnetic field lines in the second switching state only extend within the clamping plate and the magnetic field is as it were “shorted”. If a ferromagnetic workpiece is brought into the region of the magnetic field lines extending beyond the clamping surface (before or after activation), it is magnetically attracted by the clamping plate and thereby fixed securely on the clamping plate. The ferromagnetic workpiece fixed on the clamping plate forms as it were a bridge for the magnetic flux between the north and south poles, the magnetic lines of flux or field lines passing through the workpiece. In this activated switching state, the magnetizations of the switchable permanent magnet and the lateral permanent magnets reinforce and direct one another, while the magnetizations in the other or deactivated switching state act against one another or compensate for one another. Clamping plates of this type are—as such—also known as square-pole clamping plates. In connection with the use according to the invention, however, it has surprisingly been found by the applicant that the magnetization of the clamping plate brought about after a flow of current of only three to four seconds, for example, remains maintained apart from minor losses, i.e. is predominantly maintained, even in spite of ongoing vibrations lasting for several days, and is therefore suitable for the claimed apparatus. The permanent magnets that preferably cannot be changed in their polarity and are disposed laterally in relation to the magnetizing elements may be, for example, so-called rare-earth magnets, for example NdFeB magnets. The clamping plates described may be purchased, for example, from Assafag GmbH, Schwäbisch Gmünd. They are suitable for securely clamping workpieces with a ferromagnetic property; that is to say workpieces which for example contain mild steel, alloyed steel, cast iron or the like. In comparison with clamping means having conventional electromagnets, it is advantageous that the external magnetic effect is maintained even after the flow of current through the coil is switched off. This results not only in lower energy consumption but also in an insensitivity to failure of the power supply. It is preferably provided that the clamping plate is attached to the treatment
container, the clamping surface thereof extending transversely, preferably perpendicularly or substantially perpendicularly, to a geometrical axis of the treatment container, preferably transversely to a perpendicular longitudinal center axis of the treatment container. Said attachment may be chosen to be permanent or releasable (for example by means of a screw connection). It is also preferred that the clamping surface faces in the same direction as the bottom of the container, so that its surface normal is directed at least substantially in the same direction. This makes the clamping plate easily accessible when a workpiece or a workpiece holder is lowered from above (for example by means of a crane or some other lifting gear).

In a preferred exemplary embodiment, it is provided that the magnetizing device or the free magnet pole faces thereof is or are regularly spaced apart from one another laterally, on a cross-sectional circumference of the treatment container, preferably along a circular line, a uniform spacing of the pole faces from one another being provided either along the entire cross-sectional circumference or along curved or straight line segments only at two or more portions of the cross-sectional circumference. It is specifically preferred that the clamping plate is of a wholly annular form and is attached to the treatment container in the region of or adjacent to the container opening, so that the clamping plate borders the upper container opening. If the clamping is only desired at specific circumferential portions, clamping plates similar to ring segments, or for example of a wholly rectangular or cuboidal form, may be used instead. There is also the possibility that the workpiece anchoring device comprises a workpiece holder, which has a preferably ferromagnetic base for the releasable secure clamping on the clamping plate and holding devices, secured to the base, for workpieces, a peripheral contour of the base preferably being adapted to a peripheral contour of the one or more clamping plates secured to the treatment container. A workpiece holder of this type serves as it were as an adapter for connecting a wide variety of workpieces to the clamping plate of the treatment container in a secured manner, preferably being possible for a number of workpieces to be fixed, and consequently simultaneously processed, by a number of holding devices of a workpiece holder. Such a workpiece holder also makes it possible for workpieces of virtually any desired materials, i.e. also non-ferromagnetic workpieces, that can be secured to the workpiece holder, to be processed. For this purpose, the workpieces may be secured to the workpiece holder in virtually any desired manner (for example by a screwing or clamping connection), and the workpiece holder may be clamped by means of its ferromagnetic base to the clamping plate. As an intermediate piece or adapter, the workpiece holder may preferably be made to match both the shape and disposition of the clamping plates on the treatment container and made to match the respective workpieces. In particular, it is suitable that at least one clamping plate is disposed on the outer side of the treatment container and/or on a portion of the treatment container that is an upper portion with respect to the height of the container, preferably in the upper half of said container. As still to be explained, this advantageously makes it possible for the grinding or polishing elements to remain in the treatment container even during the insertion and removal of workpieces. In this context it may be advantageous that the main direction of extension of the holding devices, preferably formed in the manner of rods, runs transversely to an imaginary geometrical plane defined by the base of the workpiece holder. The workpiece holder can then be securely clamped with its base on the clamping plate or plates at the upper periphery of the container, so that the rod-like holding devices extend downwardly inside the container sufficiently far that the workpieces secured to the respective free end of the rod, for example screwed on, are partially or completely submerged in the fill of grinding or polishing elements. According to a further aspect that is of significance within the scope of the invention, on the one hand as a preferred development, on the other hand also as an independent inventive concept, the base may be configured in the manner of a plate and it is also provided that one or more grip elements for a lifting means, such as for example for a crane or the like, are attached to the base, preferably on the side thereof opposite the holding devices, the grip elements being elastically deformable, at least transversely to the plane defined by the plate. This creates an elastic connection between the lifting equipment and the workpiece holder. If the workpiece holder is lowered by the lifting equipment toward the clamping plate, the magnetic force of attraction is first produced when there is a small residual clearance, which may for example be a few millimeters (or possibly even only fractions of a millimeter), and increases strongly as the plate is further approached. If in this case the magnetic force of attraction reaches or exceeds the force needed for the elastic deformation of the grip elements, the approach becomes quicker, so that dependable secure clamping is speeded up and an otherwise problematic “lag” is avoided. In the case of a different preferred embodiment, it is provided that the clamping plate is formed, as regards its area, in a circular or substantially circular shape and secured on the bottom of the treatment container, for example screwed on it. The clamping plate may in this case preferably cover most or even the entire surface of the bottom of the container. Depending on the dimensions of the container bottom, even comparatively large workpieces, such as for example drop forging dies or plastics injection molds, can consequently also be clamped on the clamping plate, either directly or if need be by means of a workpiece holder serving as a connecting piece. In particular in connection with a clamping plate disposed on the container bottom, it is preferred that the workpiece anchoring device has an underlay plate, which for example also has ferromagnetic properties, whereby the peripheral contour of the underlay plate may be adapted to the peripheral contour of the clamping plate (or, as the case may be, the clamping plates). If the underlay plate is placed between the clamping plate and the workpiece, the imprints of the clamping surface on sensitive workpiece surfaces that are otherwise possible due to the vibratory drive can be avoided. By means of an underlay plate that has a contour adapted to the clamping plate, it is also possible to prevent the clamping plate from being damaged by the grinding or polishing elements.

The invention also relates to a method for operating a grinding or polishing apparatus which may preferably have one or more of the features described above and, against the background of the restrictions to achieving the stated object that exist in the prior art and were explained at the beginning, proposes that grinding or polishing elements are filled into the treatment container, that one or more workpieces is or are secured to the workpiece holder, that the treatment container and the grinding or polishing elements contained therein are made to oscillate by means of at least one oscillation exciter and that the workpiece or workpieces secured to the workpiece holder is or are partially or completely submerged in the
fill of the grinding or polishing elements through the opening in the treatment container by means of the workpiece holder during the oscillatory excitation of the treatment container with the grinding or polishing elements, and that subsequently the workpiece holder is secured clamped magnetically on the clamping plate or plates which are disposed outside the treatment container and/or on a portion of the treatment container that is an upper portion with respect to the height of the container. The method according to the invention advantageously makes it possible that the fill of grinding or polishing elements can remain inside the container when workpieces are inserted and taken out, whereby the setup times and downtimes are shortened and cost-effective operation is made possible. The oscillatory excitation of the grinding or polishing elements and the fluidization thereof brought about as a result reduces the penetration resistance for the workpieces into the fill of the grinding or polishing elements.

It goes without saying that, as an alternative to or in combination with the clamping plates described in their construction above, the grinding or polishing apparatus may also have different types of electromagnetic clamping plates, the outwardly acting magnetic field of which can be selectively switched on or off. The switchable clamping plate for which the outwardly emanating magnetic field can be selectively activated or deactivated does not necessarily have to have the construction described above that includes permanent electromagnets. Alternatively, there is the possibility that the clamping plate of the grinding or polishing apparatus according to the invention has one or more electromagnets, which have in particular a coil and additionally have in particular a metal coil core, so that the magnetization only lasts as long as a current is flowing through the coil. Also in this context, there is the possibility that the clamping plate comprises a number, preferably an even number, of magnetizing devices, it being possible for each magnetizing device to have at least one electromagnet. To this extent, in the case of an embodiment of this type, neighboring magnetizing devices could, and when required, have polarities that are opposite to or the same as one another when the magnetic field is activated. Such a clamping plate may also be switchable electrically between different operating states in which the magnetic field outside the clamping plate is either activated or deactivated. As an alternative to or in combination with the variants previously described, there is the possibility that the clamping plate has a number of magnets, the relative positions of which in relation to one another can be changed by mechanical means in such a way that a magnetic field emanating outwardly from the clamping surface of the clamping plate can be selectively activated or deactivated in the overall effect of the magnets. These magnets may in practice be any desired magnets, i.e. for example permanent magnets or electromagnets. There are similarly various possibilities within the scope of the invention for the rest of the construction of the apparatus. Preferably, a grinding or polishing apparatus of the type of construction known from DE 10 2005 047 503 A1 may be developed according to the invention in the manner described above by means of the switchable magnetic workpiece anchoring device. The entire content of this laid-open application is hereby also incorporated in the disclosure of the present application, including for the purpose of incorporating features disclosed therein if required in the claims of the present application.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described below with reference to the accompanying figures, which show preferred exemplary embodiments and in which specifically :

[0010] FIG. 1 shows in perspective the grinding or polishing apparatus according to the invention as provided by a first preferred exemplary embodiment, with a workpiece holder securely clamped on the clamping plate,

[0011] FIG. 2 shows the apparatus shown in FIG. 1, but with the workpiece holder removed,

[0012] FIG. 3 shows a partial section through the clamping plate along sectional line III-III in FIG. 2, enlarged in comparison,

[0013] FIG. 4 shows a side view of the apparatus according to FIG. 1 in viewing direction IV, but as a departure therefrom only just before the secure clamping of the workpiece holder, and additionally (as a detail) a lifting means acting on the workpiece holder,

[0014] FIG. 5 shows an enlargement of detail V from FIG. 4,

[0015] FIG. 6 shows the enlargement of the detail according to FIG. 5, but with the workpiece holder securely clamped (corresponding to FIG. 1),

[0016] FIG. 7 shows in perspective a workpiece holder according to the invention as provided by a preferred embodiment when viewed obliquely from above,

[0017] FIG. 8 shows the workpiece holder shown in FIG. 7, with the viewing direction changed in comparison and with a detached workpiece,

[0018] FIG. 9 shows in perspective a grinding or polishing apparatus according to the invention as provided by a further preferred exemplary embodiment, with the workpiece holder removed from it,

[0019] FIG. 10 shows the apparatus shown in FIG. 9, but with the workpiece holder securely clamped on it,

[0020] FIG. 11 shows in perspective a grinding or polishing apparatus according to the invention as provided by yet another preferred embodiment, with the treatment container partially broken open,

[0021] FIG. 12 shows in perspective an enlargement of detail XII, for which a portion of the clamping plate has been graphically removed,

[0022] FIG. 13 shows the detail of the clamping plate that is shown in FIG. 12, but in a different switching state,

[0023] FIG. 14 shows the grinding or polishing apparatus shown in FIG. 11, on the clamping plate of which a workpiece has been securely clamped on an underlay plate by way of example,

[0024] FIG. 15 shows the apparatus shown in FIG. 1 in the case of a preferred method step of the method according to the invention in which grinding or polishing elements are located in the treatment container,

[0025] FIG. 16 shows a later preferred method step in which the workpieces are lowered by means of the workpiece holder into the fills of oscillation-excited grinding or polishing elements and

[0026] FIG. 17 shows a following preferred method step in which the workpiece holder has been securely clamped and the grinding or polishing processing is being performed.

DETAILED DESCRIPTION OF THE INVENTION

With reference to FIGS. 1 to 6, a grinding or polishing apparatus 1 according to the invention as provided by a first preferred exemplary embodiment is firstly presented. This apparatus has a pot-like treatment container 2. This comprises a cylindrical side wall 3 and a plate-shaped bottom 4, which on the underside is supported at two opposite edges on a respective group of four cylindrical compression springs
5 on a base 6. At diametrically opposite regions of the side wall 3, an unbalanced drive 7 is respectively mounted on a flange 8, the pattern of holes in which allows the unbalanced drive 7 to be fixedly connected to the treatment container at different angles of inclination (for example with respect to a horizontal reference plane). Alternatively, a stepless adjustment of the angle of inclination would also be conceivable, for example by means of clamping by workholding claws. The two unbalanced drives 7 together form a first oscillation exciter 9. Attached to the underside of the bottom 4 is a further unbalanced drive 10, the geometrical longitudinal drive axis of which extends parallel to the imaginary diametrical joining line between the two unbalanced drives 7 and which forms a second oscillation exciter 11. The unbalanced drives 7, 10 respectively comprise an electric motor in the center, and on the two sides thereof, unbalanced flywheels driven in a rotating manner in a respective housing. In order to process workpieces in the treatment container 2, they are submerged therein in a fill of pourable grinding or polishing elements that can be fluidized by means of the oscillatory or vibratory drive (cf. also FIGS. 15-17). In order to anchor the workpieces 12 (in FIGS. 7 and 8 ferromagnetic cylinders have been chosen by way of example as workpieces 12), during the grinding or polishing treatment, in the treatment container 2 and connected to the container, and releasable again as and when required, the grinding or polishing apparatus 1 has a workpiece anchoring device 13 formed from one or more components. In the example, this device comprises a clamping plate 14, which is formed as a whole in an annularly closed manner and is securely screwed on the upper periphery of the treatment container 2, i.e. enclosing the upper opening therein, on a container flange 15. It can be gathered that the clamping plate 14 has a multiplicity of magnetizing devices 16, which are disposed in such a way that they are distributed such that they are uniformly spaced apart from one another along the circumference. In the example chosen (cf. FIG. 3), each magnetizing device 16 comprises a switchable permanent electromagnet 33, the magnetic polarity of which is selectively reversible by an electric current flowing, for a limited time in a direction that can be chosen, in a coil 36 surrounding the electromagnet or the permanent magnet 35 thereof that can be changed in polarity. Preferred details in this context are still to be discussed. Depending on the switching state or operating mode of the clamping plate 14 that is chosen in this respect, the magnetizing devices 16 produce a magnetic field which extends upwardly beyond the clamping surface 17, i.e. beyond the annular surface of the clamping plate 14. In another switching state or operating mode that can be chosen, the magnetic field does not extend upwardly beyond the clamping surface. The clamping plate 14 and the unbalanced drives 7, 10 are supplied with energy and controlled by means of an energy supply and control device 19, which is connected to the grinding or polishing apparatus 1 by means of lines 20. In the example, the workpiece anchoring device 13 also comprises a workpiece holder 18. This has a plate-shaped base 21 of ferromagnetic material. On the upper side thereof, two parallel, spaced-apart, elongate grip elements 22, produced from rubber, for a lifting means, (for example for a crane) are securely screwed such that they are spaced apart from one another in parallel. The grip elements 22 have, transversely to their longitudinal direction, a narrow cross-section, which is elastically deformable. In the example, attached to the opposite underside of the base 21 are a number of rod-like holding devices 24 (in the example seven), the main direction of extent of which extends perpendicularly, that is to say transversely to the plane of the plate of the base 21. FIG. 1 illustrates that the peripheral contour 25 of the base 21 is adapted on the opposite narrow sides to the shape of a circular arc and, with respect to the radius, is adapted to the peripheral contour 26 of the clamping plate 14.

FIGS. 7 and 8 show that the holding devices 24 carry at the free longitudinal ends a threaded bolt 27, onto which cylindrical workpieces 12 can be fitted, whereupon fixing is possible by means of a threaded nut 28 that can be screwed onto the threaded bolt. The workpieces 12 shown by way of example may consist of any desired material, i.e. they do not necessarily have to consist of ferromagnetic material. For example, they could be workpieces 12 of plastics material, ceramic or for example also of metallic, but for example non-ferromagnetic, materials. In order to be able to empty grinding or polishing elements 23 that have been filled into the treatment container 2 out of it again, the treatment container has on the side wall 3 a flap 29 that can be selectively opened or locked. If it is unlocked and swung open, this exposes an opening, from which the grinding or polishing elements pass (in particular assisted by the oscillatory drive) into a collecting container 31.

FIGS. 2 and 3 show as a sectional view that the clamping plate 14 comprises an even-numbered multiplicity of magnetizing devices 16 (in the example 24), which are embedded in a ferromagnetic clamping plate housing 32 such that they are uniformly spaced apart from one another along a closed circular line.

FIG. 3 serves (in a way similar to FIGS. 12 and 13) as a simplified schematic view only for schematically indicating the relationships given in the example chosen. Each magnetizing device 16 respectively comprises a switchable permanent electromagnet 33, which is disposed with respect to the clamping surface 17 at the lower bottom in a housing pocket 34. This electromagnet is formed by a permanent magnet 35 (in the example disk-shaped) that can be changed in polarity and by an electrical coil 36 which surrounds said magnet and is connected in a way not shown to the energy supply and control device 19 represented in FIG. 1, so that, depending on the switching state, the coil 36 is flown through by current either in one direction or the other or not at all. Each magnetizing device has a magnetizing element 37 of mild steel or comparable material disposed above the permanent electromagnet 33 in the housing pocket 34, the underside of which element is adjacent to the permanent magnet 35 that can be changed in polarity and the opposite upper side of which element, as a component part of the clamping surface 17, represents a free magnet pole face 38. In a plane parallel to the clamping surface 17, the magnetizing element 37 has in the example a square cross-section (other cross-sections, for example also rectangular or elongated, would also be conceivable). Also disposed in the housing pockets 34, at the four side edges of the magnetizing elements 37, are permanent magnets 39 that are non-changeable and cannot be reversed in their polarity. Their permanent magnetic polarity or orientation is schematically indicated by means of arrows 40. The magnetic polarities of the oppositely-disposed permanent magnets 39 on a magnetizing element 37 run opposed to one another. At the same time, the polarity or north-south orientation of two oppositely-disposed permanent magnets 39 on a magnetizing element is also opposed to the polarity of correspondingly disposed permanent magnets on magnetizing devices 16 that are neighboring in the direction of the pole.
axes. This means that two neighboring magnetizing elements 37 undergo opposite magnetization in comparison with one another, by their in each case four uniformly oriented permanent magnets 39.

[0031] In FIG. 3 there is first represented by way of example, by the polarities or arrows illustrated without parentheses at the permanent electromagnets 33, a state of magnetization or operating state of the clamping plate 14 in which, with respect to the magnetizing elements 37, the magnetization of the permanent magnets 35 that can be changed in polarity as it were opposed to the magnetization or polar orientation of the permanent magnets 39 cannot be changed in their polarity. If, for example, with respect to a magnetizing element 37 being considered, at the four adjacent permanent magnets 39 thereof their magnetic north pole faces toward the magnetizing element 37, at the same time, at the permanent magnet 35 that can be changed in polarity and is associated with this magnetizing element, the magnetic north pole is directed away from the magnetizing element 37. At the neighboring magnetizing device or two neighboring magnetizing devices, the circumstances are in each case reversed. In this operating state, the clamping plate 14 is magnetically deactivated outwardly. As indicated in this respect in a greatly simplified manner, the magnetic field lines 42 indicated by way of example only run within the clamping plate 14 and consequently do not bring about any magnetic force of attraction on a neighboring workpiece. The magnetic field lines 42 associated with the deactivated state are indicated by dash-dotted lines. In order to activate the clamping plate 14 by means of electrical control, the polarity of the permanent magnets 35 can be changed over, so that the opposite direction of the arrows is obtained respectively in relation to FIG. 3 (see in this respect the arrows within parentheses in FIG. 3). This can be achieved by a flow of current of a direction, strength and duration suitable for this being initiated in the coil 36. Just a brief surge of current of a few seconds in duration may be sufficient, the magnetization brought about as a result then being maintained virtually completely or predominantly over a relatively long period of time, even after the flow of current is switched off. With this reversed polarity of the permanent magnets 35, the magnetizing influences emanating from the permanent magnet 35 that can be changed in polarity and from the permanent magnets 39 on their central magnetizing element 37 support one another, but act with an opposing effect with respect to neighboring magnetizing devices. In this way, the magnet pole faces 38 form alternating magnetic north or south poles along the circumference of the clamping plate 14, so that an even number of magnetizing devices is suitable. In FIG. 3, dashed lines are used to indicate by way of example magnetic field lines 43, which extend outwardly beyond the clamping surface 17 between magnetizing devices 16 of unlike polarity. The path of the field lines 42 and 43 is considerably simplified and not complete and serves solely for distinguishing in principle between the outwardly magnetically active and deactivated states.

[0032] FIG. 5 shows the lowering of a workpiece holder 18, on the grip elements 22 of which the clamping jaws 44 of a crane act. The distance between the underside of the base 21 and the clamping surface 17 is designated by S. If the distance S is reduced, in the active state of the clamping plate 14 being considered, the base 21 enters the outer magnetic field lines thereof (not included in the representation in FIG. 5), the magnetic force increasing as the surface is further approached. When there is a small distance S, the magnetic force is sufficient to stretch the rubber-elastic grip elements 22, as indicated in FIG. 6, to such an extent that the remaining distance S is quickly overcome and the base 21 is securely clamped on the clamping plate 14. In order to release the workpiece holder 18 from the clamping plate 14 again, the permanent magnets 35 that can be changed in polarity can once again be changed in their polarity, by a reversed flow of current of limited duration being caused in the coils 36, so that the clamping plate 14 goes over into the outwardly deactivated state.

[0033] FIGS. 9 and 10 show a grinding or polishing apparatus 1 according to the invention as provided by a second preferred exemplary embodiment. The difference from the first exemplary embodiment is that two clamping plates 14 of the same construction as one another are securely screwed to the treatment container 2 on the upper container flange, at two positions lying diametrically opposite on the circumference. Each clamping plate 14 has four magnetizing devices 16, which are respectively integrated in groups in a rectangular-cuboidal clamping plate housing 32. As in FIG. 1, 45 designates a supply line for a liquid treatment agent, which can also be fed into the treatment container 2 during the grinding or polishing treatment.

[0034] FIGS. 11 to 13 relate to a grinding or polishing apparatus 1 as provided by a third preferred exemplary embodiment. There, the clamping plate 14 has a clamping plate housing 32 which is circular in plan view and in which an even-numbered multiplicity of magnetizing devices 16 are disposed in a matrix-like manner. The clamping plate 14 is securely screwed on the bottom 4 of the treatment container, so that the clamping surface 17 faces upward or toward the opening of the treatment container 2. FIGS. 12 and 13 show, in a greatly simplified form, that is to say only for schematic description, a region of the clamping plate 14 with magnetizing devices 16 disposed in a matrix-like manner that has been cut out and enlarged. Also differing somewhat from FIG. 3, it is shown that only one non-changeable permanent magnet 39 is used in each case between two neighboring magnetizing elements 37, respectively with respect to the longitudinal and transverse directions of the matrix. The magnetic polarity has again been chosen such that, at all four permanent magnets 39 of one and the same magnetizing element 37, it is the same with respect to this element, but is opposed with respect to the respectively neighboring magnetizing elements 37. FIG. 12 shows the outwardly deactivated state and FIG. 13 shows the outwardly magnetically activated state of the clamping plate 14. Threaded bores 46, which may serve for the connection of so-called pole extensions (not included in the representation), have been introduced into the upper side of the free magnet pole faces 38. FIGS. 11 and 12 show a state of use in which the clamping plate 14 is still deactivated and a drop forging die, chosen by way of example as the workpiece 12, is still located above the emptied treatment container 2. FIG. 14 shows a further position for use in which an underlay plate 47 has been placed onto the clamping plate 14 and the workpiece has been deposited on said underlay plate. If the clamping plate 14 is then outwardly activated as in FIG. 13, the workpiece 12 covers over a plurality of magnetizing devices with magnetic polarization alternating with respect to the rows and columns of the matrix, whereby the workpiece 12 is securely clamped.

[0035] With respect to FIGS. 15 to 17, a method according to the invention for operating the grinding or polishing apparatus 1 as provided by a preferred manner of implementation
is described. FIG. 15 shows a method step in which a supply of grinding or polishing elements 23 has already been introduced into the treatment container 2 as a fill. The workpieces to be processed, which are secured to the workpiece holder 18, are still located outside the treatment container 2. Starting from the method step that is shown in FIG. 15, the unbalanced drives 7 and 10 are switched on, whereby the treatment container 2 is made to oscillate, the oscillations being transmitted to the grinding or polishing elements 23 and making them undergo micro-movements or “fluidizing” them. This reduces the penetration resistance for the workpieces 12 that are only then lowered from above with the workpiece holder 18, so that said workpieces can be submerged in the fill of the grinding or polishing elements 23 with only little force. In the case of the further method step that is shown in FIG. 17, the workpiece holder 18 was lowered still further and securely clamped on the clamping plate 14, whereupon the desired grinding or polishing processing of the workpieces 12 is performed in the treatment container 2.

[0036] All features disclosed are (in themselves) pertinent to the invention. The disclosure content of the associated/ accompanying priority documents (copy of the prior patent application) is also hereby incorporated in full in the disclosure of the application, including for the purpose of incorporating features of these documents in claims of the present application. The subclaims characterize in their optionally subordinated wording independent inventive development of the prior art, in particular for the prosecution of divisional applications on the basis of these claims.

1. A grinding or polishing apparatus, in particular a circular vibrator, for grinding or polishing at least one workpiece, in particular a workpiece having a ferromagnetic property, by way of barrel finishing, having at least one pot-like treatment container, mounted so as to be able to oscillate, for receiving one or more workpieces and grinding or polishing elements, also having at least one workpiece anchoring device for disposing one or more workpieces within the treatment container and for connecting the workpiece or workpieces to the treatment container in a releasably secured manner, and also having at least one oscillation exciter, by means of which at least one oscillation component can be imparted to the treatment container, wherein the workpiece anchoring device comprises at least one switchable clamping plate, in particular at least one clamping plate having one or more permanent electromagnets, which is adapted such that a magnetic field emanating outwardly from a clamping surface of the clamping plate can be selectively activated or deactivated.

2. The grinding or polishing apparatus according to claim 1, wherein the clamping plate comprises two or more magnetizing devices neighboring one another in a plane defined by the clamping surface, each of which devices has at least one permanent electromagnet which has a permanent magnet that can be changed in polarity and a coil surrounding the permanent magnet, the coil being connected to a source of direct current or direct voltage with the direction of the current or voltage being switchable.

3. The grinding or polishing apparatus according to claim 1, wherein each magnetizing device has a magnetizing element which is facing the clamping surface and in particular comprises mild steel or a comparable material, behind which the permanent electromagnet is disposed, preferably adjacently.

4. The grinding or polishing apparatus according to claim 1, wherein a plane parallel to the clamping surface, some or all of the magnetizing devices or magnetizing elements are disposed in such a way that they are distributed in a matrix-like or linear manner and in particular have a square or rectangular cross-section, and in that permanent magnets are disposed at the side edges, in particular at all the side edges, of the magnetizing elements, so that the magnetic pole axes of said permanent magnets run parallel to the clamping surface, whereby, for each magnetizing element, the pole axes of all the permanent magnets neighboring a specific magnetizing element point with the same polarity toward this magnetizing element.

5. The grinding or polishing apparatus according to claim 1, wherein the clamping plate is attached to the treatment container, the clamping surface thereof extending transversely, in particular perpendicularly or substantially perpendicularly, to a geometrical axis of the treatment container, in particular transversely to a perpendicular longitudinal center axis of the treatment container.

6. The grinding or polishing apparatus according to claim 1, wherein the magnetizing devices or the free magnet pole faces thereof are regularly spaced apart from one another laterally, on a cross-sectional circumference of the treatment container, in particular along a circular line, a uniform spacing of the magnet pole faces from one another being provided either along the entire cross-sectional circumference or along curved or straight line segments only at two or more portions of the cross-sectional circumference.

7. The grinding or polishing apparatus according to claim 1, wherein at least one clamping plate is disposed on the outer side of the treatment container and/or on a portion of the treatment container that is an upper portion with respect to the height of the container, in particular in the upper half of said container.

8. The grinding or polishing apparatus according to claim 1, wherein the workpiece anchoring device comprises a workpiece holder, which has a ferromagnetic base for the releasable secure clamping by means of the clamping plate and a number of holding devices, secured to the base, for one or more workpieces, a peripheral contour of the base in particular being adapted to a peripheral contour of the one or more clamping plates secured to the treatment container.

9. The grinding or polishing apparatus according to claim 1, wherein the main direction of extent of the holding devices, in particular formed in the manner of rods, runs transversely to a plane defined by the base of the workpiece holder.

10. The grinding or polishing apparatus according to claim 1, wherein the base is configured in the manner of a plate and in that one or more grip elements for a lifting means, such as for example for a crane or the like, are attached to the base, in particular on the side thereof opposite from the holding devices, the grip elements being elastically deformable, in particular at least transversely to the plane defined by the base.

11. The grinding or polishing apparatus according to claim 1, wherein the clamping plate is formed at least in a substantially circular shape and secured on the bottom of the treatment container.

12. The grinding or polishing apparatus according to claim 1, wherein the workpiece anchoring device has an underlay plate, which has ferromagnetic properties or does not have ferromagnetic properties, the peripheral contour of the underlay plate being adapted to the peripheral contour of the clamping plate or the clamping plates.

13. (canceled)
14. A method for grinding or polishing at least one workpiece, comprising the steps of:

- providing a grinding or polishing apparatus that includes a treatment container, at least one oscillation exciter, and a workpiece anchoring device with a workpiece holder and at least one switchable clamping plate having one or more permanent electromagnets, which is adapted such that a magnetic field emanating outwardly from a clamping surface of a clamping plate can be selectively activated or deactivated;
- filling the treatment container with grinding or polishing elements;
- securing one or more workpieces to the workpiece holder;
- oscillating the treatment container and grinding or polishing elements;
- partially or completely submerging the workpiece or workpieces in the grinding or polishing elements through an opening in the treatment container by means of the workpiece holder while the treatment container is oscillating;
- after partially or completely submerging the workpiece or workpieces, clamping magnetically the workpiece holder on the clamping plate which is disposed outside the treatment container and/or on a portion of the treatment container that is an upper portion with respect to the height of the container.