June 13, 1967 P. KRAFT 3,324,493

BRUSHING AND POLISHING MACHINE

Filed Oct. 14, 1965 5 Sheets-Sheet 1

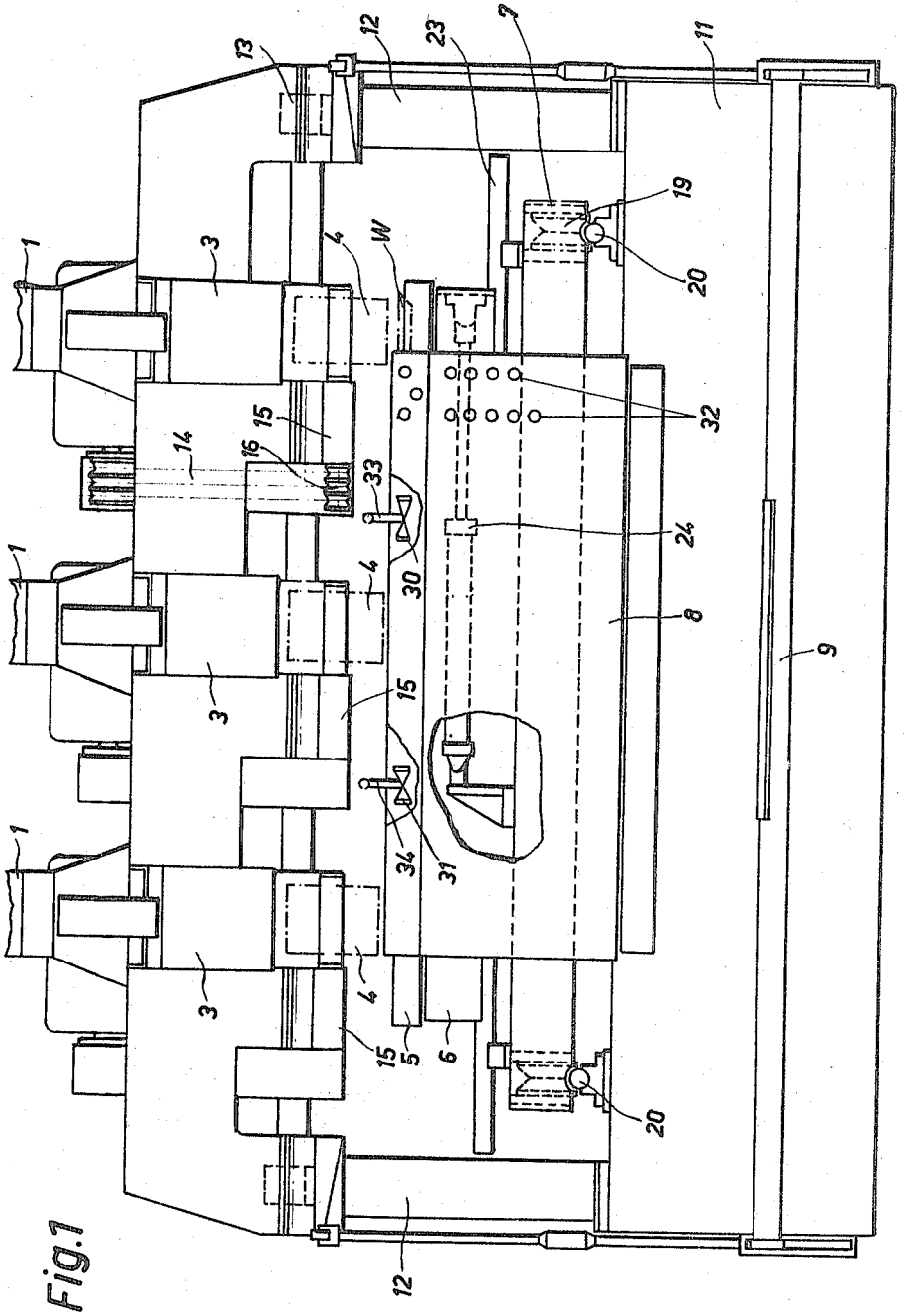

Fig.1

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BRUSHING AND POLISHING MACHINE

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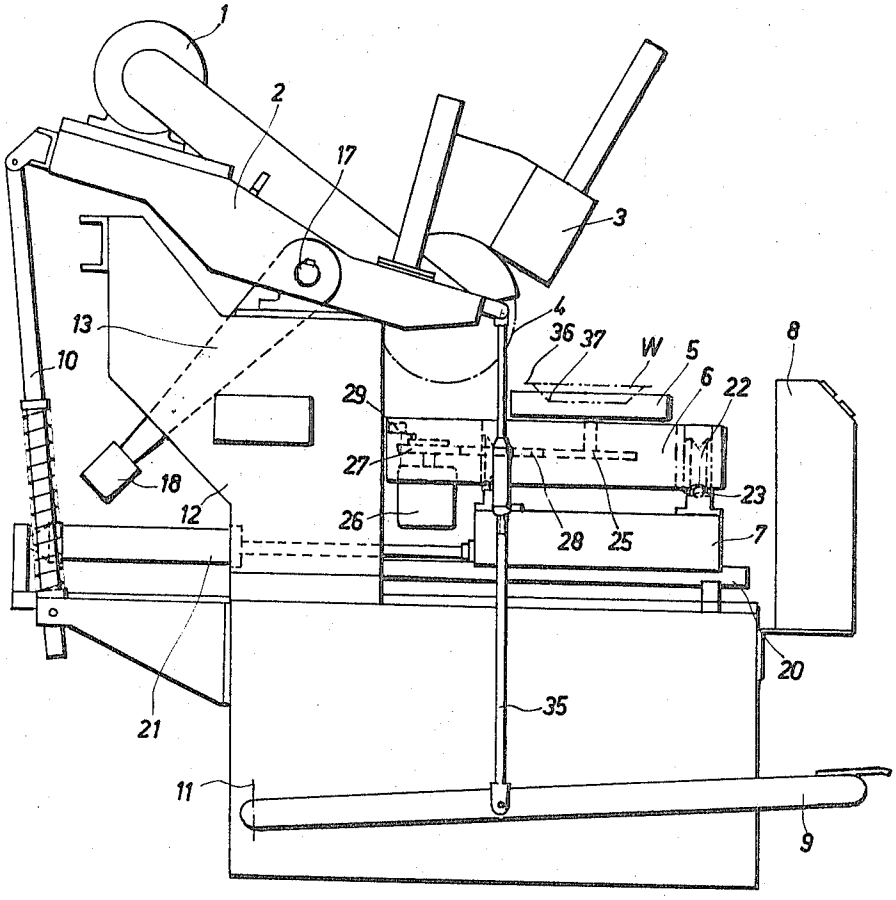
Fig. 2



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BRUSHING AND POLISHING MACHINE

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5 Sheets-Sheet 3

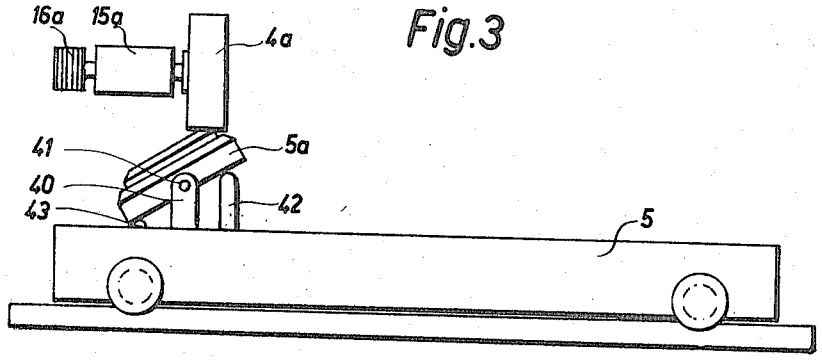

Fig.3

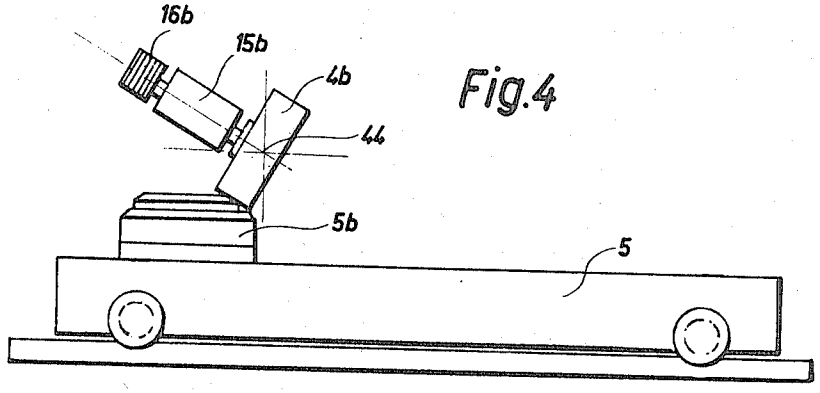

Fig.4

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BRUSHING AND POLISHING MACHINE

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Fig.5

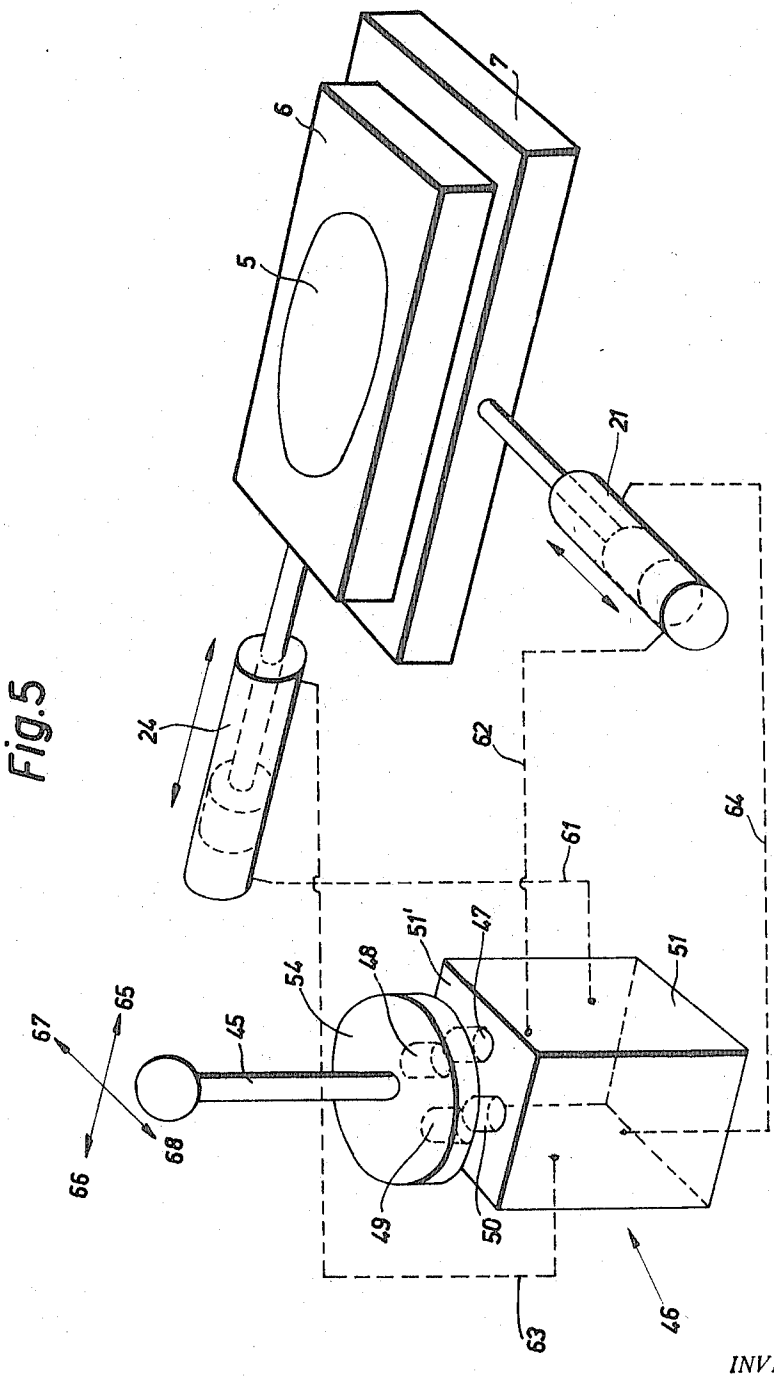

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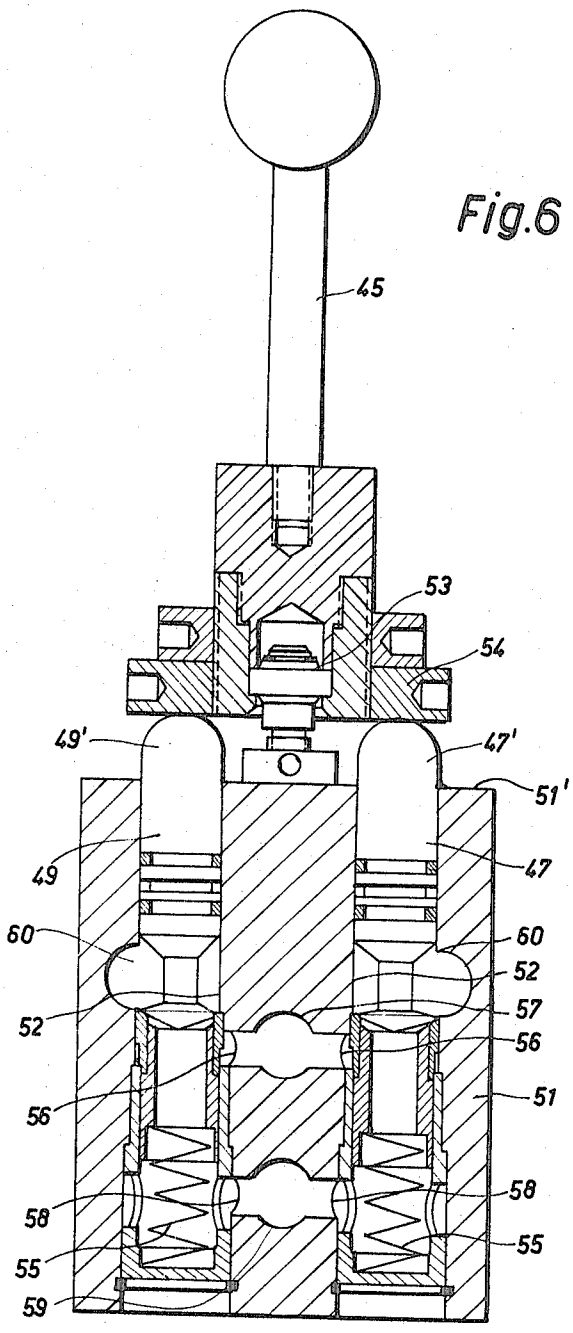
Fig.6



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3,324,493

BRUSHING AND POLISHING MACHINE

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Claims priority, application Germany, Oct. 16, 1964, W 37,769
10 Claims. (Cl. 15—21)

This invention relates to a machine for polishing of hollow-ware workpieces, particularly of a nonsymmetrical shape with respect to an axis of rotation, with at least one cylindrical polishing means being mounted onto a tool spindle, with at least one workpiece carrier being mounted swingably around at least one swing axis, with a workpiece support being driveable parallel to the tool spindle and with a controllable support adjusting device being operated by an operating lever which is operated by either hand or foot and with a feeding device for workpieces also being operated by an operating lever which is operated by either hand or foot.

A machine of the above-identified type is known, in which two or more groups of polishing tools are provided, whereby in each group several polishing tools by means of polishing wheels are mounted coaxially on a common horizontal tool spindle and whereby the tool spindles of both groups operate both parallel to and spaced from each other. Each polishing wheel of the one group of polishing tools lies, together with one polishing wheel of the second group of the polishing tools, in a common vertical plane. Beneath the group of polishing tools in each vertical plane there is provided one workpiece carrier for holding the workpieces. The workpiece carriers are arranged on a common support which is swingable selectively beneath the first or second group of polishing tools by means of a hand lever mechanism. By means of a workpiece feeding device, which preferably is a foot pedal operated lever system, the support can be lifted toward the respective groups of polishing tools to move the workpieces toward the polishing wheel. The support is by means of a hand lever operable by solely manual force parallel to the tool spindles. A movement in a transverse direction, while maintaining the engagement of a given group of polishing tools, is not possible. The workpiece carriers, also by means of hand levers, are swingable around axes which are parallel to the plane of the support movement. In this manner small workpieces, for instance, silverware and the like, can be worked on by said machine. However, bigger bowls, trays and the like cannot be polished on presently known machines because of a lack of movement of the workpiece carrier vertically to the tool spindle and also because of a lack of rotation of the workpiece carrier in the plane of movement. Furthermore, an economic operation is not possible if the force for moving the workpiece is only manual. The moving of a relatively heavy carrier is too tiresome for a worker over extended periods of operation. Besides, he could effect such moving only relatively slowly.

Further grinding machines are known which are provided with a cross slide, on which workpiece carriers are arranged. The control of the slide is accomplished through limit switches which reverse the slide drives at the respective end points of their reciprocating movements. A disadvantage of this is that the slides cannot be stopped or reversed at points other than said end points which might be desired. It is also not possible to control the speed of movement of the slide as desired as selected points in its path of movement. It is therefore not possible with these grinding machines to selectively work on

particular places of large surfaces of the workpieces and in particular it is not possible to work on hollow parts.

There are also grinding machines known having cross slides with a threaded spindle drive which is operated by hand. The slides of said cross slides can be stopped in any position but the movement of the slide requires much effort and is very slow. Consequently said machines are uneconomical.

Attachments for grinding machines with a horizontal grinding wheel spindle are also known by which the workpiece is swingable around a vertical axis. Said attachments are provided for working on symmetrical workpieces. However, said attachments cannot be controlled by the controls of the grinding machine, but only by separate control means. A central control, positioned in one place is not possible with such machines. The operation of said machine is therefore very complicated and poorly arranged for effective use. Accurate work on surfaces of nonsymmetrical workpieces cannot be carried out.

Therefore it is the purpose of the invention to build a simple, accurate and reliable machine of the type described above which can polish hollow workpieces which are of nonsymmetrical shape and which have surfaces relatively large with respect to the contact surface of the polishing wheel, and to provide a machine which will polish such workpieces as effectively as up to now has been possible only through handpolishing. Such machine should have the capacity of driving the polishing tool over individual places faster or slower in comparison to other places as desired. It also should be possible to repeat the polishing process at selected positions and to obtain a pattern by going over the workpiece in a selected direction.

These objectives are obtained according to the invention by utilizing the known cross slide as a support and providing same with a pressure-means drive, by causing the support moving device to influence the pressure-means drive in such a way that the speed of the workpiece is proportional to the deflection from neutral position of the operating lever, that the workpiece movement is reversible at any place on the cross slide, and that the swivel axis of the workpiece carrier is also arranged in a known manner vertically to the plane of movement of the cross slide.

Because the support of the machine of the invention is constructed as a cross slide with a pressure means drive, it is possible to bring into polishing position any desired, large surfaced, workpiece of all contours, for instance, ovals, triangles, asymmetrical parts. Consequently there is very little deadtime when working with the machine of the invention. No force worth mentioning is needed by the person who operates the movement of the support so that the person does not get tired. By means of the support moving device of the machine of the invention, which controls the pressure-means drive, it is possible through operation of the operating lever to adjust accurately the speed of the support means and with it the speed of the workpiece at any instant and at any place. Furthermore the direction of movement of the support can be reversed at any desired place in its path of movement through suitable actuation of the operating lever. Consequently it is possible to move a desired area on the workpiece quickly and accurately beneath the polishing tool and to work said area individually, for instance, by means of a back and forth moving of the support and of the workpiece for only a distance as needed. It is possible to also polish locally limited recesses of the workpiece. It is possible for the machine of the invention to accomplish a finish with a pattern on a workpiece which looks like manual labor. The workpiece

carrier of the machine is swingable around an axis which is vertical to the plane of movement of the cross slide. It is therefore possible, during the polishing of a workpiece, to change the direction of the stroke. By this means polishing with cross strokes can be made. The cooperating characteristics of the cross slide support, said support providing a speed control by means of a control of the support drive, and a reversal of the slide at any desired point in its path of movement, and a rotation of the workpiece carried around an axis vertical to the plane of movement of the slide, for the first time make it possible to obtain all the requirements of a polishing machine for hollow workpieces having a relatively large surface. The machine of the invention is built simply and sturdily and therefore easy to operate and reliable during operation. The machine of the invention, of course, can be provided with several polishing tools and accordingly can be provided with several workpiece carriers on the support. Then it is possible to work on several workpieces at the same time and only one operator is needed. The machine of the invention is therefore very good for use in mass production.

One advantageous construction of the machine of the invention is that the workpiece carrier is rotatable around the swivel axis through at least 180°. By this means it is possible through a turning of the workpiece carrier to rework locations on the workpiece, which were worked insufficiently by the polishing tool during the movement of the workpiece in one direction beneath the polishing tool, because the polishing tool may have been moved away from such location by such movement. After the workpiece is rotated the polishing tools can then easily reach the places which have still to be worked. Accordingly the inside of a dish can be polished without leaving an unfinished shadow at the point where the wall of the dish blends into the bottom of the dish. At the movement of the dish towards the polishing tool, the polishing tool works well on all the surfaces facing same, however, the other surfaces facing opposite the movement of the dish were not worked well. By a rotation of 180° of the workpiece around the axis being in vertical position to the plane of the movement of the support slide the orientation of the surfaces of the workpiece is changed. Upon subsequent additional polishing in the same direction of movement, all the places which were polished only insufficiently at the first polishing are repolished. Furthermore because of the rotation of 180- of the workpiece, the direction of the approach is reversed at the second polishing in comparison to the first polishing. Because of this the polished surface has an especially effective finish.

An effective embodiment of the polishing machine of the invention is accomplished by means of the workpiece carrier which can be fixed in any desired angular position. By said construction of the machine, for instance, a cross grinding or similar effect can be produced on the surface of the workpiece, which allows said surface to look especially attractive.

It is an advantage for hollow workpieces with a large curvature if the machine according to the invention is constructed to provide that the workpiece carrier is additionally rotatable with respect to an axis which is parallel to the plane of movement of the cross slide and vertical to the tool spindle. By this means the working zone of the surface of the workpiece can be directed in a way that the desired working surface is presented to the polishing tool.

It is an advantage that the machine of the invention can also be constructed in a way that the direction of rotation of the polishing tool is reversible. Because of the reversible direction of rotation of the polishing tool, "shadows" in hollow workpieces can be polished, which were not worked or which were badly worked during the original direction of rotation. Furthermore, a special stroke effect can be obtained by polishing the surface of a workpiece in two opposed directions of working by means of a reversed direction of rotation of the polishing tool.

Further characteristics of the invention are shown in the following examples of construction in connection with the drawings:

FIGURE 1 is a front elevational view of the machine of the invention in a schematic presentation.

FIGURE 2 is a side elevational view according to FIGURE 1 also in a schematic presentation.

FIGURE 3 is a partial view of the upper slide with a swingable workpiece carrier.

FIGURE 4 is a partial view of a polishing tool in a swung position.

FIGURE 5 is a schematic view of the construction and of the operation of the pressure-means drive of the cross slide support of the machine of the invention and one example of the support adjusting device according to the invention.

FIGURE 6 is a cross sectional view of the support adjusting device according to FIGURE 5.

The two side supports **12** are at the right and left sides affixed to the box shaped, welded base support **11**. On said side supports the swingable upper part **2** is mounted in two pillow blocks **13**.

The swingable upper part holds three driving motors **1** which drive by means of V-belts **14** three polishing tools which are constructed as polishing brushes **4**. The polishing brushes **4** are arranged on a tool spindle which is fastened to a swingable upper part **2** in form of a shaft **15**. The end of the shaft remote from the polishing brush has a V-belt pulley **16** for the V-belt **14** of the driving motor **1**. Furthermore at the swingable upper part **2** there is provided a polishing paste feeding device **3** for each polishing brush.

The brushes **4** can be moved toward or away from the workpiece W on the rotatable workpiece carrier **5** by means of the rocker **9** for the feeding device of the brushes, which is operated by foot. At the rearward end of the swingable upper part **2** there is provided the spring like buffer **10** which limits the upward movement of the brushes. In order to avoid the use of too much force for the movement of the brush over the rocker **9**, a counterweight **18** is arranged above the point of rotation **17** of the swingable upper part **2** and said counterweight balances the weight of the upper part **2**.

The machine of the invention is provided with a support comprising a cross slide **6**, **7**. One slide **7** for lengthwise movement is positioned on the base support **11**. Said slide is moved on two guides **20** by means of rolls **19**. The drive of the slide **7** for lengthwise movement is achieved by means of a hydraulic cylinder **21** which is here built into said slide.

The slide **6** for crosswise movement is built onto the lengthwise moveable slide **7**. Said slide also moves on two rod-like guides **23** by means of four rolls **22**. The drive is achieved by means of a built-in hydraulic cylinder **24**. The slide **6** for crosswise movement has built in a rotary drive **25** for the workpiece carrier **5**. The drive of the workpiece carrier is accomplished by means of an electric motor **26**, through a gear **27** and a chain **28**. The rotatable movement of the workpiece carrier is limited by means of limit switches **29** which can be used selectively.

A control console **8** is placed in front of the base support. The control console has a support adjusting device for controlling the slides **6** and **7**. FIGURE 1 shows a schematic view of one example of the construction of the support adjusting device. It shows two 4 way, 3 position hydraulic valves **30** and **31**. Each of the hydraulic valves **30** and **31** through one of its four outlets is connected to a hydraulic pressure supplying apparatus (not shown) to produce the drive pressure. The hydraulic apparatus for instance is arranged at one side of the machine. A second outlet of each of the hydraulic valves **30** and **31** is connected to a return path leading back to the hydraulic ap-

paratus for idling operation. The remaining two outlets of each hydraulic valve 30 and 31 are connected respectively with both ends of each one of the hydraulic cylinders 24 and 21. Each hydraulic valve 30 and 31 is respectively adjustable and controllable by means of operating levers 33 and 34 which are operated by hand. Depending on the position of the operating lever 33 and 34, one or the other end of each hydraulic cylinder 24 and 21 is supplied with pressure fluid. At the same time, the corresponding cylinder ends are connected to the return path and the pistons within the cylinder are connected with the slides 6 and 7 by suitable piston rods which are moved by the drive fluid. Each of the hydraulic valves 30 and 31 can be put in neutral position at which both ends of the corresponding hydraulic cylinders 24 and 21 are completely separated from the hydraulic pressure source. The slide 6 or 7 which is driven by the corresponding hydraulic cylinder then stops. The movement of the slides 6 and 7 can thus be controlled independently from each other. A return movement of the slide is possible at any time by means of a movement of the operating lever 33 or 34 and a resulting appropriate adjustment of the hydraulic valve 30 or 31.

A second example of construction of the support moving device of the slide 6 and 7 is shown schematically in FIGURES 5 and 6. In said support moving device the pressure means drives of both the slides 6 and 7 are controlled by hand by means of only one operating lever 45. The support moving device has a control valve 46 at which four slide valves 47, 48, 49, 50 are provided which are parallel to each other, which are spaced at intervals of about 90° around a circle and which are constructed identically. The slide valves 47–50 are positioned lengthwise movably, each in a cavity 52 of the common valve body 51, and extend each with one end 47', 48', 49' and 50' at one outer surface 51' of the valve body 51. At the outer surface 51' of the valve body 51 on the middle axis the operating lever 45 is positioned swingable in all directions between the ends of the slide valve in a ball-mounting 53. A plate 54 is fastened, for example screwed, to the operating lever 45. The slide valves 47–50 are pushed towards said plate 54 from underneath by springs 55. Each cavity 52 is connected to a conduit 57 which leads by means of an opening 56 to the source of pressure. Furthermore each cavity 52 is connected by means of an opening 58 to the pressure-means return path 59 which leads back to the hydraulic pressure source. The conduits 57 and 59 are shown in cross sectional view in FIGURE 6. Said conduits are omitted from FIGURE 5 for clarity of illustration. Furthermore each cavity 52 is connected to one end of one of the hydraulic cylinders 21 or 24 by means of an opening 60 and conduit 61, 62, 63, or 64 (FIGURE 5). FIGURE 5 shows that the cavities positioned diametrically opposite each other, in which the slide valves 47 and 49 are positioned, are connected with the ends of the hydraulic cylinder 24. The two other cavities, also positioned diametrically opposite each other, are connected with the hydraulic cylinder 21. The slide valves 47 to 50 in their respective neutral middle positions block all the paths as shown in FIGURE 6. According to the deflection from the neutral position of the operating lever 45, operated by hand, and with it connected the slope of plate 54, the slide valves 47 to 50 are pushed downwardly or upwardly. For instance with the operating lever 45 as shown in FIGURE 6 deflected to the right, the slide valve 47 goes down and the slide valve 49 goes up. The slide valve 47 renders thereby the openings 56 and 60 at least partially free, so that driving fluid can flow through the conduit 61 into the left end of the hydraulic cylinder 24 (FIGURE 5). At the same time the slide valve 49 opens a passageway through the openings 58 and 60, so that the driving fluid can flow from the right end of the hydraulic cylinder 24 through the conduit 63 into the return path conduit 59. The slide 6 is then, as shown in FIGURE 5, moved rightwardly. The speed of the slide movement thereby is proportional to the deflection from neutral position of the operating lever 45 because the amount of driving fluid let through by the control valve is dependent on the degree of opening of the opening 56, 58 and 60, and said degree of opening being determined by the displacement of the slide valve. Through an exact adjustment of the operating lever 45, any desired speed of the movement can be set. If the operating lever only swings in the plane of the double arrows 65–66, shown in FIGURE 5, only slide 6 is moved, Said slide is moved to the right when the operating lever swings in the direction of arrow 65 and to the left when swinging in the direction of arrow 66. The slide valve 48 and 50 thereby stay in neutral position and the slide 7 stands still. If the operating lever is only swung in the plane of the double arrow 67–68, the slide 7 is moved and the slide 6 stands still. By a swinging of the operating lever in a direction between the double arrows 65–66 and 67–68, both slides are moved at the same time. Accordingly, it is possible to control exactly with the only one operating lever 45 the movement of both slides 6 and 7 with respect to their direction and speed.

The control members 32 for the electrical parts are affixed at the side of the control console 8. Besides the switches for the tool motors and the rotatable drive of the workpiece carrier, main switches and emergency switches are provided at the control console. The other parts of the electrical circuit are placed in a special switch cabinet (not illustrated).

The brushing and polishing with the machine of the invention works as follows:

The three workpieces W are put into three forms which are arranged on three rotatable carriers 5 and are held in place by means of vacuum being produced by a vacuum pump (not illustrated) which is attached to the machine. Both slides 6, 7 are rendered operative by operating the support moving device, that is, said slides are moved beneath the brushes 4. After the brushes are working the operator brings together the brushes and the workpiece by means of the rocker 9 and the rod 35.

The operator starts the work at the far edge 36 of the workpiece and sweeps over the workpiece with back and forth movements. Thereby it is possible, because of the practical construction of the machine, to pass intensively over the places 37 which are hard to reach at first and then to give the entire workpiece a pass. Through this procedure, surfaces are produced which are equal to hand-brushed or hand-polished surfaces.

During the brushing and polishing the direction of feed has to be changed continuously to avoid so-called "tails"—those are shadows which are produced by an uneven engagement of the brushes. This rotatable movement can easily be achieved by the built-in rotary drive 25. By an adjustment of the end switches 29, accordingly, the rotation of the workpiece can take place through any desired angle between 0 and 360°. The brush at regular brushings and polishings is not engaged during the rotation of the workpiece. However, it also would be possible to keep the brush engaged during rotation for the polishing and brushing of certain features or to achieve certain effects at the surface thereof.

To have better contact conditions for working on the curved surfaces with the brushing and polishing tools 4, the workpiece carrier of FIGURE 1 can be constructed pivotally (FIGURE 3). The carrier 40 of the workpiece carrier is built with a hinged joint 41 at its upper end, in which the workpiece carrier 5 is pivotally mounted. For movement of the workpiece carrier a post 42 is provided which is operated by a hydraulic cylinder (not illustrated) which is built into the cross slide 6. To keep the pivotal workpiece carrier in its selected position with respect to the horizontal during its rotation about a vertical axis, guides, not shown, of any convenient type, may be provided at locations spaced circumferentially less than 90° from the post 43. The post 43, the movement of which is coupled with the post 42, is offset to the post 42 by 180°.

The brushing and polishing tools 4 in FIGURE 4 are shown in swung position. In such swinging, the tool carrier is moved around a point of pivoting provided on an axis of the grinding spindle. The best position for said point of pivoting lies at 44 in the rotational axis of the brushing and polishing tools. The parts necessary for the swinging of the brushing and polishing tools are not illustrated in FIGURE 4, because said means are known.

The invention is not restricted to the examples which are above set forth. For example, in the machine of the invention which is provided with a support moving device according to FIGURES 5 and 6, the operating of the tool feeding device can be done by means of a hand lever instead of the rocker 9 which is operated by foot. In this type of construction, the operator controls the entire machine with two hand levers whereby, for instance, the left hand operates the hand lever for the feeding of the polishing brushes and the right hand operates the operating lever for the support moving device. It is also possible to construct the machine of the invention in such a way that the polishing tools are not moved to the workpiece by means of a feeding device but that the cross slide with the workpiece is liftable to the polishing tool for feeding. It is also possible for instance to provide swingable and lockable control levers, buttons which are operated by hand at the machine of the invention for the control of the rotatable and swingable movement of the tool carrier 5 and to transfer the movement of the control lever, control button or the like over rods or simple transmission to the workpiece carrier 5.

Although a particular preferred embodiment of the invention has been disclosed above for illustrative purposes, it will be understood that variations or modifications thereof which lie within the scope of the appended claims are fully contemplated.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A machine for polishing workpieces, particularly hollow-ware workpieces of a nonsymmetrical shape, said machine comprising:

a base;

tool feeding means mounted on said base and a tool spindle mounted on said tool feeding means and having mounted thereon a cylindrical polishing tool;

first manual control means operatively connected with said tool feeding means for bringing the tool and the workpiece into coacting relation;

support means mounted on said base for movement in a plane parallel to the tool spindle axis, said support means comprising cross slide means so that said support means is movable in said plane in a first direction parallel to the tool spindle axis and in a second direction perpendicular to the tool spindle axis;

fluid pressure drive means coupled to said support means for selectively moving the same in said first and second directions;

a workpiece carrier, and means rotatably mounting said carrier on said support means for rotation about an axis perpendicular to said plane;

second control means for controlling said fluid pressure drive means, said second control means having manually operable actuating means which controls said fluid pressure drive means such that the speed of movement of said support and said workpiece carrier is proportional to the deflection from neutral position of said actuating means, said second control means permitting the movement of said support and the workpiece mounted thereon to be reversed at any selected location thereof.

2. The machine according to claim 1, wherein said cross slide means comprises a first slide mounted on said base for movement thereon in one of said directions and a second slide mounted on the first slide for movement in a direction perpendicular to the direction of movement of said first slide.

3. The machine according to claim 1, further including means for rapidly rotating the workpiece carrier about its axis of rotation through an arc of at least 180 degrees.

4. The machine according to claim 1, wherein said workpiece carrier can be fixed against rotation about its axis of rotation relative to the slide means at any desired angle.

5. The machine according to claim 1, wherein the means mounting said workpiece carrier on said cross slide means includes a pivot having an axis which is parallel to the plane of movement of said support means and transverse to the tool spindle axis, and adjustment means for moving said workpiece carrier about said pivot axis and fixing the carrier at any desired angle.

6. The machine according to claim 1, wherein said tool spindle is mounted on said tool feed means by a pivot which has an axis parallel to the plane of movement of the slide means and perpendicular to the tool spindle axis, the pivot permitting the tool spindle and the polishing tool carried thereon to be swingable about said pivot axis.

7. The machine according to claim 1, further including tool drive means mounted on said base for rotating said polishing tool, and means for reversing the direction of rotation of said tool.

8. The machine according to claim 1, wherein said cross slide means includes a first slide mounted on said base for movement thereon and a second slide mounted on said first slide for movement thereon, one of said slides being mounted for movement parallel to the spindle axis and the other of said slides being mounted for movement perpendicular to the spindle axis; and

wherein said fluid pressure drive means comprises a first pressure cylinder mounted on said base for controlling the movement of said first slide and a second pressure cylinder mounted on said first slide for controlling the movement of said second slide.

9. The machine according to claim 8, wherein said second control means includes control valve means to control said first and second pressure cylinders, said control valve means being operated by a single manually operable lever, said lever being mounted for swinging movement in all directions;

whereby the swinging of the operating lever in a first direction controls the first pressure cylinder and the first slide connected thereto, and swinging said operating lever in a second direction perpendicular to the first direction controls the second pressure cylinder and the second slide connected thereto.

10. The machine according to claim 9, wherein the control valve means includes a housing having four cavities therein;

four slide valves mounted in the respective cavities, the axes of the slide valves being parallel to each other and being spaced in a circular pattern at 90 degree intervals;

spring means biasing each of said slide valves in a direction to cause one end of said valves to extend beyond one end of said valve housing;

said control lever being mounted to said end of said valve housing centrally located among the extended ends of said valves by means of a ball joint to permit universal pivotal movement of said operating lever;

a plate means mounted on said operating lever, the extended ends of said valves being maintained in contact with said plate means by said spring means;

each of said cavities being provided with a supply port connected to a common pressure source, and a return port and a load port, and means connecting the load ports of two diametrically opposed slide valves to said first pressure cylinder, and means connecting the load ports of the other two diametrically opposed slide valves to the second pressure cylinder;

said slide valves being maintained in a middle neutral position when the plate means is located in a plane perpendicular to the slide valve axes, all valve ports being closed when said slide valves are in said neutral position;

lengthwise movement of each slide valve in one direction connecting the supply and load ports, and lengthwise movement in the opposite direction connecting the load and return ports;

movement of said plate means by said operating lever causing the slide valves which are diametrically opposite each other to be simultaneously moved in opposite directions whereby one slide valve interconnects one end of a pressure cylinder with the pressure source while the other slide valve interconnects the other end of the same pressure cylinder with the return port.

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