This invention relates to lapping machines and more particularly to an automatic lapping machine for internal tapered screw threaded members.

A primary object of the present invention is to provide a slow feeding or advancing movement of the lapping tool relative to the work piece being lapped continuously during operation.

Another object of the invention is to provide a single hydraulically actuated piston adapted to oscillate a spindle carrying a lapping tool between adjustable limits and also to simultaneously oscillate a member preferably in the form of a sleeve to which the work piece being lapped is attached so that the lapping tool and work piece may be simultaneously oscillated.

Another object of the invention is to actuate the spindle carrying the lapping tool and the member attached to and actuating the work piece so that the oscillations of the spindle and this member are always in opposite directions to each other.

Another object of the invention is to provide improved adjusting means for varying the extent of oscillatory movements of the lapping tool spindle and sleeve for the work piece.

A feature enabling the above objects to be accomplished is that the hydraulically actuated piston is provided with a threaded portion and also with an annular rack portion, the threaded portion serving to oscillate the spindle by engagement of the threaded or worm section with a gear on the spindle, the annular rack teeth engaging a gear to oscillate the sleeve through a pair of intermeshing gears, one of which is on the sleeve.

Another feature of the invention that is important is that rotation of the hydraulically reciprocated piston by a slow and preferably step by step movement actuated by an independently actuated piston and operating through the worm drive to the threaded portion of the piston slowly advances the spindle rotatably during its oscillatory movements so that the work being lapped will be engaged by larger diameter portions of the lap.

With the above and other objects in view, the invention may include the features of construction and operation described in the following specification and illustrated in the accompanying drawings.

In the accompanying drawings annexed hereto and forming a part of this specification, I have shown the invention embodied in a lapping machine for small screw thread ring gages, but it will be understood that the invention can be otherwise embodied and that the drawings are not to be construed as defining or limiting the scope of the invention, the claims appended to this specification being relied upon for that purpose.

In the drawings:

Figure 1 is a side elevation in section showing the spindle and sleeve, their actuating mechanism and their connections to the lapping tool and work piece respectively. Fig. 2 is a front elevation of the principal parts shown in Fig. 1.

Fig. 3 is a detail of the gear drive employed in the mechanism for rotatably advancing the lapping spindle during operation of the machine. Fig. 4 is a sectional view in elevation showing the connections for oscillating the spindle and sleeve by vertical movements of a hydraulic piston.

Fig. 5 is a detail plan view in section of the hydraulically actuated ratchet means for effecting slowly advancing or rotating movements of the spindle for the lapping tool.

Figs. 6 and 7 are detail sectional views showing the control valves for actuating the hydraulically operated piston vertically and rotatably, and Fig. 8 is a detail sectional view showing one end of the hydraulic piston, its operating valve and its cylinder.

In the above mentioned drawings there has been shown but one embodiment of the invention which, is now deemed preferable, but it is to be understood that changes and modifications may be made within the scope of the appended claims without departing from the spirit of the invention.

The present invention constitutes an improvement over my previous Patent No. 2,379,693, granted July 3, 1945. The present construction covers an improved oscillating mechanism for the work piece and also provides a means to continuously advance or feed the work piece relative to the lapping tool. This advancing feed is adjustable for either right or left hand screw threads and for different extremely slow feeds.

The work piece holder corresponds to the holder described and claimed in my Patent No. 2,408,246, granted August 6, 1946, and permits manual adjustment of the work piece along the lapping tool during operation or when initially setting up the work piece for the lapping operation.

Briefly, and in its preferred aspect, the invention may include the following principal parts: First, a fixed headstock mounted on a base or other support (not shown); second, a sleeve mounted for rotation preferably upon a horizontal axis within the headstock; third, a spindle supported for rotation coaxially within the sleeve; fourth, a lapping tool mounted at one end of the spindle; fifth, connections from the sleeve to a holder for supporting and actuating the work piece being lapped while mounted in position on the lapping tool; sixth, a vertically
mounted piston adapted to be reciprocated between adjustable limits, preferably by hydraulic means; seventh, a worm wheel on the piston engaging a worm on the inner end of the spindle so that vertical movements of the piston and its worm acting as a rack will oscillate the spindle; eighth, annular rack teeth on the piston meshing with a gear on an intermediate shaft connected by intermeshing gears with the sleeve so that vertical movements of the piston and rack will oscillate the sleeve; ninth, an elongated spur gear on the piston drivingly connected to a corresponding gear on the lower end of a vertical shaft; and tenth, suitable means for slowly, preferably step by step, rotating this vertical shaft to slowly rotate the piston and the lap carrying spindle.

Referring more in detail to the figures of the drawings, there is shown in section in Fig. 1 a headstock 10 having rotatably mounted thereon a sleeve member 12. At its forward or outer end there is a radially extending plate 14 having a horizontally extending arm 16 detachably mounted thereon. As shown in Fig. 1, this sleeve 12 may be rotated upon aligned anti-friction bearings 18 mounted within the headstock 10 adjacent its opposite ends so that it may oscillate, as presently to be described, upon a horizontal axis. On the rear or inner end of the sleeve 12 is a spur gear 20 in mesh with a corresponding spur gear 22 on an intermediate shaft also having arranged thereon a second gear 24 meshing with the annular teeth 26 of a circular rack portion on the vertical piston 28. Mounted within the sleeve 12 and coaxial therewith on anti-friction bearings 30 therein is a spindle 32 having at its forward or outer end a chuck 34 adapted to drivingly engage a lapping tool 36. At the opposite end of the spindle 32 is a worm wheel 38 intermeshing with a worm 40 on the vertically operated piston 28 presently to be more fully described.

It will be seen from the above described mechanism that vertical movements of the piston 28 will oscillate the spindle 32 by worm gear 38 meshing with worm 40 dependent upon the extent of vertical movement of the piston 28. Simultaneously the sleeve 12 will also be oscillated through an angle dependent upon the ratio of its connecting gears 20, 22 and 24 and the vertical movements of the piston 28. Also by reason of the interposed pair of spur gears between the driving rack 26 and the sleeve 12 the direction of any oscillatory movement of the sleeve will always be in the opposite direction to the simultaneous oscillatory movement of the spindle 32.

In order to slowly rotate the spindle 32 so that the workpiece W will engage portions of slightly increased diameter of the lapping tool during the progress of the lapping operation, means are provided to rotate the vertically actuated piston 28 preferably by a step by step means. A small horizontally actuated piston 42 is reciprocated hydraulically during oscillatory movements of the sleeve 12 and spindle 32 by any desired means. This reciprocatory movement, by means of a pawl 44 carried by the piston, advances a ratchet gear 46 on the rear end of a shaft 48. This shaft 48 carries at its forward end a spur gear 50 intermeshing, as shown in Fig. 1, directly with a gear 52 on the forward end of a horizontal shaft 54. On the rear end of shaft 54 is a bevel pinion 56 and this pinion meshes with a bevel gear 58 at the upper end of a vertical shaft 60 rotatably mounted within a portion of the headstock 10. At the lower end of this shaft 60 is a spur gear 62 meshing with an elongated spur gear 64 on the vertically actuated piston 28 so that this gear 64 is always in engagement with its companion gear during reciprocatory movements of this piston. The step-by-step rotation of shaft 48 by the ratchet 44 will thus slowly rotate shafts 54 and 60 and piston 28 in a step-by-step manner.

To reverse the direction of slow step-by-step rotation of the piston 28 so that the machine may be adapted for advancing either right or left hand threaded work pieces along the lapping tool 36, an alternative drive is provided between the ratchet gear 46 and the bevel pinion 56. For this purpose a third shaft or stud 66 is provided parallel to shafts 48 and 54. By gearing, therefore, from gear 51 on shaft 48 to a gear 66 on stud 66 and from the gear 66 on stud 66 to a gear 57 on shaft 54, rotation in opposite directions from the direct gearing between shafts 48 and 54 may be effected.

Slow step by step rotational movements are imparted to the piston 28 by the above-described mechanism. By the selection of the proper gearing between the pawl carrying pinion 42 and the vertical shaft 60 driven thereby the direction and amount of rotation of the vertical piston 28 can be reversed and limited to accommodate the machine for lapping left or right hand threads of different types and sizes. By changing the angular position of the work piece W within its holder 67 by rotation of the manually operated member 68 the advancing movement of the work piece W along lapping tool 36 can be speeded or retarded by the operator as required by the progress of the lapping of the particular work piece.

The pistons 28 and 42 are reciprocated by hydraulic elements and are disposed in a hydraulic system similar to the means for actuating the spindle and work oscillating mechanism disclosed and claimed in my above referred to Patent No. 2,397,698. As these means form no part of the present invention, it will be unnecessary to describe them in detail.

It will be understood that the piston 42 is slideable within its cylinder 70 and reciprocated by alternately admitting fluid under pressure to its opposite ends. Similarly, the vertical piston 28 within aligned cylinder portions 72 is similarly reciprocated as by means of suitable valves 74 and 76. To control the length of oscillatory movements of the sleeve 12 and spindle 32, adjustable dogs 13 may be provided on the lower portion of the sleeve 12 for engaging by a control lever 15 within the hydraulic system of the machine. Reversals of movement of the vertical piston 28 and oscillatory movements of the sleeve 12 are effected by contact with and operation of the control lever 15 by the dogs 13. For this purpose the control lever 15 is connected to an oscillating distributing valve 19 by means of which fluid under pressure in the hydraulic system is admitted to the cylinders for pistons 28 and 42.

I claim:

1. A lapping device for threaded members comprising a fixed headstock, a slider having a reciprocating movement mounted within said sleeve, a thread lapping tool on said spindle, means to oscillate said sleeve, means to oscillate said spindle simultaneously with said sleeve, means connecting said sleeve to a holder for the work piece being lapped, whereby os-
cillations of said sleeve will oscillate said work-piece, and means to slowly advance said spindle rotatably during oscillations thereof.

2. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle rotatably mounted within said sleeve, a thread lapping tool on said spindle, means to oscillate said sleeve, said means also oscillating said spindle simultaneously with said sleeve, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, and means to slowly advance said spindle rotatably during oscillations thereof.

3. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle rotatably mounted within said sleeve, a thread lapping tool on said spindle, a piston, means to reciprocate said piston, connections from said piston to said sleeve and spindle to oscillate said sleeve and spindle, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, and means to slowly advance said spindle rotatably during oscillations thereof.

4. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle mounted coaxially within said sleeve, a thread lapping tool on said spindle, a piston within said headstock, means to oscillate said sleeve and spindle by reciprocatory movements of said piston, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, means to slowly rotate said piston, and means to slowly advance said spindle rotatably by said rotary movements of said piston.

5. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle mounted coaxially within said sleeve, a thread lapping tool on said spindle, a hydraulically actuated piston, connections between said piston and sleeve and between said piston and spindle whereby reciprocation of said piston will oscillate said sleeve and spindle, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, rotating means for said piston, and means to advance said spindle rotatably during its oscillations.

6. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle rotatably mounted within said sleeve, a thread lapping tool on said spindle, a thread lapping tool on said spindle, a hydraulically actuated piston, connections between said piston and sleeve and between said piston and spindle whereby reciprocation of said piston will oscillate said sleeve and spindle, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, rotating means for said piston, and means to advance said spindle rotatably during its oscillations.

7. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle mounted coaxially within said sleeve, a thread lapping tool on said spindle, a hydraulically actuated piston, connections between said sleeve and spindle and between said sleeve and spindle whereby reciprocation of said sleeve will oscillate said workpiece, rotating means for said piston, and means to advance said spindle rotatably during its oscillations.

8. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle rotatably mounted within said sleeve, a thread lapping tool on said spindle, a thread lapping tool on said spindle, a hydraulically actuated piston, connections between said piston and sleeve and between said piston and spindle whereby reciprocation of said piston will oscillate said sleeve and spindle, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, supplementary hydraulic means to slowly rotate said piston step by step during its reciprocations, and connections from said piston to said spindle to slowly advance said spindle rotatably during its oscillations.

9. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle rotatably mounted within said sleeve, a thread lapping tool on said spindle, a thread lapping tool on said spindle, a hydraulically actuated piston, connections between said piston and sleeve and between said piston and spindle whereby reciprocation of said piston will oscillate said sleeve and spindle, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, means to slowly rotate said piston during its reciprocations, and gear connections from said piston to said spindle to slowly advance said spindle rotatably during its oscillations.

10. A lapping device for threaded members comprising a fixed headstock, a sleeve rotatably mounted therein, a spindle rotatably mounted within said sleeve, a thread lapping tool on said spindle, a hydraulically actuated piston, connections between said piston and sleeve and between said piston and spindle whereby reciprocation of said piston will oscillate said sleeve and spindle, means connecting said sleeve to a holder for the workpiece being lapped, whereby oscillations of said sleeve will oscillate said workpiece, means to slowly rotate said piston during its reciprocations, and gear connections from said piston to said spindle to slowly advance said spindle rotatably during its oscillations.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,684,972</td>
<td>Logue</td>
<td>Sept. 28, 1922</td>
</tr>
<tr>
<td>2,287,850</td>
<td>Miller</td>
<td>Oct. 1, 1941</td>
</tr>
<tr>
<td>2,336,745</td>
<td>Drake</td>
<td>Nov. 30, 1943</td>
</tr>
<tr>
<td>2,379,593</td>
<td>Drake</td>
<td>July 3, 1945</td>
</tr>
<tr>
<td>2,399,477</td>
<td>Drake</td>
<td>Apr. 30, 1946</td>
</tr>
<tr>
<td>2,406,346</td>
<td>Drake</td>
<td>Aug. 6, 1946</td>
</tr>
</tbody>
</table>