

Jan. 5, 1954

P. K. A. CÜPPERS
FINISHING OF WORKPIECES

2,664,676

Filed June 1, 1950

2 Sheets-Sheet 1

Fig. 1

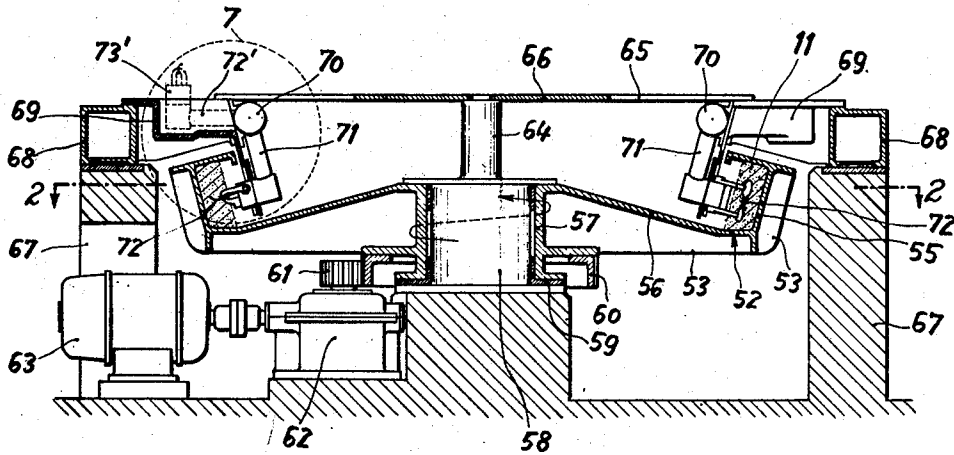
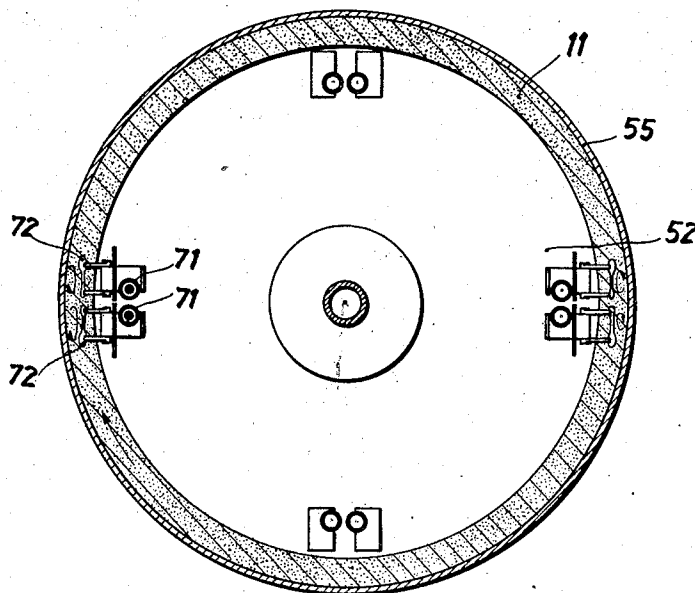


Fig. 2



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Fig. 3

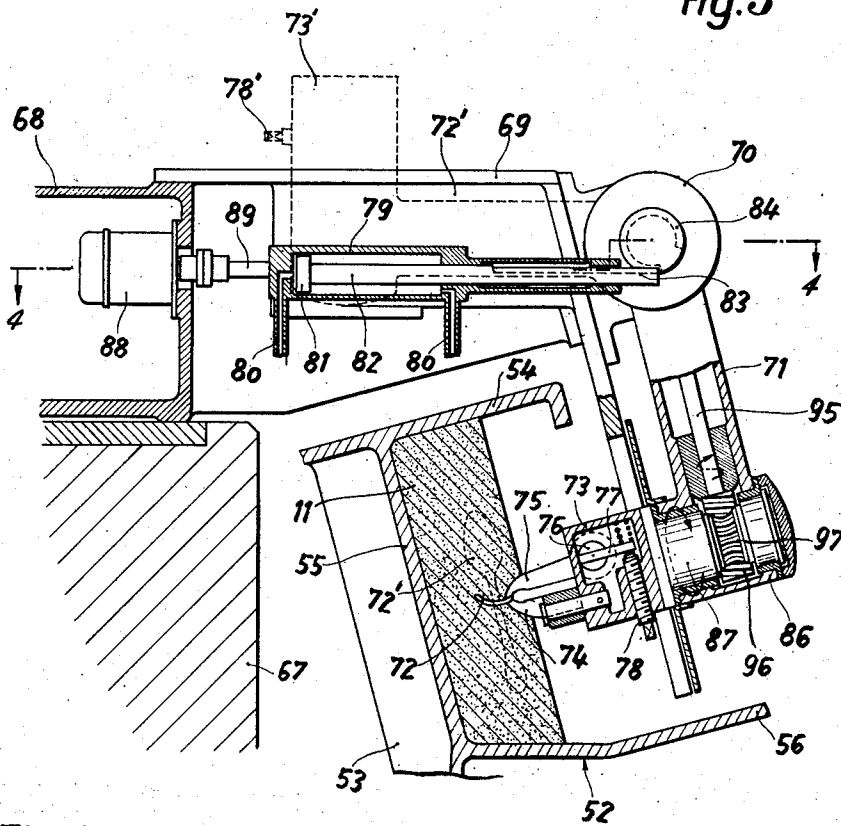
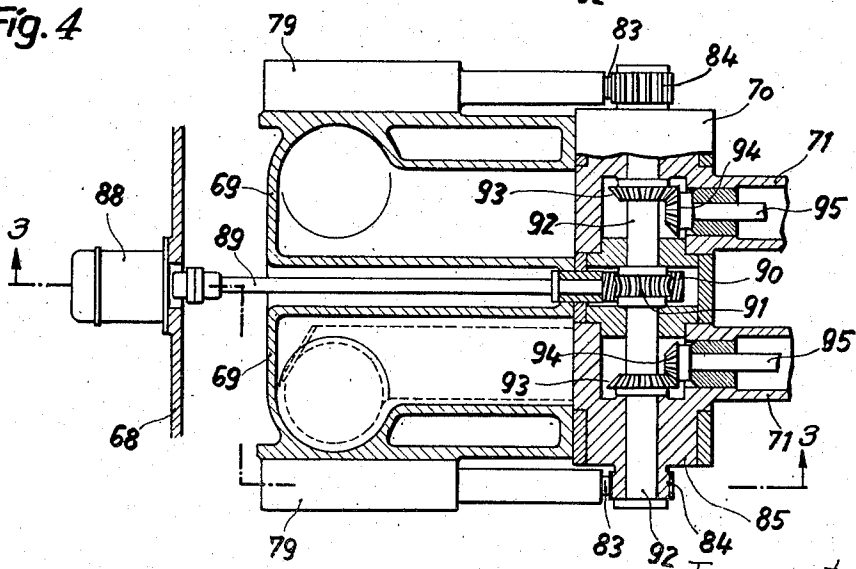


Fig. 4



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FINISHING OF WORKPIECES

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This invention relates to improved means and a method for finishing the surface of workpieces as by grinding, polishing or the like, with the aid of tool means which are relatively moved past the surfaces of the workpieces which are to be treated.

It is an object of the invention to provide means which permit such finishing treatment in a very economical manner.

A special object of the invention is to provide means for finishing the surface of workpieces extending in different planes or having intricate shapes, ornaments or the like. By way of example, such a workpiece may be in the form of a spoon or other piece of cutlery, which is to be finished primarily in order to obtain a neatly ground and polished surface, but it is also contemplated to finish in accordance with the invention workpieces requiring accurate grinding, such as in case of round journals or the like.

The working and finishing of the surfaces of such workpieces, more particularly of an intricate shape, by means of rigid or resilient grinding discs is elaborate, time-wasting and expensive, since the workman has to press the workpieces onto the grinding disc by hand, possibly adding a grinding agent, such as, sand, emery, pumice powder, corundum or the like, moving them to and fro in accordance with the varying contours of the surface. This method is of poor efficiency, yet it requires very much physical force and skill and is very unwholesome. The working of such workpiece surfaces in rotary drums or by means of sand blast is too coarse and, therefore, unsuitable for the production of ground surfaces and smooth, bright surfaces.

It is an important object of the present invention to provide means and methods for removing the drawbacks of the conventional finishing methods.

With this and further objects in view, according to the present invention the working tool serving for the finishing of workpiece surfaces is formed by a loose mass of a grinding, polishing or other working agent, preferably in a powdery, granular or pasty state, which mass is confined in a vessel or pan at least partly surrounding it (hereinafter referred to as the "tool vessel" or "tool pan"), and kept under pressure during its relative movement along the workpiece surfaces.

According to a preferred embodiment of the invention the loose working mass is kept under pressure by centrifugal force. To this end the

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tool vessel preferably consists of a centrifugal vessel or pan mounted for rotation about its center axis and being only partly filled up by the working mass. On rotation of this centrifugal vessel this mass under action of the centrifugal force forms a ring, on the freely accessible inner part of which the surfaces of the workpiece to be treated can be put in contact with the rotary working agent. Preferably, for enlarging the working surface, the workpiece in this case may be at least partly immersed in the inner annular zone of the rotary ring formed by the working mass; if desired, it may be additionally moved, turned or swivelled for working it on all sides. By such a movement which, if desired, may take place in a direction contrary to the direction of motion of the rotary working agent, the surfaces to be treated may be acted upon by the working mass more or less intensively and/or during longer or shorter periods of time. The working pressure in this case may advantageously be regulated by suitable adjustment of the speed of rotation and/or of the diameter of the mass ring formed by the working agent. The centrifugal force determining the compression and so the quasi consistence or hardness of this grinding ring formed of the loose material is proportional to the mass of the material and to the square of the speed and inversely proportional to the radius of rotation. If the speed of rotation and the diameter of rotation are determined, the working pressure may moreover be varied by admixing to the working material substances whose specific gravity differs from that of the working agent, such as, for instance, saw dust, cork powder or the like. These admixtures may be heavier or lighter than the working mass and may consist of abrasive or non-abrasive materials. Further details of this centrifugal type grinding device, more particularly the supporting and feeding of the workpiece and the swinging thereof during the working will be hereinafter explained in greater detail.

An apparatus designed and operated in accordance with the present invention permits a finishing treatment, more particularly the achieving of a grinding or polishing effect, which was not attainable by any of the known methods and apparatuses. Depending on the kind of the grinding material or polishing substance, workpiece surfaces of any quality can be obtained up to a beautifully ground surface with a clear reflection at every point. The grinding effect follows exactly the existing contours so that defor-

mations or disfigurements of the surface or ornaments being thus treated are safely avoided. The surfaces disposed in different planes pass over into each other without any transition and without noticeable grinding lines. Even work-
 5 pieces of an intricate shape can be worked by the novel method and apparatus according to the invention without any difficulties. The grinding capacity is extremely increased and the time of working reduced, since the working material is able to act simultaneously on large sur-
 10 faces of the workpiece. The working and preferably also the feeding and removal of the workpieces are achieved by mechanical means so that human labor is saved. Moreover, a single device,
 15 for instance, a centrifugal grinding device, permits the simultaneous finishing of numerous workpieces.

Other and further objects, features and advantages of the invention will be pointed out hereinafter and appear in the appended claims forming part of the application.

In the accompanying drawing some now preferred embodiments of the invention are shown by way of illustration and not by way of limita-
 20 tion.

Fig. 1 is a vertical section of a centrifugal grinding apparatus according to the invention.

Fig. 2 is a horizontal section, on the line 2—2 of Fig. 1, through the centrifugal vessel alone.

Fig. 3 is a view similar to Fig. 1, but showing on an enlarged scale the mechanism marked by the circle in Fig. 1 and taken on line 3—3 of Fig. 4; and

Fig. 4 is a horizontal section on the line 4—4
 25 of Fig. 3.

A particularly advantageous and practical form of the invention can be obtained by providing the loose mass of the working material in the form of a mass ring produced by centrifugal force, for tight engagement of the work-
 30 piece surfaces with the inner ring zone of this mass ring which is moved past the workpiece surfaces. An embodiment of this preferred form of the invention is shown in Figs. 1 to 4. The tool
 35 vessel in this case consists of a centrifugal tray or pan 52 provided at its circumference and bottom with reinforcing ribs 53 and being open in its central upper part. The upper pan edge 54
 40 together with the side wall 55 thereof and the outer part of the preferably conically shaped pan bottom 56 forms an annular channel having a U-shaped cross section in which the working material 11 which in its state of rest lies on
 45 the bottom of the pan, is forced outwardly against the side wall of the pan under action of the centrifugal force caused by rotation of the pan. The mass of the working agent 11 thus
 50 forms a mass ring of a loose, granular, powderous or pasty grinding or polishing material, which, if desired, may be mixed with filling substances. The centrifugal pan 52 is mounted for rotation
 55 on a vertical journal or pivot 58 by means of its hub 57, a slide bearing 59 being provided to form a thrust or step bearing. A toothed rim 60 connected to the hub 57 meshes with a pinion 61
 60 which through a reduction gear 62 is driven from an electromotor 63, whereby the centrifugal pan 52 is rotated at an adjustable rate of speed. Secured on the journal or trunnion 58 is a tubular
 65 member 64 bearing a stationary covering plate 66 provided with perforations 65.

Secured on a foundation ring 67 surrounding the centrifugal pan 52 with a suitable clearance is an annular carrier 68 with a hollow box-
 70

shaped cross section on which are secured at least one, but preferably several, bearing supports 69 extending radially towards the center axis of the apparatus. The bearing supports 69
 5 are advantageously downwardly recessed trough-fashion and at their free ends carry bearing bodies 70 about the horizontal axis of which the swingable arms 71 serving for chucking the work-
 10 pieces are rotatable in vertical radial planes. The workpieces 72, for instance, spoons, are detachably secured to the heads 73 of the swingable arms. The fastening is preferably effected with the aid of clamping blocks 74, 75 gripping
 15 the workpieces tong-fashion, the clamping block 75 being rotatable about a shaft 76 and provided with a lever arm 77 against which presses an adjustable press bolt 78, whereby the jaws of the clamping block are pressed against the work-
 20 piece 72 clamped therebetween, as will be seen from Fig. 3.

Since many workpieces, such as spoons and other articles of cutlery for complete finishing have to be rechucked in order that the surfaces
 25 chucked during the first treatment may be brought into contact with the working material in a subsequent treatment, I prefer to arrange always two swingable arms 71 with chucking
 30 devices side by side, so as to form a pair. The two arms of each pair may be swingable independently of each other, but preferably they are simultaneously swung from their position
 35 of rest to their operative position. Such swingable arms or pairs of arms may be arranged at various parts of the circumference of the tool pan in the annular carrier 68 so that a corresponding number of workpieces may be worked
 40 simultaneously.

In their position of rest the swingable arms are swung upwards so as to take up the position indicated in dotted lines 72', 73' in Figs. 1 and 3, in which position the clamping blocks
 45 74, 75 are freely accessible and the pressure screw (in this case denoted 78') can be released or tightened by means of its quadrangular end. After the workpiece 72 has been fixedly clamped,
 50 the swingable arm 71 is swung about the horizontal axis of the bearing body 70 through about 270° until it comes into its operative position, in which the clamping blocks 74, 75 dip the
 55 workpiece 72 more or less deep into the inner freely exposed annular zone of the mass ring 11. The working material being kept under pressure by the centrifugal force is moved past the workpiece surfaces at a suitable adjustable
 60 speed. The circumferential speed of the centrifugal pan 52 must at least reach an amount sufficient to urge the grinding, polishing or other working material, lying on the bottom of the pan in the position of rest, onto the circum-
 65 ference of the pan, as indicated in the drawing.

The swingable arms 71 may be swung manually, mechanically, electrically or hydraulically etc. In the example, hydraulic pressure cylinders 79 are arranged at the sides of the bearing supports 69, pressure pipes 80 being provided for feeding a fluid (liquid, gas or air) to the cylinder from a source of such fluid under pressure (not shown). A piston 81 slidable in the cylinder 79 has at the outwardly projecting end of its piston rod 82 a toothed rack 83 meshing with a pinion 84 secured to the rotatably mounted head 85 of the swingable arm 71. By forward or backward motion of the piston 81 in the pressure cylinder 79 the swingable arm 71 is thus
 75 swung upwards or downwards.

In order to insure uniform exposure of all surfaces of the workpiece to the impinging working material, the workpiece may additionally be swung or turned while being in an operative position. To this end, for instance, the head 73 of the swingable arm with the clamping blocks 74, 75 is mounted for rotation about its longitudinal axis by means of a shaft 87 rotatably mounted in a head casing 86. The rotation of the shaft 87 may be achieved, for instance, from outside by an electromotor 88 rotating, through a driving shaft 89, a worm 90 and a worm wheel 91, a horizontal shaft 92 mounted for rotation in the swingable head or heads 85. The shaft 92 through bevel wheels 93, 94 drives one or, in case of pairs of swingable arms 71, two intermediate shafts 95 which are mounted for rotation in the hollow swingable arms 71. At its end disposed in the casing 86 of the swingable head each intermediate shaft 95 bears a worm 96 engaging a worm wheel 97 seated on the clamping head shaft 87.

In case of workpieces such as spoons 72 there are advantageously two pairs of clamping blocks 74, 75 arranged at both sides of the clamping head 73, so that the workpiece can be chucked simultaneously at two spots, e. g., a spoon at its stem and at its bowl, by swinging the swingable arm 71 into its operative position. The workpiece is dipped into the grinding or other working agent 11 from inside and then slowly rotated at least once about the axis of the shaft 87 during the grinding or polishing. Then the swingable arms 71 are swung out and the workpiece, for instance, the spoon 72, is rechucked in order that the chucked spots may be treated in a second operation. In this second operation the workpiece again is swung at least once about the axis of the shaft 87. In Fig. 3 the dotted lines 72' show one position of this swinging motion of the spoon 72 in which it is turned through 90°.

The additional rotation of the workpiece 72 about the axis of shaft 87, e. g. about an axis being disposed approximately radial to the center axis of the centrifugal pan, can take place at a variable speed, so that the working material acts upon the workpiece for a more or less extended period of time in the different angular positions of the workpiece. This variable rotary motion may be controlled according to a predetermined program adapted to the respective workpiece. The surfaces of the workpiece are thus ground off or worked partly more and partly less intensively without producing sharply defined transition lines.

Owing to the fact that the workpiece holders, e. g., the clamping blocks 74, 75, extend from inside at least approximately in the direction of the centrifugal radius, the centrifuged working material is subject to minimum disturbance by still zones formed at the lee-side of the holders. It is also possible, however, to produce such still zones in the flow by suitable configuration of the design of the workpiece holders so as to expose certain zones of the surface to a reduced grinding effect.

Workpieces having curved surfaces of different inclinations passing over into each other, such as, e. g. spoons, are advantageously held in such a way in relation to the centrifugal axis that as far as possible all spots of the surface will successively come into an effective grinding position during one revolution of the workpiece about its axis of rotation extending approxi-

mately in the direction of the centrifugal radius. The flat stem side of a spoon in this case may be disposed, for instance, perpendicularly to this plane of swinging.

While the invention has been described in detail with respect to some now preferred examples and embodiments of the invention, it will be understood by those skilled in the art after understanding the invention that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended, therefore, to cover all such changes and modifications in the appended claims.

Having thus described the invention, what is claimed is:

1. A device for finishing the surfaces of workpieces comprising a pan mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials only partly filling said pan, means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in said pan, a swingable arm and a workpiece holder arranged at the free end of said arm and adapted to hold the workpiece, said arm being swingable in a plane extending substantially radially and parallelly to the centrifugal pan axis into a position where the workpiece holder is disposed freely accessible outside of the centrifugal pan, for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is disposed in the inner annular zone of the mass ring.

2. A device for finishing the surfaces of workpieces comprising a pan mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials only partly filling said pan, means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in said pan, a swingable arm and a workpiece holder rotatably mounted on the free end of said arm and adapted to hold the workpiece, said arm being swingable in a plane extending substantially radially and parallelly to the centrifugal pan axis into a position where the workpiece holder is disposed freely accessible outside of the centrifugal pan, for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is disposed in the inner annular zone of the mass ring, the axis of rotation of the holder being disposed substantially perpendicularly to the swingable arm and, in the second position thereof, in a direction substantially radially to the centrifugal pan axis.

3. A device for finishing the surfaces of workpieces, comprising a pan mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials partly filling said pan, means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in said pan, a number of swingable arms non-rotatably arranged around the periphery of the rotatable pan, and workpiece holders arranged each at the free end of said arms and adapted to hold the workpiece, said arms being swingable in planes extending substantially radially and parallel to the centrifugal pan axis into a position where the workpiece holders are disposed freely accessible outside of the centrifugal pan for chucking and removing the workpieces, and into a second position where the workpieces fastened

to the workpiece holders are disposed in the inner annular zone of the mass ring.

4. A device for finishing the surfaces of workpieces, comprising a pan mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials partly filling said pan, means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in said pan, a number of swingable arms distributed around the periphery of the rotatable pan on a carrying ring surrounding the said pan with a clearance, each of said arms having a workpiece holder rotatably mounted on the free end of said arm and adapted to hold a workpiece, each of said arms being swingable in a plane extending substantially radially and parallel to the centrifugal axis of the pan into a position where the workpiece holder is disposed freely accessible outside of the centrifugal pan for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is disposed in the inner annular zone of the mass ring, the axis of rotation of the workpiece holder being disposed substantially perpendicularly to the swingable arm and, in the second position thereof, in a direction substantially radially to the centrifugal pan axis.

5. A device for finishing the surfaces of workpieces, comprising a pan mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials partly filling said pan, means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in said pan, at least one pair of swingable arms arranged side by side, both arms of the said pair having a workpiece holder arranged each at the free end of each of said arms and adapted to hold the workpiece, each arm being swingable in a plane extending substantially parallel to a plane extending radially and parallel to the centrifugal axis of the pan into a position where the workpiece holder is disposed freely accessible outside of the centrifugal pan for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is at least partly immersed in the rotating mass ring of finishing material.

6. A device for finishing the surfaces of workpieces, comprising a pan mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials partly filling said pan, means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring of loose finishing materials in said pan, at least one pair of swingable arms arranged side by side, each of said arms having a workpiece holder rotatably mounted on the free end of said arm and adapted to hold a workpiece, each of said arms being swingable in a plane substantially parallel to a plane extending radially and parallel to the centrifugal axis of the pan into a position where the workpiece holder is disposed freely accessible outside of the centrifugal pan for chucking and removing the workpieces, and in a second position where the workpiece fastened to the workpiece holder is held in the path of movement of the rotating mass ring of finishing material.

7. A device for finishing the surfaces of workpieces, comprising a pan mounted for rotation about its central vertical axis and being adapted to contain therein a finishing mass of abrasive and like materials only partly filling said pan,

means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring of abrasive and like materials in said pan, the pan having a peripheral wall concentric with the axis of rotation and provided on its upper edge with a concentric annular inturned cover portion, a stationary carrying ring surrounding the centrifuge pan with a clearance, bearing supports secured on the carrying ring, workpiece holders rockably mounted on the said bearing supports and provided on their free ends with means for detachably securing the workpieces, said workpiece holders being rockable in substantially radial vertical planes independently of one another and into a position where the workpiece holder is disposed freely accessible outside of the centrifugal pan, for chucking and removing the workpieces, and into at least one other position where the workpiece fastened to the workpiece holder is disposed in the path of movement of the rotating mass ring of abrasive and like materials.

8. A device for finishing the surfaces of workpieces, comprising a rotary container adapted to be partly filled with abrasive and like materials having a peripheral wall concentric with the axis of rotation, means for revolving said container at a speed sufficient to cause, under action of the centrifugal force, the formation of a mass ring of the said abrasive and like materials against said peripheral wall, and workpiece holders stationarily arranged around the periphery of the container, each workpiece holder being swingable in a plane extending substantially vertically from the periphery to the middle zone of the container into a position where the workpiece holder is disposed freely accessible outside of the container for chucking and removing a workpiece, and into a second position where the workpiece fastened to the free end of the swingable workpiece holder is at least partially held in the path of movement of the rotating mass ring of abrasive and the like materials.

9. A device for finishing the surfaces of workpieces, comprising a rotary container mounted for rotation about a vertical central axis and having therein a finishing mass of abrasive and like materials only partly filling said container, means for rotating said container at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring of abrasive and like materials against a peripheral wall of the container concentric with the axis of rotation, at least one swingable arm and a workpiece holder rotatably mounted on the free end of said arm and adapted to hold the workpiece, the axis of rotation of the holder being disposed substantially perpendicularly to the swingable arm, said arm being swingable in a plane extending substantially radially and parallel to the centrifugal container axis into a position where the workpiece holder is disposed freely accessible outside of the container, for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is disposed in the path of movement of the rotating mass ring and at least partially immersed in the abrasive and like material forming the mass ring.

10. A device for finishing the surfaces of workpieces, comprising a rotary container for abrasive material in loose form having a peripheral wall concentric with the axis of rotation, the upper edge of said wall being provided with a

concentric annular cover portion, means for rotating said container at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring of abrasive and like materials in said container against the peripheral wall, pairs of workpiece holders stationarily mounted and distributed around the upper periphery of the rotating container, said workpiece holders being adapted to hold the workpieces at their free ends and being rockable each in a plane substantially vertical and extending from the periphery of the container to the middle zone of the container from outside the container into the interior of the container where the workpieces are held at least partly immersed in the stream of abrasive material forming said mass ring.

11. A device for finishing the surfaces of workpieces, comprising a container mounted for rotation about its vertical center axis and having therein a finishing mass of abrasive and like materials partly filling said container, means for rotating said container at a speed at least sufficient to cause the formation, under the action of the centrifugal force, of a mass ring in the container, the base of the said container having a frusto-conical inclined part adjacent its periphery, at least one swingable arm and a workpiece holder arranged at the free end of each arm and adapted to hold the workpiece, each arm being swingable in a plane extending substantially radially and parallel to the centrifugal container axis into a position where the workpiece holder is disposed freely accessible outside of the centrifugal container for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is at least partly held in the path of movement of the abrasive material forming the mass ring.

12. A device for finishing the surfaces of workpieces, comprising a container mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials partly filling said container, means for rotating said container at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in said container, at least one pair of swingable arms arranged side by side and workpiece holders arranged at the free ends of said arms and adapted to hold the workpieces, both arms of the pair being adapted to be rocked together in a plane extending substantially radially and parallel to the centrifugal container axis into a position where the workpiece holders are disposed freely accessible outside of the centrifugal container for chucking and removing the workpieces, and into a second position where the workpieces fastened to the workpiece holders are at least partly held in the path of movement of the abrasive and like materials forming the mass ring.

13. A device for finishing the surfaces of workpieces, comprising a container mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials only partly filling said container, means for rotating said container at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in the said container, at least one pair of swingable arms arranged side by side, and a workpiece holder

rotatably mounted on the free end of each arm and adapted to hold the workpiece, the arm of each pair being swingable together in a plane extending substantially radially and parallel to the centrifugal container axis into a position where the workpiece holders are disposed freely accessible outside of the container for chucking and removing the workpieces, and into a second position where the workpieces fastened to the workpiece holders are at least partly immersed in the mass ring.

14. A device for finishing the surfaces of workpieces, comprising a container mounted for rotation about its center axis and having therein a finishing mass of abrasive and like materials only partly filling said container, means for rotating said container at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring in said container, at least two workpiece holders adapted to hold the workpieces, said workpiece holders being movable independently of one another into a position where each workpiece holder is disposed freely accessible outside of the centrifugal container, for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is at least partly held in the path of movement of the mass ring.

15. A device for finishing the surfaces of workpieces, comprising a pan mounted for rotation about its central vertical axis and having therein a finishing mass of abrasive and like materials partly filling said pan, means for rotating said pan at a speed at least sufficient to cause the formation, under action of the centrifugal force, of a mass ring of finishing material in said pan, a plurality of swingable arms mounted on bearing supports arranged stationarily around the periphery of the pan, a workpiece holder arranged at the free end of each swingable arm and adapted to hold the workpiece, each of the said arms being swingable independently of one another on a stationary pivot pin mounted on the said bearing support in a plane extending substantially vertically from the periphery to the middle zone of the centrifugal pan into a position where the workpiece holder is disposed freely accessible outside of the centrifugal pan, for chucking and removing the workpiece, and into a second position where the workpiece fastened to the workpiece holder is disposed in the path of movement of the rotating mass ring of finishing material.

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