Nov. 17, 1959 S. A. BOETTCHER 2,912,799

LAPPING MACHINE

Filed June 28, 1956 4 Sheets-Sheet 1

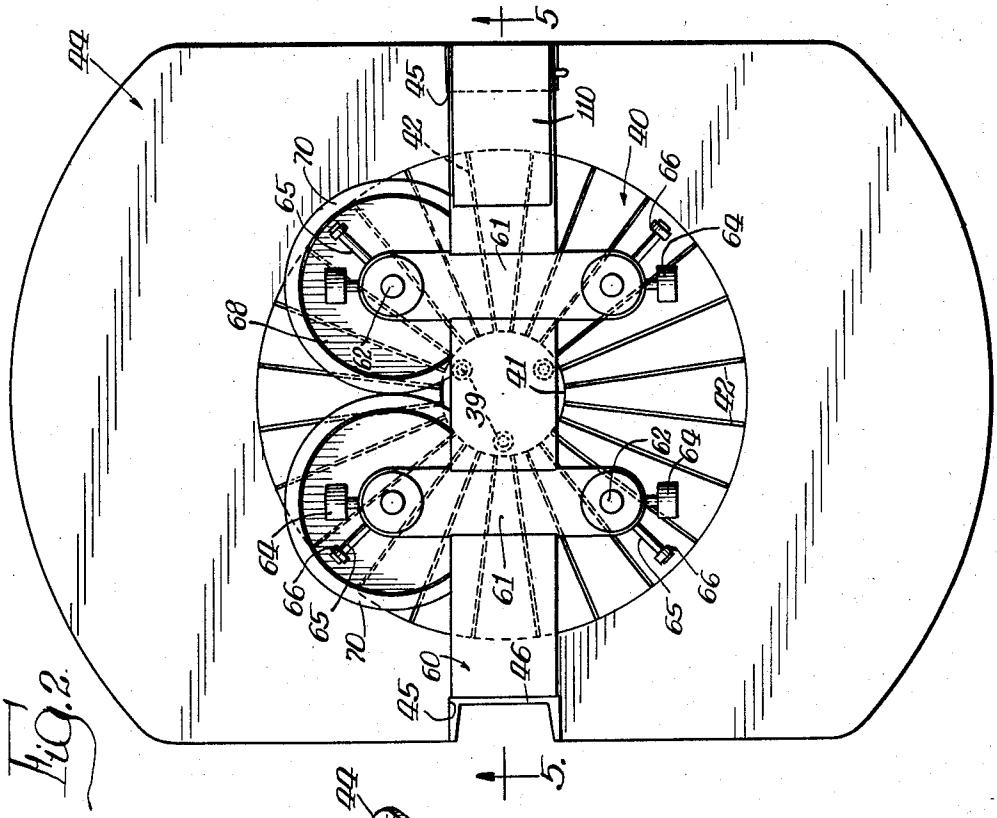


Fig. 2.

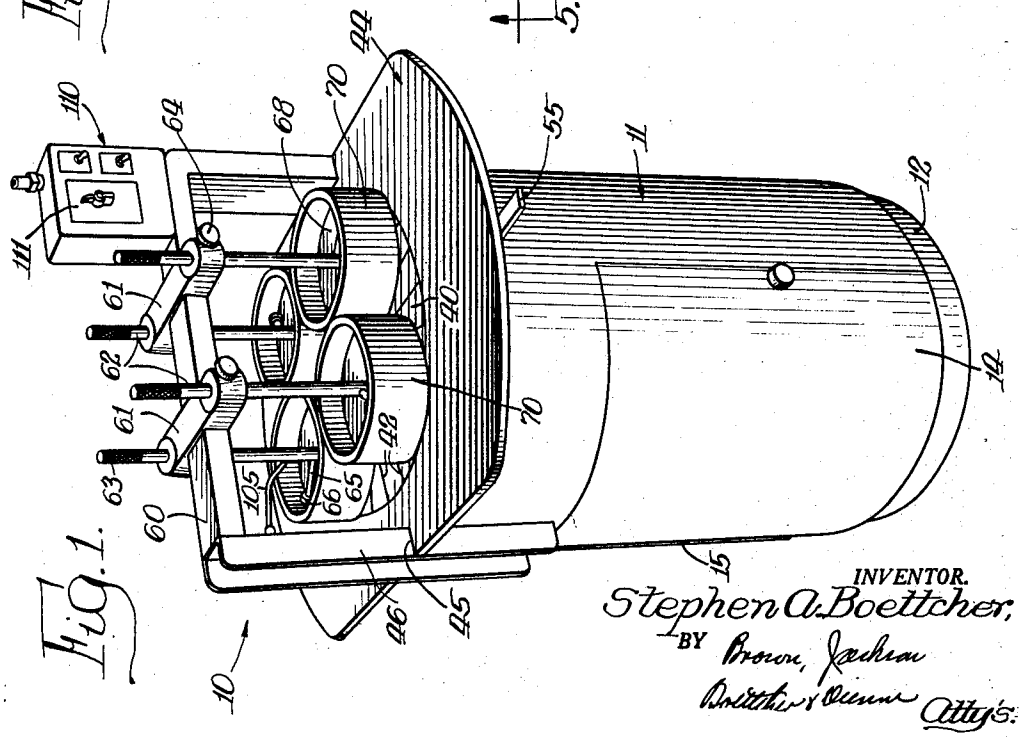


Fig. 1.

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Fig. 3.

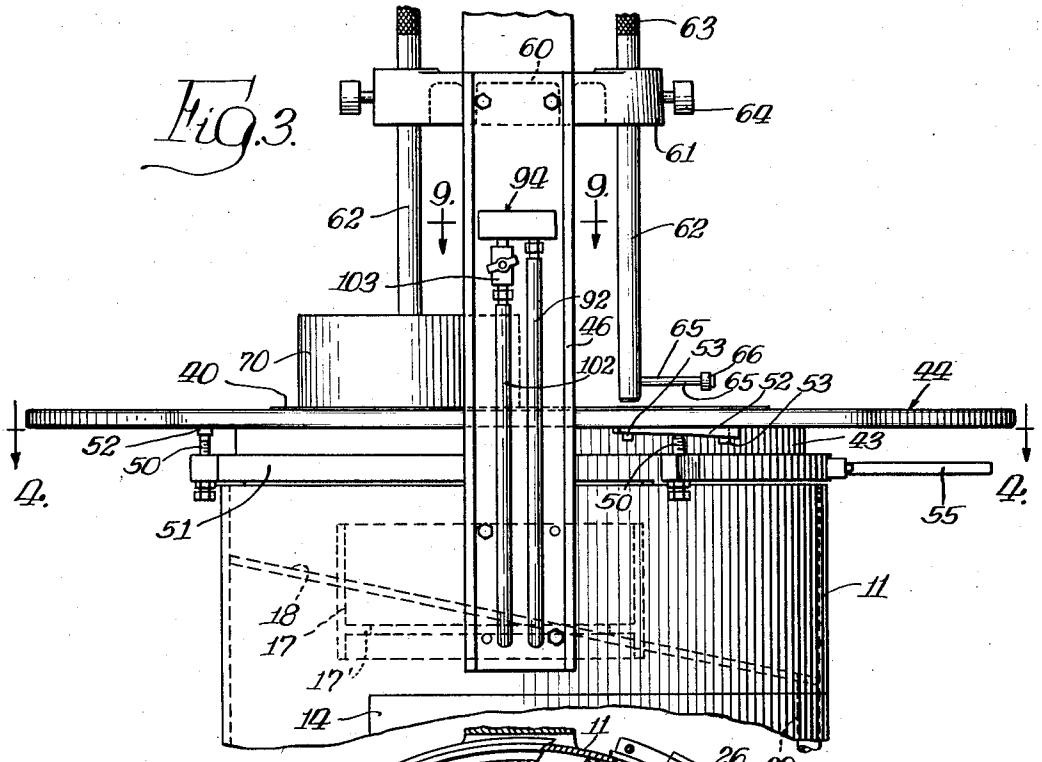
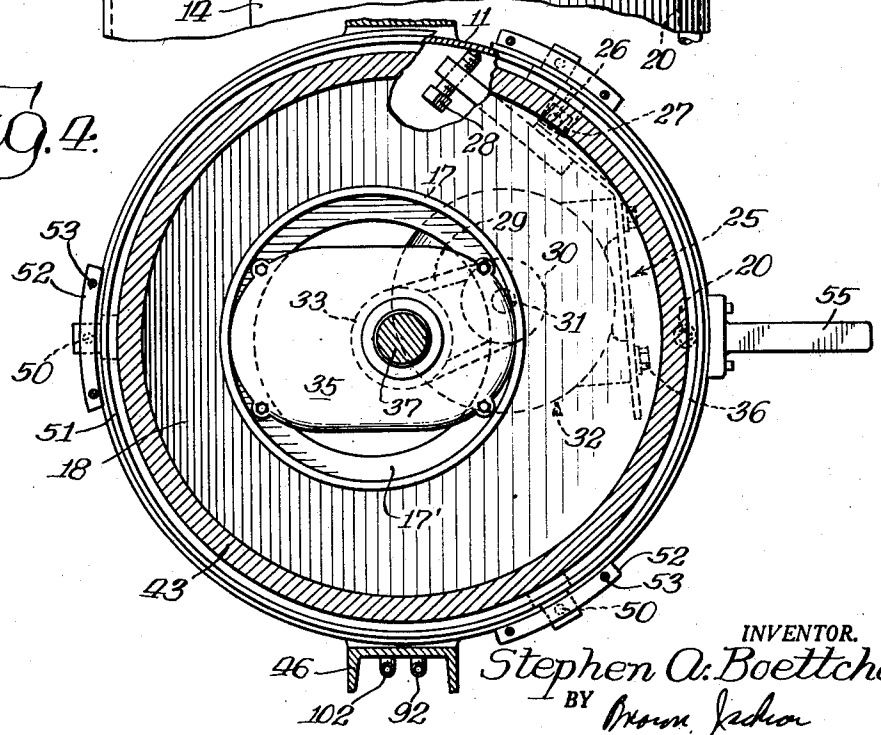


Fig. 4.



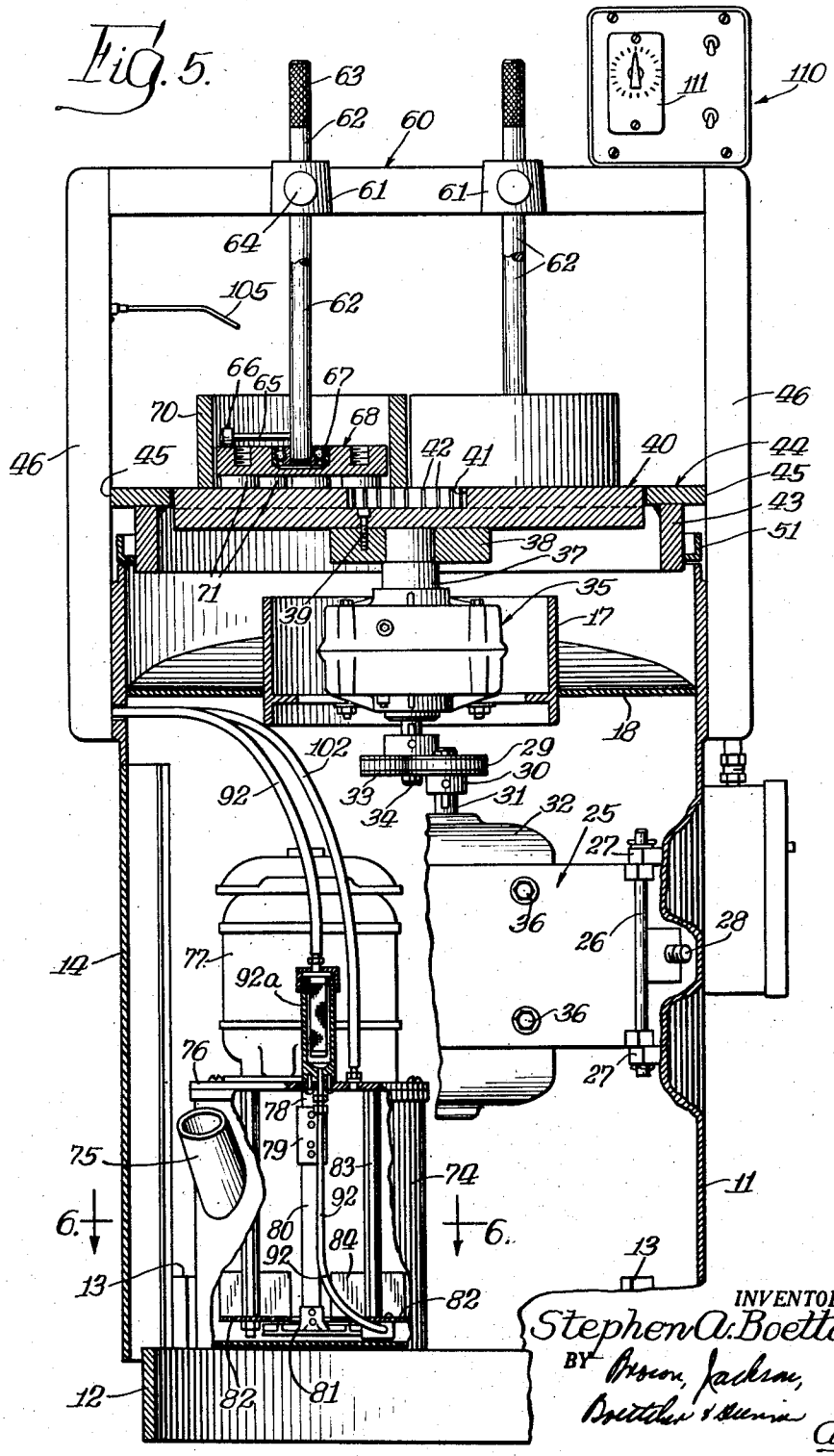
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Fig. 5.



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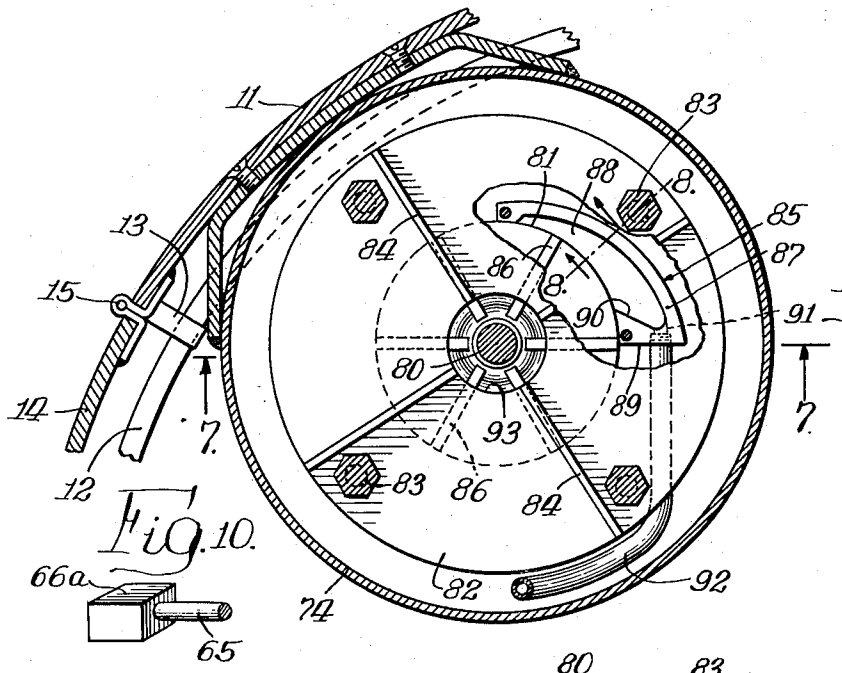


Fig. 6.

Fig. 10.

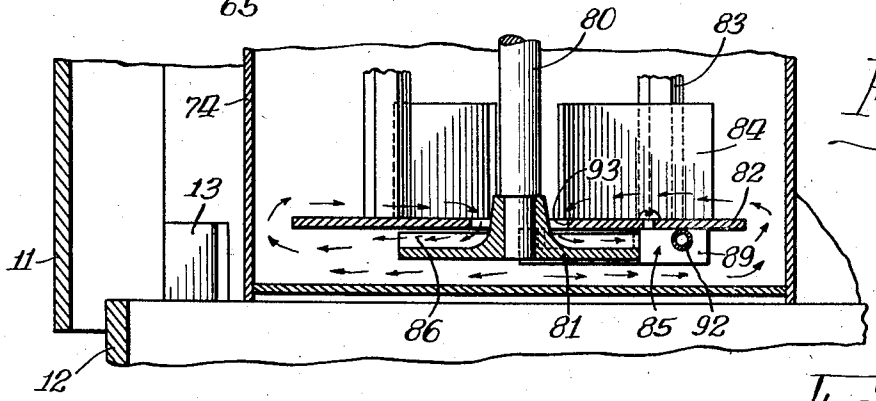


Fig. 7.

Fig. 9.

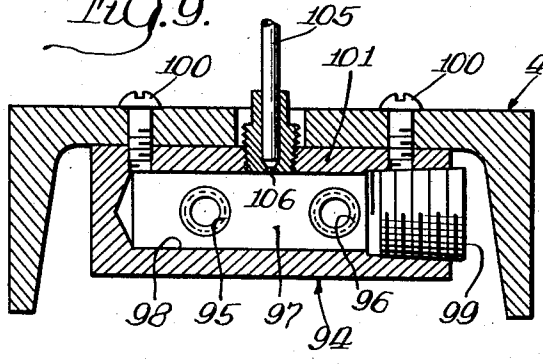
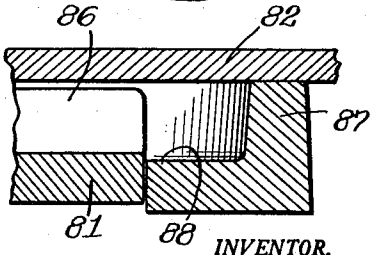


Fig. 8.



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2,912,799

LAPPING MACHINE

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Application June 28, 1956, Serial No. 594,416

9 Claims. (Cl. 51—131)

My invention relates to lapping machines and particularly to improvements in machines for lapping flat and parallel surfaces.

Numerous machines have been devised for producing flat lapped surfaces on machined, ground, or precision-cast work pieces. Generally, a lapping machine of the class to which the present invention pertains comprises a lapping wheel or plate, usually annular in configuration, which is rotated about a vertical axis and on which the work pieces are placed in confined position such that the movement of the lap wheel relative to the work pieces brings about abrasive wear of that surface of each work piece engaging the lap wheel to gain the desired surfacing. A prime consideration in a machine of this class is the maintenance of the lapping surface of the lap wheel itself in planar condition. It is well-known that the abrasive engagement of such lapping surface with the work pieces wears it unevenly, and, if that is not corrected, it ceases to serve its purpose.

In my invention, improved and simplified means are provided for keeping the lapping surface corrected to true planar condition, doing so substantially simultaneously with the lapping operation which creates the need of it.

Also, my invention provides improved means for loading and unloading work pieces onto and off of the lap wheel, eliminating excessive machine-idle time for the loading and unloading operation. I have devised a table means, hereinafter termed a staging table, which permits the operator to load work pieces to be lapped in spare retainer rings during the lapping of previously loaded pieces; at the termination of a given lapping period, when finished lap pieces are removed from the machine, the feeding of further work pieces is accomplished by merely transferring the preloaded work pieces from the staging table to the lapping wheel.

Of importance in the lapping of work pieces by a rotatable lapping plate is the provision of a suitable lapping grit carried by a suitable vehicle, such as oil. In prior machines, difficulty has been encountered in maintaining the abrasive particles in adequately uniform suspension within the carrier. As the removal of stock from the work pieces and the finish of their lapped surfaces are dependent not only on time, but also on the uniformity of the abrading operation, it is desirable to keep the lapping mixture homogeneous and available for controlled application. The improved lapping machine of my invention embodies means to this end.

My invention is also intended to simplify the structural aspects of a lapping machine, and the features in this regard will be evident from the detailed description to follow.

The machine has a drum-like cylindrical base or pedestal at the upper end of which is supported a horizontally disposed annular lapping wheel, rotatable about a vertical axis. A staging table is disposed in adjacent surrounding relationship to the lapping wheel, this staging table being readily shiftable up and down so that it can be set either slightly above or in or slightly below

the plane of the lapping surface of the lapping wheel. A bridge structure, above the lapping wheel, carries a plurality of vertical spindles, each of which, at its lower end, centers a circular weight plate, which in turn centers a retainer ring resting on the lapping wheel, the spindle also carrying a pressure member at its lower end to engage the corresponding weight plate. The retaining rings serve to confine the raw work pieces and to act as truing elements, the combined wear effect of the rings and the work pieces beneath the weight plates maintaining the surface of the lapping wheel in planar condition. The spindle members define rotational axes for the truing-retainer rings and the weight plates; the spindle members being adjustable vertically and angularly to regulate the pressure with which the underdisposed work pieces engage the lapping surface of the lapping wheel. Pump means are provided for constantly circulating the abrasive-carrying vehicle, and also means for selectively diverting desired amounts thereof to the lapping wheel to regulate the stock removal and finish of the work pieces.

In the drawings:

Figure 1 is a perspective illustration of the improved lapping machine of this invention;

Figure 2 is a plan view, on a somewhat larger scale, of the machine shown in Figure 1;

Figure 3 is a partial side elevational view, substantially on the scale of Figure 2, showing the upper portions of the machine illustrated in Figure 1;

Figure 4 is a horizontal cross-sectional view taken substantially at line 4—4 of Figure 3, looking down;

Figure 5 is a vertical cross-sectional view taken substantially at the vertical center line of the machine at right angle to the plane of Figure 3, looking to the left;

Figure 6 is a partial cross-sectional view taken substantially at line 6—6 of Figure 5, and on a somewhat larger scale, to show details of the improved pump means of my invention;

Figure 7 is a cross-sectional view taken substantially at line 7—7 of Figure 6 and looking in the direction of the arrows thereon;

Figure 8 is a partial cross-sectional view, on a larger scale, taken at line 8—8 of Figure 6 and looking in the direction of the arrows thereon to illustrate the particulars of an improved discharge scroll employed with the improved pumping mechanism shown in Figures 6 and 7;

Figure 9 is a cross-sectional view taken substantially at line 9—9 of Figure 3, and on a larger scale, looking in the direction of the arrows thereon, to illustrate the particulars on an improved manifold means employed for the selective discharge of liquids from the circulating system associated with the pump means of Figures 6 through 8, and

Figure 10 is a perspective view of a modification which will be referred to.

As seen in Figures 1–5, the improved machine of my invention is indicated generally by the numeral 10; such including a substantially cylindrical pedestal 11 supported by an underlying concentrically related base ring 12. Connection between base ring 12 and pedestal 11 is brought about by welding the same to intervening support lugs 13; there being at least three such lugs equally spaced about the ring 12. The pedestal 11 also includes an access door 14, hinged as at 15, which makes the interior of the pedestal accessible to the operator.

As shown best in Figures 3, 4 and 5 of the drawings, a cylindrical collar 17 is disposed within the upper end of pedestal 11; the same being mounted slightly off-center with respect to the longitudinal axis of the pedestal by means of an inclined, elliptically-shaped drip pan 18 securely welded at its outer periphery to the inside surface of the pedestal 11 and at its inner periphery to the outside surface of collar 17. Pan 18 is provided for the

purpose of catching abrasive and carrier mixture used in the lapping operation. A vertical down-spout 20 leads from the lower end of the drip pan 18 to return the recovered mixture to a removable tank (not shown) within the interior of the pedestal housing 11.

Mounted within the cylindrical interior confines of the pedestal 11 is a motor mount plate 25 carried by a vertical axle 26 mounted in brackets 27 secured to the pedestal wall. The motor mount plate 25 is bent at an angle, as best viewed in Figure 4, and carries an adjustable bolt member 28 adjacent its outer end for adjusting a V-belt 29 trained between a sheave wheel 30 mounted on armature shaft 31 of a main drive motor 32 and a second sheave wheel or pulley 33 mounted at the lower end of a shaft 34 of a conventional gear reducer unit indicated generally by numeral 35. Motor 32 is mounted to the motor mount plate 25 by means of plural stud connector bolts 36, as seen best in Figure 5 of the drawings. With this arrangement, the normal tension of the V-belt 29 tends to swing the motor 32 clockwise, as viewed in Figure 4, with the tension of such belt being regulated by adjusting the bolt means 28 engaged with the inside face of the pedestal housing 11.

The gear reducer unit 35 is mounted within the ring 17, resting on and bolted to the internal flange 17', with the output shaft 37 thereof carrying a hub member 38 keyed or otherwise rigidly fixed to the shaft 37 for rotation therewith. Hub 38, in turn, has secured thereto, as by screw means 39, rotatable lapping wheel or plate 40, supporting the same.

From Figures 2 and 5, in particular, it will be seen that the lapping wheel 40 comprises a circular wear-resisting metallic alloy disc with a central well-bore 41, providing an annular lapping area. A plurality of radial slots 42, 42 are cut downwardly to the depth of the well-bore from the upper lapping surface of the lap wheel, according to conventional practice, to trap and carry abrasive oil mixture fed to the lapping wheel for discharge to the drip pan 18.

Surrounding the lapping table 40 is a ring 43 upon which is mounted a planar staging table 44, said table having notched-out portions 45 at its opposite sides for loosely fitting about vertical channel columns 46, 46 mounted in upright position at diametrically opposite sides of the pedestal housing 11 and joined at the top by bridge member 60, hereinafter referred to. Said channel columns 46 act as guide means in notches 45 during vertical elevation and lowering of staging table 44.

The staging table is supported directly on three adjustable studs 50, 50, as best shown in Figures 3 and 4. The studs 50 are, in turn, carried on an angularly shiftable ring 51 resting upon the upper end of the pedestal housing 11, preferably by way of three-point contact, said ring 51 fitting about ring 43 all as shown in Figure 5. The upper ends of the adjustable studs 50 engage respective inclined cam blocks 52, secured by bolts 53 to the underside of table 44 and curved in horizontal plane to conform to the arc of the ring 51. Bolts 53 also serve as stops for limiting the arcuate travel of the ring 51 through engagement by studs 50.

Ring 51 has a handle 55 by which the operator may manipulate it about ring 43. By moving the handle 55 clockwise (viewing the machine from above as in Figure 2) the adjustable studs 50 are moved along the upward slope of the inclined cam blocks 52 to lower the staging table 44 slightly beneath the plane of the annular lapping surface presented by the lapping wheel 40. By reversing the direction of movement of the handle 55, the studs 50 move along the cam blocks 52 in reverse direction to raise the staging table 44 to coincide with or slightly exceed the plane of the lapping surface of the lapping wheel.

Mounted between the upright columns 46, 46 is a horizontal bridge member 60 (previously referred to) provided with two intermediary transverse arms 61, 61; the bridge member 60 being rigidly affixed, as by welding, to the upper ends of the columns. At the outer end of each of the arms 61, 61, is a vertical bore for receiving a vertical spindle 62; there being four such spindles in all in the embodiment of the invention illustrated in the drawings. Each of the spindles 62 has a knurled upper end 63 for manual grasping and each spindle rod can be held by a set-screw 64. By loosening the set-screws 64, the spindles are free to rotate and to slide vertically, and thus they can be adjusted both vertically and angularly.

Near the lower end, each spindle 62 is provided with a radially extending arm 65, at the outer end of which a roller 66 is mounted. The lower end of each spindle takes into a ball bearing 67 in the center of a circular weight plate 68, the spindle thus serving to define the axis of rotation of such weight plate.

The weight plates, normally four being used as illustrated in Figure 1, for example, fit, with slight clearance, within the truing-retainer rings 70. It will be noted in Figure 5, for example, that work pieces, indicated at 71, are arranged beneath the weight plates 68 and are positioned freely within the confines of the rings 70. Each spindle 62 is therefore associated with a weight plate and a truing-retainer ring, such elements cooperating in the lapping of a plurality of work pieces confined by the ring, with the vertical positioning of the spindle, as explained above, serving to regulate the amount and position of the pressure, other than that imposed by gravitational weight of the weight plate, at which the work pieces engage the surface of the lapping wheel. In operation, each ring and associated weight plate may rotate about the axis defined by the associated spindle, altogether controllably serving accurately to lap the lower surfaces of the work pieces and continuously to dress the lapping wheel for maintenance of its planar condition.

I have found that some lapping actions are enhanced by substituting a plain friction block 66*a* (Fig. 10), of wood or other material having similar effect, for the roller 66, said friction element braking the rotation of the weight plate 68, and my invention contemplates such substitution where advantageous.

To this point, I have described the improved lapping machine of my invention, with the exception of the means for supplying the abrasive and carrier mixture to the work articles as they are engaged by the lapping wheel. Such means will now be discussed.

As shown in Figure 5, a cylindrical tank 74 is suitably mounted within the pedestal 11. Such tank constitutes a sump well for the novel abrasive and carrier mixture circulating means of the present invention. The tank 74 is equipped with a filling spout 75 and is closed off at its top by a plate 76 upon which is mounted a pump motor 77 having an armature shaft 78 which is coupled, as at 79, to an extended impeller shaft 80. At the lower end of the impeller shaft 80 is mounted a vane type centrifugal impeller 81 which is disposed beneath a baffle plate 82 carried by vertical rods 83 depending from the cover plate 76. Baffles 84 project upwardly from plate 82 in radial relation to the axis of shaft 80; these details are best illustrated in Figures 6 and 7 of the drawings.

It will be seen that the impeller 81 works beneath the baffle plate 82 constantly to circulate the abrasive and carrier mixture within the tank 74 and to centrifugally impact the same against a partial scroll member 85 disposed beneath the baffle plate 82 and adjacent a portion of the periphery of the impeller 81; the impeller 81 has vanes 86 which throw the mixture peripherally outward, a portion into the scroll member 85. Figure 8 is a cross-sectional showing of the scroll member 85, constituting a curvilinear outer wall 87, a bottom wall 88 of flaring formation, and an end wall 89, best shown in Figure 6, having a pocket 90 for trapping mixture centrifugally thrown against the wall 87. At the apex of the pocket

90 is an opening 91 communicating with a discharge tube 92.

One of the features of this scroll impeller is its relationship to the baffle plate 82 which is formed with a central opening 93, for the passage of the shaft 80 and hub of impeller 81, enlarged for circulatory purposes, as will be noted from the arrows in Figure 7. This circulation keeps the mixture agitated and the abrasive particles in adequately uniform suspension in the carrier.

The centrifugal impact of the mixture into the scroll member 85 effectively drives it through the discharge tube 92, which includes the lint filter 92*a* and leads upwardly and outwardly through the wall of pedestal 11 and upwardly along one of the columns 46, as illustrated in Figures 5 and 3.

As shown in Figure 3, the discharge tube 92 terminates at a distributor manifold 94 located within the channel column 46 and which is shown in cross-section in Figure 9 of the drawings. The manifold 94 is formed as a prismatic block having openings 95 and 96 in its lower wall 97. A bore 98 is formed in the block 94; the same being closed by plug 99. Screws 100 hold the manifold block 94 in the channel column 46. The tube 92 leads into the opening 96. Also communicating with the bore 98 is a return line 102 leading from the opening 95 back to the tank 74, thus completing the pump circuit. A valve 103 is located in line 102, conveniently adjacent the manifold block 94.

Leading from the wall 101 of manifold 94, and passing through the web wall of the column 46, is a valveless bleed-off tube 105 disposed in overhanging relation to the lapping wheel 40. Such bleed-off line is to permit restricted feed of the circulating abrasive mixture passing through the manifold 94 to the surface of the lapping wheel, drop by drop, the same being gauged by the valveless orifice 106 at inner end of the tube 105, as seen in Figure 9 of the drawings.

The valve 103 in the return line 102 serves as a means for regulating the back pressure on the centrifugal pump; and, by regulating the opening of this valve, the amount of mixture delivered, by the effect of the centrifugally acting impeller 81, to the discharge line 92 is correspondingly regulated.

In order to control the energization of the drive motor 32 and the pump motor 77, I equip my machine with a conventional timing switch 110, conveniently mounted on the bridge member 60. The timer section 111 of the switch serves to regulate the length of lapping time, and suitable electrical interconnection is made between such timer and the motors 32 and 77, so that, at the expiration of a given preselected lapping period, both the drive motor 32 and pump motor 77 are automatically shut down.

I have illustrated and described a specific embodiment of my invention, and it is to be understood that modifications may be made, or equivalents substituted, without departing from its spirit and scope; consequently, while I make claims to the specific construction, I also make claims of such scope as to include such modifications and equivalent substitutions.

I claim:

1. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface, a retaining and truing ring resting on said lapping surface, a weight plate fitting with close clearance in said ring and adapted to rest on work pieces confined in said ring and resting on said lapping surface, said framework having a supporting member above said disk, a vertically and angularly adjustable fixed-axis spindle mounted on said supporting member and centering said weight plate, and an arm extending radially from said spindle and carrying a member engaging said weight plate radially outward of said spindle adjustably to exert pressure on said weight plate in an axially selected location.

2. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface, a retaining and truing ring resting on said lapping surface, a weight plate fitting with close clearance in said ring and adapted to rest on work pieces confined in said ring and resting on said lapping surface, said framework having a supporting member above said disk, a vertically and axially adjustable fixed-axis spindle mounted on said supporting member and entering a roller bearing in the center of said weight plate, and an arm extending radially from said spindle and carrying a member engaging said weight plate radially outward of said spindle adjustably to exert pressure on said weight plate in an angularly selected location.

3. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface, a retaining and truing ring resting on said lapping surface, a weight plate fitting with close clearance in said ring and adapted to rest on work pieces confined in said ring and resting on said lapping surface, said framework having a supporting member above said disk, a spindle supported by said supporting member and centering said weight plate, and means supported by said framework engaging said weight plate radially outward of said spindle adjustably to exert pressure on said weight plate in an angularly selected location.

4. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface, a retaining and truing ring resting on said lapping surface, a weight plate fitting with close clearance in said ring and adapted to rest on work pieces confined in said ring and resting on said lapping surface, said framework having a supporting member above said disk, a vertically and axially adjustable fixed-axis spindle supported by said supporting member and centering said weight plate, and an arm extending radially from said spindle and carrying a friction block pressing on said weight plate.

5. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface, a retaining and truing ring resting on said lapping surface, a weight plate fitting with close clearance in said ring and adapted to rest on work pieces confined in said ring and resting on said lapping surface, said framework having a supporting member above said disk, a spindle supported by said supporting member and centering said weight plate, and means for braking the rotation of said weight plate.

6. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface, a retaining and truing ring resting on said lapping surface, a weight plate fitting with close clearance in said ring and adapted to rest on work-pieces confined in said ring and resting on said lapping surface, said framework having a supporting member above said disk, a spindle supported by said supporting member and centering said weight plate, and means carried by said spindle for braking the rotation of said weight plate.

7. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface adapted for the reception of work-piece retaining rings, said surface, in operation, forming the sole support for work-pieces in such retaining ring, a planar staging table mounted in juxtaposition to said disk with its feeding and receiving surface substantially at the level of said lapping surface, quick-acting means for moving said staging table vertically from a position slightly above to a position slightly below the plane of said lapping surface and vice versa, and means for fixing the limits of such

movement, whereby to aid the sliding of such rings containing work-pieces from said staging table to said lapping surface and vice versa.

8. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface adapted for the reception of work-piece retaining rings, said surface, in operation, forming the sole support for work-pieces in such retaining ring, a planar staging table mounted in juxtaposition to said disk with its feeding and receiving surface substantially at the level of said lapping surface, quick-acting means for moving said staging table vertically from a position slightly above to a position slightly below the plane of said lapping surface and vice versa, means for fixing the limits of such movement, whereby to aid the sliding of such rings containing work-pieces from said staging table to said lapping surface and vice versa, and means for adjusting the height of said limited movement to wear of said lapping surface.

9. In a lapping machine, a framework, a disk mounted on said framework on a vertical axis, means for rotating said disk, said disk having a horizontal planar lapping surface adapted for the reception of work-piece retaining rings, said surface, in operation, forming the sole support for work-pieces in such retaining ring, an angularly

shiftable element mounted on said framework concentrically with said disk, a planar staging table mounted in juxtaposition to said disk with its feeding and receiving surface substantially at the level of said lapping surface, said staging table being supported from said angularly shiftable element through camming means, whereby, upon the shifting of said element, said staging table is moved vertically from a position slightly above to a position slightly below the plane of said lapping surface and vice versa.

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