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L. O. DAY ET AL  
LAPPING MACHINES

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3 Sheets-Sheet 1

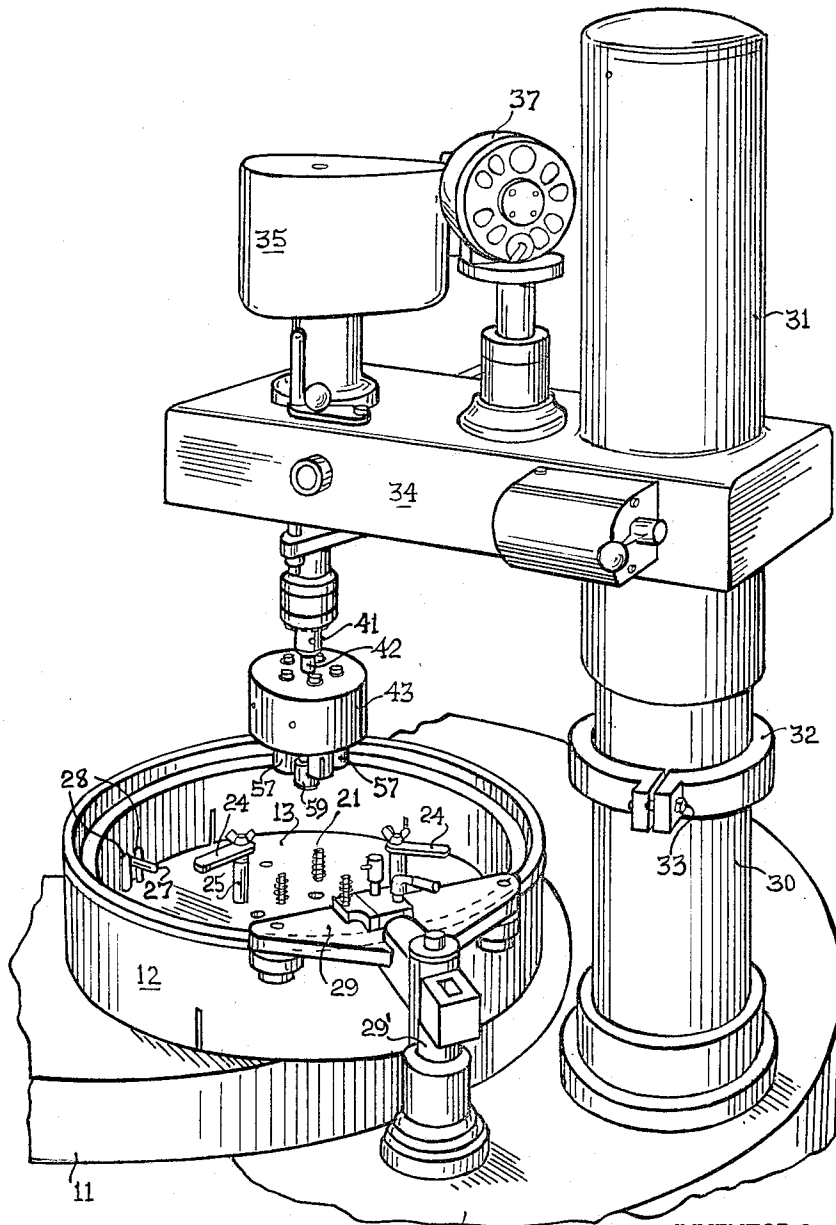


Fig. 1.

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Fig. 3.

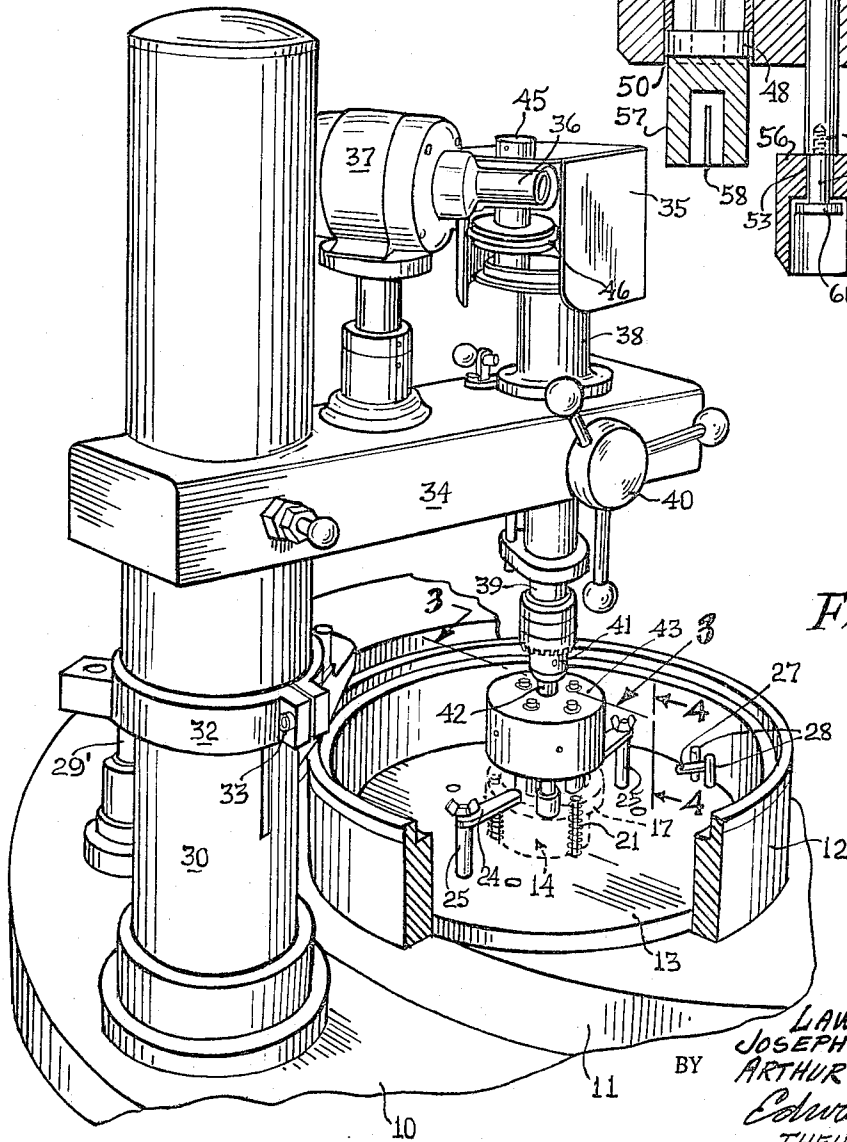
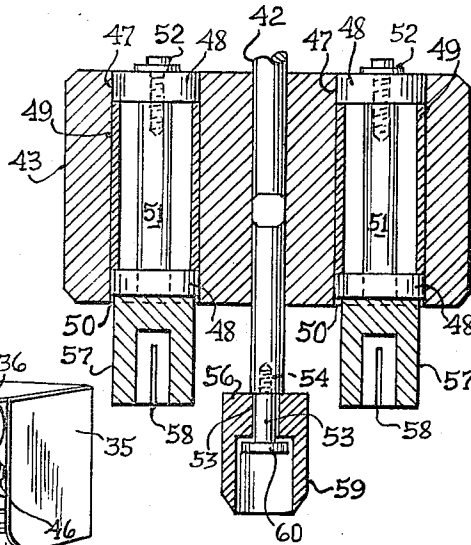


Fig. 2.

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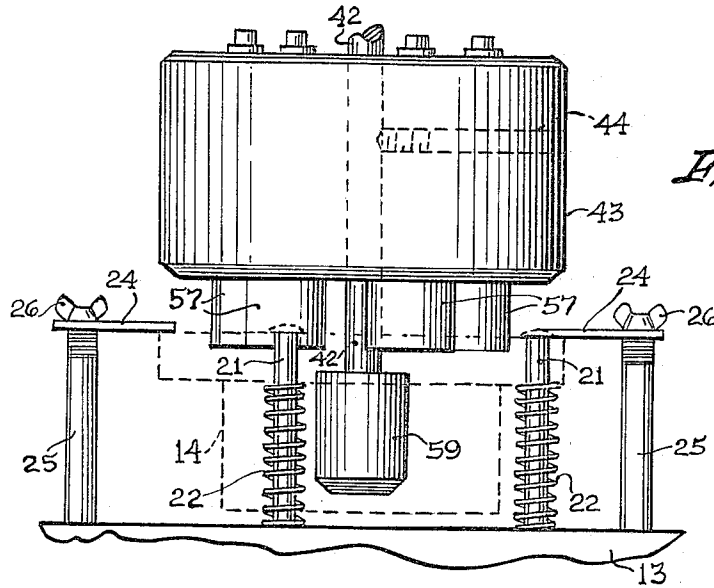
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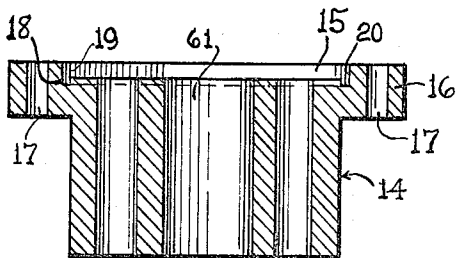
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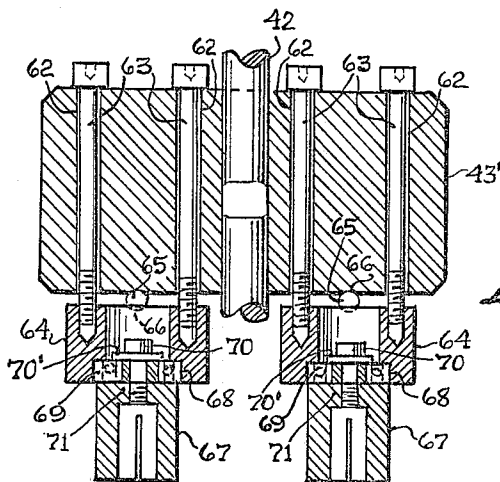
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*Fig. 4.*



*Fig. 6.*



*Fig. 5.*

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3,284,960

## LAPPING MACHINES

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Filed Jan. 6, 1964, Ser. No. 335,823  
6 Claims. (Cl. 51—120)

Our invention relates to lapping machines. More particularly our invention relates to a device for lapping the recessed surface of a workpiece.

Our invention contemplates a lapping machine in which we utilize a plurality of lapping heads arranged radially with respect to each other and which are rotatable circumferentially within the recessed end of a workpiece in lapping engagement with the surface to be lapped, the lapping heads preferably being cup-shaped and each having one or more vertical slots for better cutting or abrading action and distribution of the abrasive over the surface to be lapped.

An object of our invention is to provide a plurality of radially arranged lapping heads individually rotatable and supported by a reversible rotatable mounting block effectively to maintain flat contact between the tapping heads and the workpiece. In this connection, the invention contemplates rotating the lapping heads circumferentially with respect to the axis of rotation of the mounting block and individually rotating the lapping heads about their respective axes by the combined rotation of the mounting block and the workpiece being lapped.

Other objects will appear hereinafter.

The invention consists in the novel combination and arrangement of parts to be hereinafter described and claimed.

The invention will be best understood by reference to the accompanying drawings showing the preferred form of construction, and in which:

FIG. 1 is a fragmentary perspective view of a lapping machine showing our invention associated therewith;

FIG. 2 is a fragmentary perspective view similar to FIG. 1, but showing the device in lapping position upon a workpiece;

FIG. 3 is a sectional detail view taken on line 3—3 of FIG. 2;

FIG. 4 is a fragmentary elevational view taken substantially on line 4—4 of FIG. 2;

FIG. 5 is a sectional detail view similar to FIG. 3, but showing a modified form of construction;

FIG. 6 is a sectional detail view of a workpiece having a recessed surface which is to be lapped.

Conventional lapping machines, such, for example, as shown in our Patent No. 2,895,261, dated July 21, 1959, include a base 10 rotatably supporting a lap table 11, which is rotated by a conventional electric motor. Supported on the lap table 11 is a dressing or work-holding ring 12. In conventional lapping machines, such as shown in our aforesaid patent, there are usually provided at least three of such dressing or work rings, 12. While we have shown in the drawings but one of the work holders 12, it is to be understood that the usual number may be employed.

In the work-holding ring 12, we position a disc 13 which is preferably formed of non-lapping material. The disc 13 supports the workpiece 14 which is to have a surface thereof lapped. In FIG. 6 we have illustrated a workpiece 14 which includes a recessed surface 15 which is to be lapped. The workpiece 14 need not be of the form and design shown in FIG. 6, but may assume various different forms which have a recessed surface to be lapped. The workpiece shown in FIG. 6 is therefore merely for illustrative purposes.

The workpiece 14 inches a flange 16 provided with a

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plurality of radially disposed openings 17. Extending around the peripheral edge of the surface 15 is a groove 18. The groove 18 permits the lapping heads 57 to overlap the peripheral edge 19 without engaging the walls 20 of the groove 18. If such engagement were permitted, the lapping heads might undercut the walls 20.

Fixedly carried by the disc 13 are a plurality of radially disposed stud posts 21 each encircled by an expansion spring 22. These studs are adapted to be inserted through adjacent openings 17 of the workpiece 14 so as to provide a spring seat for the workpiece 14 and to yieldably exert the same in the direction of the lapping heads 57. Such springs 22 also permit the workpiece to be self-adjustable with respect to the lapping heads so that there will always be a flat contact between the lapping heads 57 and the recessed surface 15.

Suitable work-holding fingers 24 are provided to hold the workpiece 14 in position. These fingers 24 are mounted upon posts 25 carried by the disc 13 and attached to the posts 25 by wing nuts 26. The disc 13 rotates with the ring 12. This is accomplished by providing a lateral stud 27 carried by the ring 12 and projected between vertical studs 28 carried by the disc 13.

The ring 12 is retained upon the lap table 11 and prevented from moving circumferentially therewith by a suitable holding device 29 such as shown and described in our aforesaid Patent No. 2,895,261, and which includes a supporting post 29' carried by the base 10 and by which the holding device 29 is pivotally supported. This holding device constitutes no part of the present invention.

On the base 10 is fixedly supported a vertical standard 30 comprising an upper sleeve section 31 adjustable with respect thereto. A retaining ring 32 is provided on the standard 30 and is clamped by means of clamping screws or bolts 33 in a predetermined position, which position permits proper lapping engagement between the lapping heads 57 and the surface of the workpiece 14 to be lapped.

Extending laterally from the sleeve section 31 is a supporting arm 34 which supports a gear train housing 35, the gears of which operatively mesh with a gear bearing shaft 36 of a motor 37 supported by the arm 34. A shaft sleeve 38 is supported by the arm 34, and journaled in this shaft sleeve 38 is a shaft 39 which may be adjusted vertically within limits by an adjusting hand wheel 40. The end of the shaft 39 carries a chuck 41 which is adapted to receive one end of a shaft 42 (FIGS. 2 and 4). This shaft 42 is positioned through a mounting block 43 and is secured thereto by a set screw or bolt 44.

The motor 37 is of the reversible type, so as to rotate the mounting block in opposite directions, for the reasons explained hereinafter. The shaft 39 may be connected to the gear-driven shaft 45 by a belt and pulley arrangement 46.

The means for rotating the mounting block 43 may be of any conventional type, the principal object being to rotate the mounting block 43 in opposite directions. Formed in the mounting block 43 is a plurality of openings 47 arranged radially with respect to the vertical axis of the block. In each end of each opening 47 is press-fitted a suitable bearing 48. Between the bearings 48 there is arranged within each of the openings 47 a spacer sleeve 49. The lower bearing 48 is inset in the opening 47 as at 50.

Supported for rotation by the bearings 48 and a shoulder screw 52 as shown in FIG. 3, is a shaft 51 extending through the sleeve 49. Such shaft 51 is formed as an integral part of a lapping head 57 which, together with the shaft 51, is freely rotatable with respect to the mounting block 43 and relative to the bearings 48. Each of the lapping heads 57 (there being in the instant case five of such lapping heads shown) are of inverted cup-shaped formation and each has its vertical walls provided with

several vertical slots 58. Such slots 58 provide better cutting or abrading action and distribution of the abrasive material which is deposited on the surface 15 of the workpiece being lapped.

The shaft 42 at its lower end portion carries a pilot head 59 as shown in FIG. 3, the pilot head 59 being attached to the lower end portion of the shaft 42 by a shoulder screw 60 having a shank 53 and a reduced thread-bearing stud 54 threaded into the lower end portion of the shaft 42. The shank 53 passes through an opening 55 formed in the end wall 56 of the pilot head 59. The shank 53 is of a length slightly greater than the thickness of the end wall 56 of the pilot head 59 and of a diameter slightly less than the diameter of the opening 55 formed in the wall 56 of the pilot head. Such arrangement permits free and uninterrupted rotation of the pilot head 59 relative to the shaft 42. The pilot head 59 is adapted to project into a central bore or opening 61 of the workpiece 14 (FIG. 6) so as to locate and retain the workpiece 14 concentrically with respect to the lapping heads 57.

In FIG. 5 we have shown a modified form of construction. In the form of construction shown in FIG. 5, the mounting block 43' is carried by the shaft 42 in the same manner as heretofore described and as shown in FIG. 3. Formed in the block 43 are several pairs of openings 62 through which project head-bearing bolts 63, lower ends of which are threaded into collars 64 as seen in FIG. 5. Interposed between the collars 64 and the block 43' are ball bearings 65 preferably set in sockets 66. By adjusting one of the bolts 63 relative to the collar 64, such collar may be tilted with respect to the block 43' so as to vertically align a lapping head 67 carried by the collar. Formed in the collar 64 is a countersunk opening 68 into which is press-fitted a ball bearing unit 69.

The lapping head 67 is supported by the ball-bearing unit 69 for free rotation through the medium of a shoulder screw 70 threaded into the end wall 71 of the lapping head 67, which end wall 71 projects into the center opening of the ball bearing unit 69 and on the top surface of which end wall 71 a washer 70' lies.

The operation is as follows: A workpiece 14 having a recessed surface 15 which is to be lapped is mounted on the posts 21 in the manner shown in FIG. 2, and upon the springs 22. The holding fingers 24 are then positioned upon the workpiece to hold the same in such position. The shaft 39 by operation of the hand wheel 40 and by means well known in the art is lowered to position the pilot head 59 in the opening 61 of the workpiece 14 so as to concentrically locate the workpiece with respect to the shaft 42. This lowering of the shaft 42 will simultaneously lower therewith the mounting block 43. The lowering of the mounting block 43 will project the lapping heads 57 into the recess 15 of the workpiece 14 with the bottom surfaces of the lapping heads 57 in contact with the surface 15 to be lapped. Should the workpiece 14 be tilted from a horizontal position upon the disc 13, the engagement of the lapping heads 57 with the surface 15 will tilt the workpiece 14 to a substantially horizontal position, such tilting being permitted by the expansion springs 22. With the lapping heads 57 in contact with the surface 15, the motor 37 is operated to rotate in one direction the block 43 and the lapping heads carried thereby.

Simultaneously with this operation, the lapping table 11 is caused to rotate and in so doing imparts rotation to the rings 12. As the rings 12 are keyed to the disc 13 by the studs 27 and 28, the disc 13 will rotate with the rings 12. Rotation of the disc 13 imparts rotation to the workpiece 14.

For the most effective lapping, it is desirable that the lapping heads 57 rotate faster than the workpiece 14 so that abrading action will effectively take place. The lapping heads 57 continue to rotate in a clockwise direction for a predetermined period of time, at the end of which the surface of the workpiece is checked for flatness.

If it is found that the surface has become convex, the lapping heads 57 are rotated in an opposite direction for a predetermined time, at the end of which the surface being lapped is again checked for flatness.

At the beginning of the operation, it is desirable that the operator check the condition of the surface to be lapped so that if he finds that it is convex or concave, he will effect rotation of the lapping heads 57 in the proper direction to correct such condition and to produce the desired substantially flat surface. Thus, by alternating the direction of rotation of the lapping heads, a substantially flat surface may be produced.

It is to be understood that during the lapping operation, a suitable abrasive material is applied to the surface being lapped.

Our invention as described herein may be incorporated as a part of any conventional flat lapping machine. Its construction permits effective lapping of recessed surfaces of workpieces.

An important feature of our invention lies in the fact that the rotation of the lapping heads is concentrically about their vertical axes by engagement with the surface being lapped, and they are rotated concentrically with respect to the long axis of the operating shaft. In addition, the work rotates at the same time that the lapping heads are rotated in the above stated direction. Such movements results in a refined lapping of a recessed surface.

While we have illustrated and described the preferred form of construction for carrying our invention into effect, this is capable of variation and modification without departing from the spirit of the invention. We therefore do not wish to be limited to the precise details of construction set forth, but desire to avail ourselves of such variations and modifications as come within the scope of the appended claims.

Having thus described our invention, what we claim as new and desire to protect by Letters Patent is:

1. A lapping machine for lapping the recessed surface of a workpiece, comprising
  - (a) a table rotatable about a vertical axis,
  - (b) a ring supported on the surface of the table for rotation relative to the table about a vertical axis spaced from the vertical axis of said table,
  - (c) means for retaining said ring against rotation about said table axis but not about said ring axis,
  - (d) a disc arranged in said ring for rotation therewith,
  - (e) means provided by said disc for holding the workpiece thereon,
  - (f) a plurality of concentrically arranged lapping heads engaging said recessed surface for lapping the same,
  - (g) and means for rotating the lapping heads concentrically over and in contact with said recessed surface.
2. A lapping machine for lapping the recessed surface of a workpiece, comprising
  - (a) a table rotatable about a vertical axis,
  - (b) a ring supported on the surface of the table for rotation relative to the table about a vertical axis spaced from the vertical axis of said table,
  - (c) means for retaining said ring against rotation about said table axis but not about said ring axis,
  - (d) a disc arranged in said ring and keyed thereto for rotation therewith,
  - (e) means provided by said disc for holding the workpiece thereon,
  - (f) a rotatable mounting block,
  - (g) a plurality of concentrically arranged lapping heads carried by said mounting block and engaging said recessed surface for lapping the same,
  - (h) and means for rotating the mounting block relative to said workpiece to move the lapping heads concentrically over and in contact with said recessed surface.

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3. A lapping machine for lapping the recessed surface, of a workpiece, comprising
- (a) a table rotatable about a vertical axis,
  - (b) a ring supported on the surface of the table for rotation relative to the table about a vertical axis spaced from the vertical axis of said table, 5
  - (c) means for retaining said ring against rotation about said table axis but not about said ring axis,
  - (d) a supporting means arranged in said ring for rotation therewith, 10
  - (e) means provided by said supporting means for holding the workpiece thereon,
  - (f) a plurality of concentrically arranged lapping heads engaging said recessed surface for lapping the same,
  - (g) and means for reversibly rotating the lapping heads concentrically over and in contact with said recessed surface. 15
4. A lapping machine for lapping the recessed surface of a workpiece, comprising
- (a) a table rotatable about a vertical axis, 20
  - (b) a ring supported on the surface of the table for rotation relative to the table about a vertical axis spaced from the vertical axis of said table,
  - (c) means for retaining said ring against rotation about said table axis but not about said ring axis, 25
  - (d) a supporting means arranged in said ring and keyed thereto for rotation therewith,
  - (e) means provided by said supporting means for holding the workpiece thereon,
  - (f) a rotatable mounting block, 30
  - (g) a plurality of concentrically arranged lapping heads carried by said mounting block and engaging said recessed surface for lapping the same,
  - (h) and means for reversibly rotating the mounting block relative to said workpiece to move the lapping heads concentrically over and in contact with said recessed surface. 35
5. A lapping machine for lapping the recessed surface of a workpiece, comprising
- (a) a table rotatable about a vertical axis, 40
  - (b) a ring supported on the surface of the table for rotation relative to the table about a vertical axis spaced from the vertical axis of said table,
  - (c) means for retaining said ring against rotation about said table axis but not about said ring axis, 45

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- (d) a disc arranged in said ring for rotation therewith,
  - (e) means provided by said disc for holding the workpiece thereon,
  - (f) a plurality of concentrically arranged lapping heads engaging said recessed surface for lapping the same,
  - (g) means for rotating the lapping heads concentrically over and in contact with said recessed surface,
  - (h) and means for retaining said recessed surface in proper lapping contact with said lapping heads.
6. A lapping machine for lapping the recessed surface of a workpiece, comprising
- (a) a table rotatable about a vertical axis,
  - (b) a ring supported on the surface of the table for rotation relative to the table about a vertical axis spaced from the vertical axis of said table,
  - (c) means for retaining said ring against rotation about said table axis but not about said ring axis,
  - (d) a disc arranged in said ring and keyed thereto for rotation therewith,
  - (e) means provided by said disc for holding the workpiece thereon,
  - (f) a rotatable mounting block,
  - (g) a plurality of concentrically arranged lapping heads carried by said mounting block and engaging said recessed surface for lapping the same,
  - (h) and means for rotating the mounting block relative to said workpiece to move the lapping heads concentrically over and in contact with said recessed surface,
  - (i) and means for retaining said recessed surface in proper lapping contact with said lapping heads.

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