April 2, 1957 G. PETERSON 2,787,090

LAPPING MACHINE

Filed Sept. 9, 1955 4 Sheets-Sheet 1

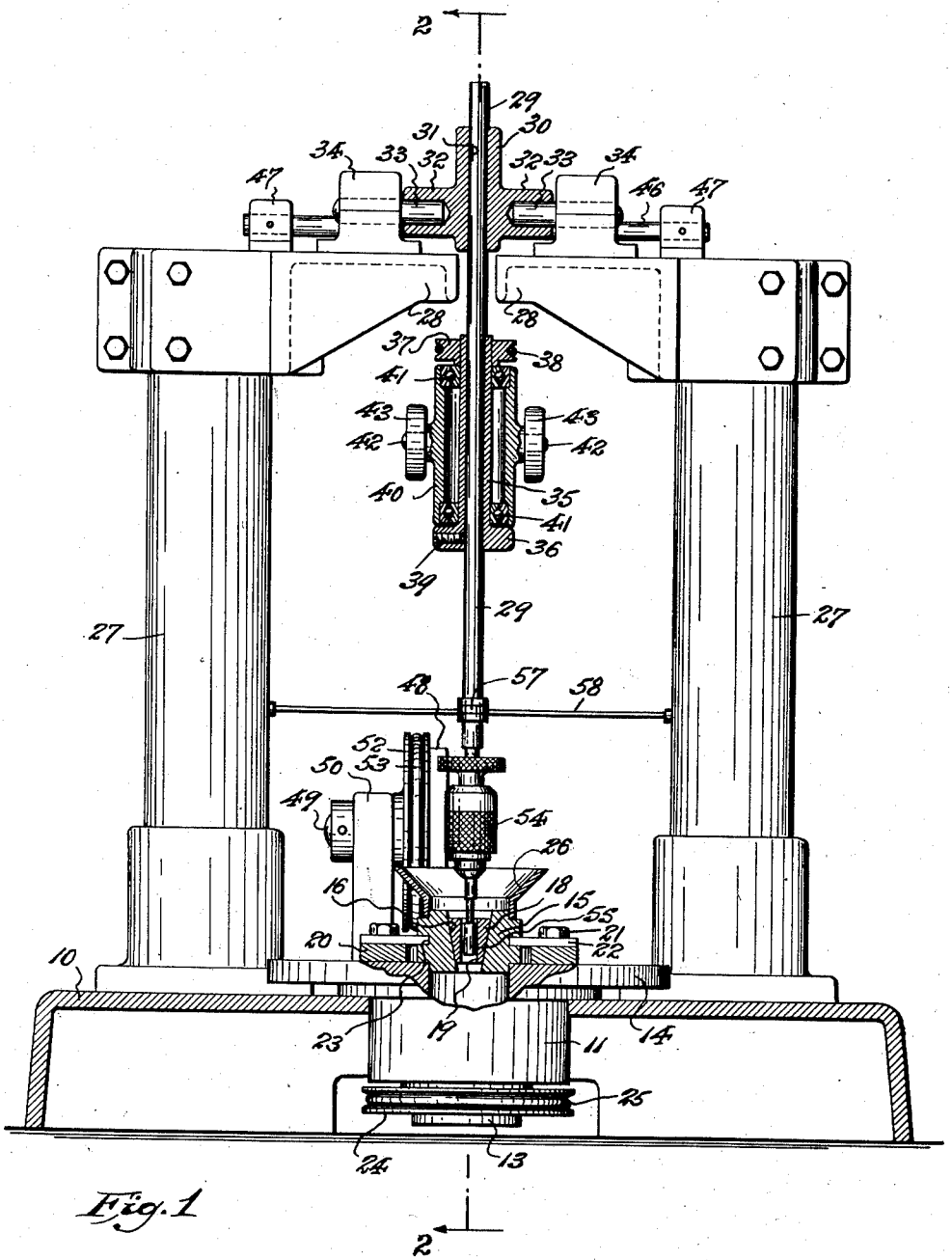



Fig. 1

INVENTOR.
Gustav Peterson,
BY
Georges D. Richards
Attorney

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LAPPING MACHINE

Filed Sept. 9, 1955 4 Sheets-Sheet 2

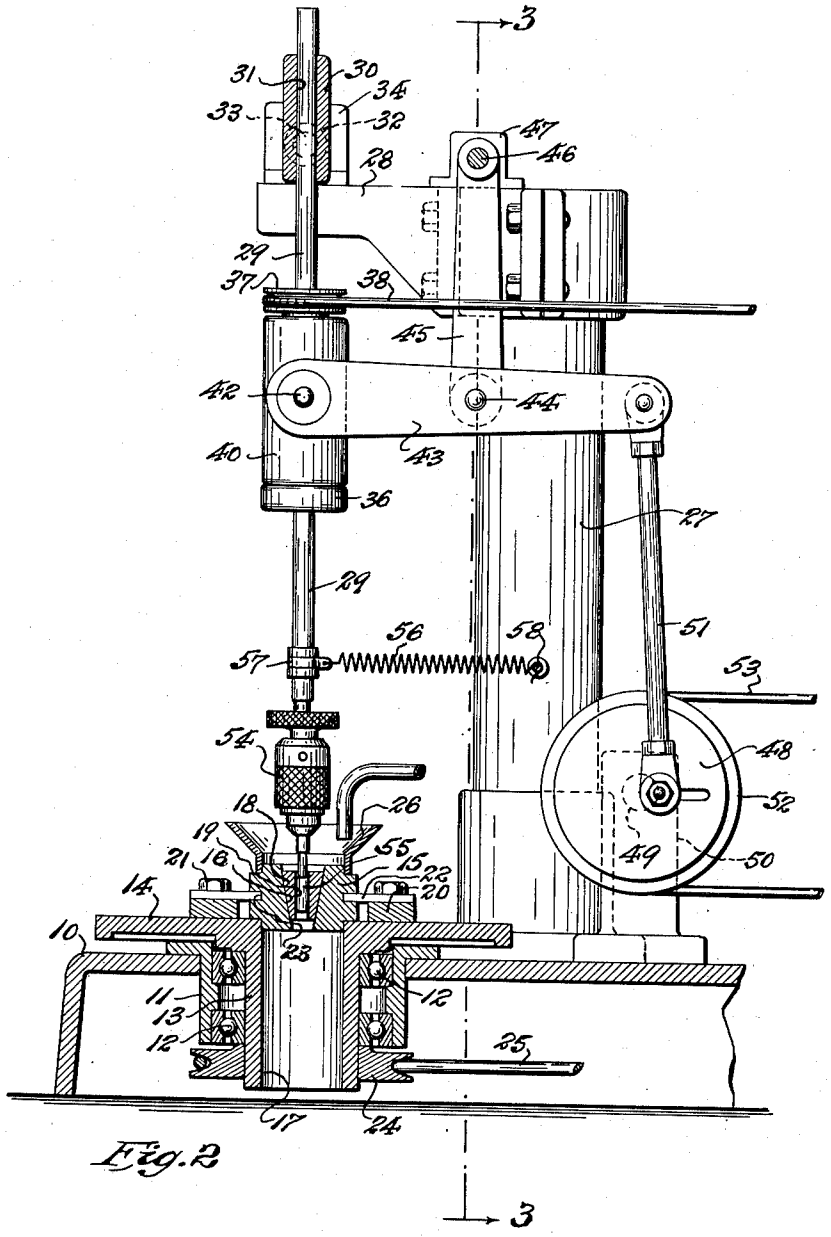



Fig. 2

INVENTOR.

Gustav Peterson,

BY

George D. Richards,

Attorney

April 2, 1957 G. PETERSON 2,787,090

LAPPING MACHINE

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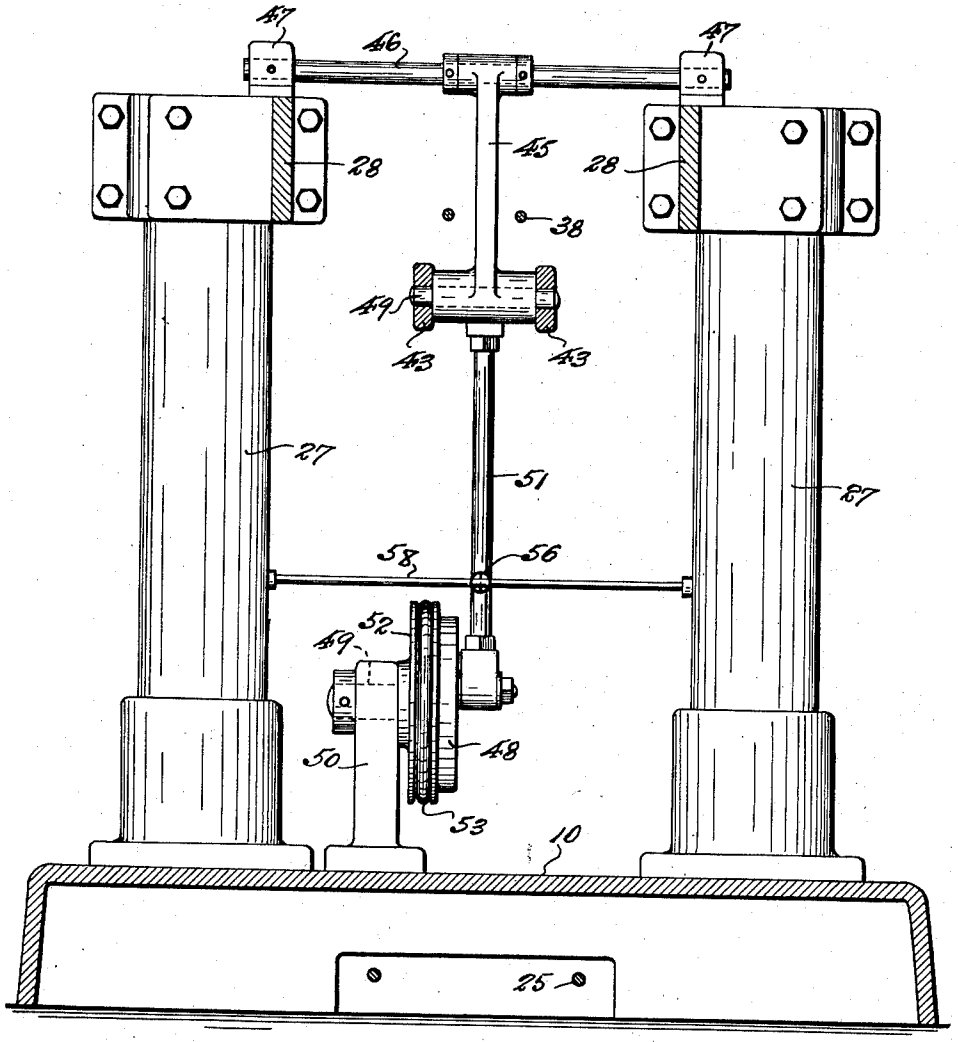



Fig. 3

INVENTOR.
Gustav Peterson,
BY George D. Richards
Attorney

April 2, 1957 G. PETERSON 2,787,090

LAPPING MACHINE

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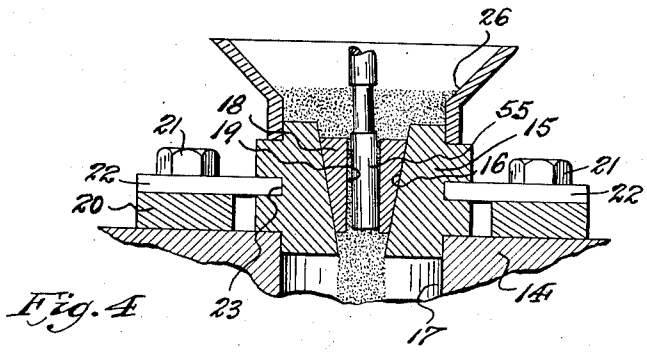



Fig. 4

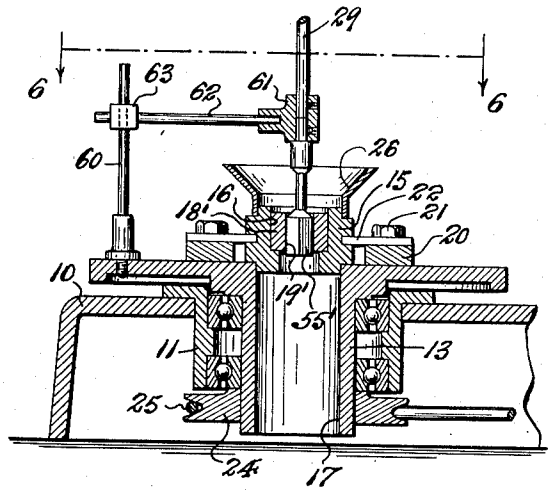



Fig. 5

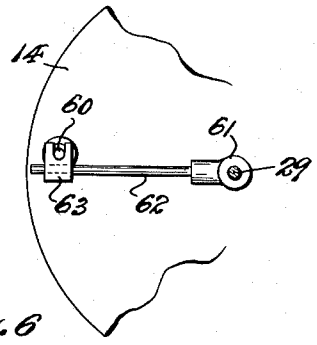



Fig. 6

INVENTOR.
Gustav Peterson,
BY George Richards
Attorney

United States Patent Office 2,787,090 Patented Apr. 2, 1957



2,787,090

# LAPPING MACHINE

Gustav Peterson, Bloomfield, N. J., assignor to Dykrex Corporation, Montclair, N. J., a corporation of New Jersey

Application September 9, 1955, Serial No. 533,368

5 Claims. (Cl. 51—50)

This invention relates to improvements in lapping machines; and the invention has reference, more particularly, to an improved lapping machine for grinding and polishing the internal surfaces of the apertures in wire drawing and other dies, in bushings, and in other work pieces desired to be so treated.

The invention has for an object to provide a lapping machine which is selectively operable (1) to impart reciprocatory movement to the work engaging lapping tool or pin accompanied by rotary movement thereof in one direction while rotating the engaged work in an opposite direction; or (2) to impart reciprocatory movement to the work engaging lapping tool or pin while synchronously rotating the same and the work in the same direction; or (3) to impart combined rotary and reciprocating movements to the work engaging lapping tool or pin while holding the work stationary; any of such modes of operation being optionally usable as may be desirable according to the form and character of the work under treatment.

The invention has for a further object to provide means for biasing the operated lapping tool or pin in axially inclined relation to the surface of a work piece aperture engaged thereby, whereby freer flow of a lapping compound through the work piece aperture under the treatment is assured, and whereby application of the lapping compound by the lapping tool or pin to the surfaces of the work piece aperture is so controlled that rounding of end edges of the work piece aperture by fillet formations is avoided, so that sharply defined angular end edges are assured, especially at an entrance end of the work piece aperture.

Other objects of this invention, not at this time more particularly mentioned, will be understood from the following detailed description of an illustrative embodiment of lapping machine according to the invention, when read in connection with the accompanying drawings thereof, in which:

Fig. 1 is a front elevation, with parts in section, of a lapping machine according to this invention; Fig. 2 is a vertical longitudinal sectional view, with parts in elevation, taken on line 2—2 in Fig. 1; and Fig. 3 is a transverse sectional view, taken on line 3—3 in Fig. 2.

Fig. 4 is a fragmentary vertical section through the work holding means of the machine showing the biased relation of the lapping tool or pin to the work piece held thereby, this view being drawn on an enlarged scale.

Fig. 5 is a fragmentary vertical longitudinal sectional view, similar to that of Fig. 2, but showing a modification of the machine operative to lap work piece apertures of polygonal cross-sectional shape; and Fig. 6 is a fragmentary horizontal sectional view, taken on line 6—6 in Fig. 5.

Referring to the drawings, in which like characters of reference indicate corresponding parts, the reference character 10 indicates a hollow base. Mounted in the forward end portion of the top wall of the base 10 is a bearing member 11, which depends within the hollow interior of



said base. Rotatably journaled in the bearing member 11, preferably by anti-friction bearings 12, is the hollow or tubular hub 13 of a rotatable work supporting table 14. Detachably mounted on the table 14, in axially aligned relation thereto, is a work piece holding member 15, which is provided with a suitably shaped, axially extending, endwise open seating opening 16 that communicates with the through passage 17 of the table hub 13. A work piece 18, the axial aperture 19 of which is to be lapped, is adapted to be removably entered in the seating opening 16 of the work holding member 15, and then suitably secured to said work holding member so that its axial aperture 19 can receive a lapping tool or pin which is operated by the machine, as hereinafter more particularly described. Any suitable means may be provided for detachably affixing the work holding member 15 to the table 14. By way of example, means for the latter purpose (as shown) comprises an annular anchor member or ring 20 that is carried by the table 14 concentric to the axis of the latter. Detachably secured by bolts 21 to the anchor member or ring 20 are radial coupling pieces 22, the free end portions of which engage in an external annular groove or channel 23 with which the work holding member 15 is provided, whereby to fasten said work holding member in place upon the table 14. Secured to the table hub 13 is a pulley 24 over which runs a drive belt 25 operative to rotate the table 14, and thus the work piece 18 mounted on the latter. Said belt 25 forms part of power transmission by which the table 14 is driven from a suitable power source (not shown), and said power transmission may include variable speed regulating means (not shown), whereby the speed of rotation of the table 14 and work piece 18 can be varied as may be desirable in any given case, such variable speed power transmission being within the skill of the art to provide.

Mounted in connection with the upper end portion of the work holding member 15 is a funnel member 26 into which a lapping compound can be supplied for down flow through the work piece aperture 19, subject to application by the lapping tool or pin to the surfaces of said aperture, whereby to grind and polish the latter.

Upstanding from the base 10 are a pair of laterally spaced apart standards 27. Supported by the upper ends of these standards are suitably shaped, laterally opposed bracket or frame members 28, the same being disposed to project forwardly in overhanging relation to the work supporting table 14.

Supported by and so as to be perpendicularly disposed between forward end portions of the bracket or frame members 28, in axial alignment with the work supporting table 14, is a pivoted slideway bearing means by which the upper end portion of a spindle or shaft 29 for actuating a lapping tool or pin is supported subject to rotative and axially reciprocative movements. This slideway bearing means comprises a bearing member 30 having an endwise open, axially disposed bore 31 through which said spindle or shaft 29 extends. Said bearing member 30 is provided with oppositely and transversely projecting trunnion portions 32 to journal pivot pins 33 which are supported by pillow blocks 34 respectively mounted on the opposed end portions of the bracket or frame members 28.

Below the pivoted slideway bearing member 30, means is provided for rotating the spindle or shaft 29, together with means for axially reciprocating said spindle or shaft.

The means for rotating the spindle or shaft 29 comprises a sleeve 35 having an annular enlarged head 36 at one end, and a drive pulley 37 affixed upon its opposite end, over which runs a drive belt 38. Said sleeve 35 is suitably secured to the spindle or shaft 29, as by a set screw 39 engaged through its head 36. As in the case

of the rotatable work supporting table 14, the drive belt 38 forms part of power transmission by which the spindle or shaft 29 is driven from a suitable power source (not shown), and said power transmission may include variable speed regulating means (not shown), whereby the speed of rotation of the spindle or shaft can be varied as may be desirable in any given case, such variable speed regulating means being within the skill of the art to provide.

The spindle or shaft 29 and its driving sleeve 35 extends axially through a reciprocable bearing knuckle 40 in which said driving sleeve is journaled, preferably by anti-friction bearings 41. The lower end of the bearing knuckle abuts the head 36 of the driving sleeve 35, and the opposite end of said bearing knuckle abuts the drive pulley 37, whereby axial reciprocatory movements imparted to said bearing knuckle will be transmitted to the driving sleeve and spindle or shaft. The bearing knuckle is provided with oppositely and transversely projecting gudgeons 42. The means for reciprocating the bearing knuckle comprises a pair of straddling rocker levers 43, which are pivotally supported intermediate their ends by a transverse pivot pin 44 that is carried by the lower end of an oscillatable hanger arm 45. The upper end of said hanger arm 45 is pivotally engaged by a transverse pivot shaft 46, from which it is suspended (see Fig. 3). Said pivot shaft 46 is supported by and between pillow blocks 47 respectively mounted on the bracket or frame members 28, so as to bridge across the latter. The forward ends of said rocker levers 43 are respectively pivotally engaged with the gudgeons 42 of the bearing knuckle 40.

Means is provided for oscillating the rocker levers 43 whereby to reciprocate the bearing knuckle 40, and through the latter, the spindle or shaft 29. By way of illustration, means suitable for this purpose (as shown) comprises a crank-wheel 48, the shaft 49 of which is journaled in a bearing pedestal 50 that is mounted on the base 10 of the machine below the rearward ends of the rocker levers 43, and is connected to the latter by a connecting rod 51. This crank-wheel 48 is of a suitable variable stroke type, whereby it may be adjusted to vary the amplitude of oscillation of the rocker levers 43, and thereby the amplitude of reciprocation imparted by the latter to the bearing knuckle 40 and spindle or shaft 29. Fixed on the shaft 49 of the crank-wheel 48 is a drive pulley 52, over which runs a drive belt 53 adapted to be driven from a suitable power source (not shown).

Mounted on the lower end of the spindle or shaft 29 is a suitable chuck 54 for coupling a lapping tool or pin 55 to the spindle or shaft whereby to enter said lapping tool or pin in the aperture 19 of the work piece 18 subject to operative movement therein.

The means for biasing the lapping tool or pin in axially inclined relation to the surface of the work piece aperture to which it is operatively opposed in use comprises a pull spring 56. The forward end of this pull spring is connected by a swivel coupling 57 to the spindle or shaft 29, preferably at a point intermediate the bearing knuckle 40 and the chuck 54. Said spring extends rearwardly from the spindle or shaft 29 at a right angle to the transverse axes of the pivoted bearing knuckle 40 and the pivoted slideway bearing 30. The rearward end of the spring is suitably anchored as, for example, by attachment to an anchoring rod 58, which is supported by and between the standards 27 of the machine frame work. The tensional pull of the spring 56 swings the spindle or shaft 29 rearwardly about the pivotal axis of the slideway bearing 30 as a center, thus effecting a small angular displacement or inclination of both the spindle or shaft and the lapping tool or pin attached thereto from a normal perpendicular axial disposition. This results in a slight longitudinal canting of the lapping tool or pin in the work piece aperture upon which it is caused to operate (see Fig. 4).

In the operation of the machine upon a work piece 18 having an axial cylindrical bore 19 (see Figs. 1, 2 and 4), the work supporting table is adapted to be rotated in one, e. g., counterclockwise, direction, and the spindle or shaft 29, with the lapping tool or pin 55 mounted thereon, is adapted to be rotated in the opposite or a clockwise direction. The speed of rotation of the table 14 and of the spindle or shaft and its lapping tool or pin can be varied as may be desirable in any given case. Such speed variations may be within a range of from 5 to 500 R. P. M. The amplitude of reciprocation of the spindle or shaft and its lapping tool or pin may be regulated to suit the same to the axial length of the work piece under treatment, by adjustment of the operative stroke of the crank-wheel 48.

During operation of the lapping tool or pin, a lapping compound, e. g., pulverized boron carbide suspended in kerosene, is delivered into the funnel member 26 to flow downwardly through the work piece aperture 19, between the surfaces of said aperture and the sides of the lapping tool or pin. Suitable means for circulating the lapping compound for flow through the work piece, although not shown since no claim is made thereto, is well known to the art, and can be provided for utilization in the machine of this invention.

When the work piece is rotated in one direction and the reciprocated lapping tool or pin is rotated in an opposite direction within the work piece aperture 19, the lapping compound flows downwardly between opposed side surfaces of said aperture and said lapping tool or pin, so that said compound is rubbed by the operated lapping tool or pin against the work piece aperture surface, with desired grinding and polishing effect upon the latter.

Due to the downwardly and inwardly inclined relation of the biased lapping tool or pin to the opposed wall surface of the work piece aperture, the working side surface of the upper end portion of the lapping tool or pin is spaced somewhat further away from the upper end surface portion of the work piece aperture than is the working side surface of the lower end portion of the lapping tool or pin from the lower end surface portion of said work piece aperture (see Fig. 4). It is believed that, as a consequence of this, the lapping compound will not be crowded above and downwardly against the entrance edge of the work piece aperture, and therefore endwise pressure of the lapping compound externally of said entrance end edge of the work piece aperture is sufficiently reduced as to avoid undesirable excessive rounding of said end edge with resultant fillet formation, so that a desirable substantially sharply defined angular edge formation is assured at said entrance end of the work piece aperture. A further advantage of the biased inclined relation of the lapping tool or pin to the surfaces of the work piece aperture is that such disposition results in provision of a more open passage for lapping compound flow behind the lapping tool or pin, so that better or freer flow of said compound through the work piece aperture is assured (again see Fig. 4).

In the use of the machine, it is sometimes desirable to hold the work piece stationary subject to the combined rotative and reciprocatory engagement of the lapping tool or pin 55 therewith. In such case, the drive belt 25 is removed from the pulley 24 which drives the table 14, or table rotation is otherwise stopped.

When lapping of a work piece aperture of polygonal cross sectional shape, or of a shape other than of circular cross-section, is required, the machine of this invention includes means to condition the same for lapping work pieces of such kind (see Figs. 5 and 6). In such case, assuming, e. g., a work piece 18' having an axial aperture 19' of square cross-sectional shape is supported on the rotatable table 14, so as to be rotated by the latter,

independent rotation of the spindle or shaft **29** is discontinued as e. g. by removal of the drive belt **38** from the pulley **37**, and means is provided for transmitting rotary movement of the work supporting table **14** to the spindle or shaft **29**, so that a lapping tool or pin **55'**, of cross-sectional shape corresponding to the cross-sectional shape of the work piece aperture **19'**, is rotated synchronously with and in the same direction as said work piece **18'** is rotated by the table **14**. To this end, an upstanding propelling member **60** is mounted on the table **14** in radially offset relation to the axis of the latter. Secured to the spindle of shaft **29**, by a suitable hub member **61**, is a laterally extending crank arm **62**. Carried by the crank arm **62** is a notched coupler block **63** adapted to be engaged by the propelling member **60**, when the table **14** is rotated. As the table **14** and work piece **18'** carried thereby is rotated, the propelling member **60** will thrust against the crank arm **62**, thus revolving the latter synchronously with and in the same direction as said table rotates. The thus revolved crank arm will rotate the spindle or shaft **29** in such manner as to cause the lapping tool or pin **55'** to rotate in company with the rotated work piece **18'**, while said lapping tool or pin is reciprocated to operatively apply lapping compound to the surfaces of the work piece aperture **19'**. The spindle or shaft **29**, with the lapping tool or pin **55'**, in such case, is also subjected to the biasing effect of the pull spring **56**, enough lateral play being allowed between the coupler block **63** and the propelling member **60** to permit the biased inclined relation of the lapping tool or pin **55'** to the surfaces of the work piece aperture **19'**, for the purposes and with the attendant advantages already hereinabove set forth.

Having now described my invention, I claim:

1. In a lapping machine, a rotatable work supporting table provided with means to hold a work piece having an axial aperture to be lapped in alignment with the table axis, a spindle extending above the table in alignment with the axis thereof, a lapping tool rigidly connected to the table opposed end of the spindle in alignment therewith, means to reciprocate said spindle, means to rotate the reciprocated spindle and lapping tool, a slideway bearing through which the upper end portion of the spindle extends, means to pivotally support said slideway bearing on an axis transverse to the longitudinal axis of the spindle, and a pull spring extending substantially at a right angel to the transverse axis of the slideway bearing and connected with said spindle so as to swing the same and the slideway bearing about the transverse axis of the latter, whereby to yieldably bias the lapping tool in inclined relation to the surface of a work piece aperture operatively engaged thereby.

2. In a lapping machine according to claim 1 wherein the means to reciprocate the spindle and lapping tool comprises rocker lever means, a pivotally suspended hanger arm in connection with the free end of which said rocker lever means is fulcrumed, a means for oscillating said rocker lever means, and a bearing knuckle structure mounted on the spindle to which the rocker lever means is pivotally connected.

3. In a lapping machine, a rotatable work supporting table provided with means to hold a work piece having an axial aperture to be lapped in alignment with the table axis, a spindle extending above the table in alignment with the axis thereof, a lapping tool rigidly connected to the



table opposed end of the spindle in alignment therewith, a slideway bearing through which the upper end portion of the spindle extends, means to pivotally support said slideway bearing on an axis transverse to the longitudinal axis of the spindle, a pull spring extending substantially at a right angle to the transverse axis of the slideway bearing and connected with said spindle so as to swing the same and the slideway bearing about the transverse axis of the latter, whereby to yieldably bias the lapping tool in inclined relation to the surface of a work piece aperture operatively engaged thereby, a drive sleeve affixed on said spindle for rotating the same and the lapping tool, said drive sleeve having an enlarged head at one end and a driving pulley affixed to its opposite end, and means to reciprocate said spindle and lapping tool comprising rocker lever means, a pivotally suspended hanger arm in connection with which said rocker lever means is fulcrumed, means for oscillating said rocker lever means, and a bearing knuckle structure mounted around said drive sleeve, between the head and driving pulley thereof, to which one end of the rocker lever means is pivotally connected.

4. In a lapping machine, a rotatable work supporting table provided with means to hold a work piece having an axial aperture to be lapped in alignment with the table axis, a spindle extending above the table in alignment with the axis thereof, a lapping tool rigidly connected to the table opposed end of the spindle in alignment therewith, a slideway bearing through which the upper end portion of the spindle extends, means to pivotally support said slideway bearing on an axis transverse to the longitudinal axis of the spindle, a pull spring extending substantially at a right angle to the transverse axis of the slideway bearing and connected with said spindle so as to swing the same and the slideway bearing about the transverse axis of the latter, whereby to yieldably bias the lapping tool in inclined relation to the surface of a work piece aperture operatively engaged thereby, means to transmit rotary movement of the table to the spindle and lapping tool comprising a propelling member upstanding from said table in radially outward offset relation to the table axis, a crank arm affixed on said spindle to extend across the path of movement of the propelling member, and coupling means carried by said crank arm for engagement by said propelling member, and means to reciprocate said spindle and lapping tool.

5. In a lapping machine according to claim 4 wherein the means to reciprocate the spindle and lapping tool comprises rocker lever means, a pivotally suspended hanger arm in connection with the free end of which said rocker lever means is fulcrumed, means for oscillating said rocker lever means, and a bearing knuckle structure mounted on the spindle to which the rocker lever means is pivotally connected.

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