This invention relates to the lapping or polishing of surfaces, such as the running surfaces of rotating precision parts such as ball-bearing race rings, and more particularly to apparatus for performing the lapping operation. The invention will be described with respect to bearing race rings for convenience, although it may be used for other devices.

Bearing race rings, on which the balls or rollers of the bearing roll, are very accurately and finely ground to the dimensions desired and are thereafter, at least in the case of high quality bearings, lapped or polished along the running surface on which the balls or rollers roll. The difference between a finely ground surface and a lapped surface may perhaps be made most clear by stating that although a finely ground surface is sufficiently smooth so that when viewed alone it would probably be considered by the inexperienced to be polished, the lapped surface is so highly polished and mirror-like that it makes the ground surface look dull by contrast. The extreme smoothness of the mirror-like lapped surface is of course highly desirable for the running surface of bearings to eliminate friction as much as possible.

The lapping of race rings in the past has been an expensive procedure and for that reason has been omitted except in high quality bearings. Each running surface has required a great deal of time of a worker, the race ring being put on a rotating spindle or chuck and the worker applying the lapping tool to the raceway and oscillating it so that the raceway would not become grooved. Furthermore, the operator must be somewhat skilled in order to apply the right pressure and manipulate the tool properly. According to the present invention a machine is provided on which the rings may be applied with the greatest ease and which automatically oscillates the lapping tool thereon, the machine being designed to apply the proper pressure so that the lapping is done as well as it could be by a skilled worker under the best working conditions and much more dependably than it could be done by less skilled workers under any conditions. One relatively unskilled operator is able to load and otherwise attend to several machines.

The ease of applying a race ring to the machine is secured by using a centerless type of rotative support on which the race ring is rested including two closely spaced rotating rolls. Thus, the ring is supported in such manner that either an inside running surface or an outside running surface may be lapped. With such precision 55 work it is important that the driving rolls be kept true, and this is made practical by a trimming unit which operates on the rolls without removing them from the machine. This in turn makes adjustment of the rolls necessary, and adequate means for adjusting them and properly driving them in spite of the adjustment is provided.

Additional advantages and objects of the invention will be apparent from the following description and from the drawings, in which:

Fig. 1 is a fragmentary front view of one bank of machines chosen for illustration of the invention.

Fig. 2 is an end view of the structure shown in Fig. 1.

Fig. 3 is a fragmentary view taken approximately on the line 3—3 of Fig. 1, showing the drive for the oscillating mechanism.

Fig. 4 is a fragmentary enlarged sectional view taken approximately on the line 4—4 of Fig. 1 or Fig. 5.

Fig. 5 is a view taken approximately on the line 5—5 of Fig. 4.

Figs. 6 and 7 are fragmentary front and side views respectively of a modified form of trimming unit.

Figs. 8 to 10 are fragmentary views similar to Fig. 2 but showing successive steps in the oscillation of the lapping tool.

Fig. 11 is a fragmentary view partly in section of a modification of the lapping arm and head for use particularly with race rings for roller bearings.

In Fig. 1 four individual machines or units have been shown supported by the frame 11. This number may be increased or decreased if desired. Each unit includes a pair of driving rolls 12 which are slightly spaced apart so that they may rotate freely and yet support a race ring 14 between them. As seen in Fig. 2, each driving roll 12 is carried by a shaft 16, on the far end of which is keyed a pulley 17 which is driven by a belt 18, the latter in turn being driven by a motor 19.

One suitable mounting for the shaft 16 can be seen in Fig. 4, wherein it is seen that one ball bearing 21 is provided near the pulley end of the shaft while two ball bearings 22 are provided at the end of the shaft carrying the driving roll 12.

The bearings 21 and 22 may be supported in a suitable housing 24 which may, if desired, be made of cast iron. Each of the housings 24 is slidably mounted on two hexagonal bars 26. The spacing between the two driving rolls 12 may be adjusted by means of a right and left-hand screw
21 which is threaded into the housings 24, and when turned in one direction the screw separates the housings and when turned in the other direction it draws the housings closer together. When the housings 24 have been adjusted to the desired positions, they may be secured in place by a screw 28 which screws into the housing 24 and slides in a slot in the bed 29 which supports the bars 30.

The belt 31 drives both of the pulleys 32 and may be adjusted automatically for the proper tension in spite of movement of the housings 24. One very simple and satisfactory form of adjustment is shown in Fig. 1, in which the belt 18 extends from the motor 19 upwardly over the outside of the pulleys, and downwardly from the inside of the pulleys to and around an idler pulley 31. This idler pulley is urged downwardly by a lever 32 which may be pivoted to the frame at 33 and may carry a weight 34 at its free end. For this arrangement the belt 18 will always have the same tension determined by the weight of the weight 34 regardless of the positions of the housings 24. The use of a single belt insures exact synchronism of the two driving rolls 12.

One satisfactory form for the roll 12 has been shown in Fig. 4, in which it comprises an annular ring secured to the shaft by two clamp plates 35 clamped against the roll 12 by nut 37. The roll 12 may be of any suitable material. A mixture of rubber and grit has been found to be very satisfactory in a commercial embodiment of the invention. Such rolls have a high coefficient of friction with the ring 14 and yet wear very well and stand up well under the heat that is generated in the lapping of the ring 14.

After the ring 14 has been set on the pair of adjacent rolls 12, or as it is set thereon, the lapping tool will be swung into position. The lapping tool comprises an arm 41 pivoted at 42 to a suitable bracket 43, and having a suitable treating member 44 at its end. The bracket 43 includes a threaded supporting portion 45 which may be adjusted vertically if desired as is apparent in Fig. 4. The treating member 44 could be a hone but is preferably felt, having a layer of emery cloth 46 applied thereon. The felt is preferably so shaped that it will fit nicely within the groove 47 of the ring 14. The emery cloth 46 is urged against the ring 14 with a proper amount of pressure by a link 48 and spring 49, and the characteristics of the felt 44 cause it to frictionally retain the emery cloth on its face against slipping and at the same time provide a backing which is at least very slightly yielding under the pressure of the spring 49.

In lapping revolving surfaces, it is necessary for the lapping element to oscillate so that it will not groove the surface. According to the present invention this is accomplished in the manner seen best in Figs. 8 to 10. A shaft 60 is suitably driven and carries a cam 62 thereon. A cam follower 53 is carried by a rod 54 which carries a shelf 56 to which the bracket 43 is secured. As the shaft 60 and its cam 62 rotate, the shelf 56 and rod 54 are reciprocated vertically between the positions shown in Figs. 8 and 10. This causes the arm 41 to shift between the corresponding positions shown in Figs. 8 and 10. In this run rocks the forces 44 in the groove 47, and in other words, oscillates it and the emery cloth 46 within the groove 47, so that scoring of the surface of this groove is prevented.

The shaft 60 may be driven as shown in Fig. 3 by a motor 67 operating through a gear reduc-
One form of trunnion unit is seen best in Figs. 4 and 5. A suitable housing 65 is secured to the frame 66 positioned generally above and between the two housings 24. Within the housing 65 a shaft 71 is slidably positioned, being keyed to prevent its rotation. It may be reciprocated forwardly and rearwardly by means of a rack 72 and a pinion 78, which latter may be operated by hand crank 74 as seen best in Fig. 7. At the front end of the shaft 71 there is positioned a head 76 in which are positioned two sliding holders 77, each carrying a suitable trunnion point 78 which may be a diamond or other cutting tool. The holders 77 may be adjusted by means of screws 79. As the crank 74 is rotated, the trunnion point 78 will be moved along the surface of the rotating rolls 12, thus trimming any unevenness from these rolls. The screws 79 may be adjusted to determine the size to which each roll will be trimmed and to make the spacing of the two rolls substantially equal. Once the screws 79 have been adjusted, they will not ordinarily need to be readjusted for each use since the adjustment of the two rolls 12 toward one another by turning screw 79 will adjust points 78 to be in a different relative position with reference to the surface of the rolls and to trim the rolls 12 as soon as the crank 74 is operated to move the points 78 back and forth across the rolls.

Figs. 6 and 7 show a modification in which the parts are a little more compactly positioned. In this form the sliding point holders 77 are angularly disposed, as seen best in Fig. 6, and thus their points 78 engage the rolls 12 at positions closer together than do the points 78. This is advantageous in substantially eliminating the need for adjustment of the screws 79 once they have been adjusted to trim the rolls 12 to the same size. In other words, the points 78 will come closer to trimming the rolls 12 to a depth equal to the movement of the rolls by screw 27 than will the points 78, and will thus tend to keep the spacing of rolls 12 more nearly constant in spite of trimming and adjustment of the rolls.

Although the emery cloth may be in the form of small pieces, one inserted under each of the felts 44 at the time that the felt is applied to the ring, it is preferred that the emery cloth be in the form of rolled-up strips automatically fed to present a new surface to the race rings each time a new ring is inserted. One suitable form of automatic feeding apparatus is best seen in Figs. 4 and 5. A reel 81, of emery cloth may be supported by an extension 82 of the bracket 43. From this reel the cloth may be threaded through guide loops 84, around the felt 44, and make the few around guides 86 to a reel 87 which is automatically actuated to draw the emery cloth through the loops and to wind it up. The automatic actuation may desirably be accomplished by means of a pawl 88 actuating a ratchet wheel 81 secured to the reel 87. Friction braking means comprising a friction washer 82 and a spring clip 83 tightened by a wing nut 84 are applied to each of the reels 81 and 87, it being understood that the spring clip 83 or the friction washer 82, or both, are keyed to the stud supporting the reel in each case.

The pawl 88 is carried by the arm 41. The ordinary oscillation of this arm, however, preferably does not keep feeding the emery cloth 48, this being prevented by providing the ratchet wheel 81 with teeth larger than the movement of the pawl 88 due to such oscillation. However, when the arm 41 is tilted to its inactive position, the movement of the pawl 88 is sufficient to cause it to pass to the next tooth and hence feed the emery cloth upon the return movement of the arm 41 after the latch 89 is released. The size of the teeth on ratchet wheel 81 is preferably such that the emery cloth will be fed just far enough to supply an entirely new surface to each of the successive rings 14 which is applied to the lapping machine. To minimize the variations in the feeding, the reel 87 will preferably have its core 86 positioned remotely from the axis of the reel 87, and of course the size of the teeth on ratchet wheel 81 should be sufficient to provide the desired feeding action of the emery cloth, even when it is being wound directly on the core 86.

From the foregoing it is seen that a machine for lapping race rings and the like has been provided which is exceedingly simple to operate and yet exceedingly dependable in its results. The rings may be placed on the machine without any adjustment of the machine for the rings, and the lapping arm swung into place, and thereafter no attention will be necessary until the lapping is completed. The movement of the arm will automatically feed the emery cloth, and the oscillation of the lapping tool and the emery cloth thereon, together with the provision of the spring for limiting the force of application, and the felt444 for spreading the force to provide a uniform pressure, make the automatic and rapid use of the emery cloth entirely practical.

The disclosures of this application are illustrative and the invention is not to be limited by them. In fact, if modifications or improvements are not at once obvious, they may be devised in the course of time to make additional use of the broad ideas taught and covered by this application. The claims are intended to point out novel features and not to limit the invention except as may be required by prior art.

I claim:

1. Apparatus for treating optionally the inside surface or outside surface of a ring, including a pair of closely and horizontally spaced driving rolls adapted to support and roll a ring between them, means for driving said driving rolls, a bracket, means for oscillating said bracket, an arm pivoted to said bracket and having a treating member on the end thereof, means for urging said treating member constantly against a surface of the ring, the oscillation of the bracket causing an oscillation of the arm to vary the contact between the treating member and the ring, and said arm being shiftable to an inactive position to permit removal of the ring, and means operated by the shifting of said arm to apply a fresh treating surface to said treating member.

2. Apparatus for treating optionally the inside surface or outside surface of a ring, including a pair of closely and horizontally spaced driving rolls having true peripheral surfaces adapted to support and roll a ring between them, said ring having a true peripheral surface enganged by driving said driving rolls, a bracket, means for oscillating said bracket, an arm pivoted to said bracket and having a single treating member on the end thereof small enough to fit within a ring to treat the inside surface thereof and said member likewise being operable with the outside surface of a ring to treat the
same, and means for urging said treating member constantly into slitting engagement with a surface of the ring, the oscillation of the bracket causing an oscillation of the arm to vary the contact between the ring and the treating member and rolls, respectively, the said roll and ring peripheral surfaces guiding the treating member to freely follow the shape of the surface being treated.

3. Apparatus for lapping optionally the running groove in the inside or outside surface of a ball-bearing ring, including a pair of closely and horizontally spaced driving rolls adapted to support and roll a ring between them and having cylin- drical surfaces permitting the ring to move axially of the rolls, said ring being similarly positioned for both inside and outside lapping thereof, means for driving said rolls, a lapping unit having a treating portion arcuate in cross section and projecting into the groove of the ring for slidding engagement therewith, and an arm extending thereto from a remote point, means for oscillating said arm at said point while leaving it angularly free, means for urging the treating portion of the lapping unit against the ring the oscillation of the remote point of the arm providing for an angular movement of the lapping unit over the surface of the groove, the lapping unit shifting the ring axially along the rolls with each oscillation.

4. In an apparatus for lapping race ways in bearing rings, including a centerless support adapted to support and rotate said ring, a lapping unit, mounting means supporting said lapping unit spaced in an axial direction from the centerless support, said lapping unit having an extension in one direction from said mounting means with one end thereof overlying the centerless support to lap a ring on said support, and having an extension in the other direction having a hand grip at one end for gripping to pivot the unit toward and away from a supported ring at the one end of said first extension and oscillating means for effecting a relative movement between said ring and said unit and support, respectively, to provide for the free following of said unit over the complete surface of said bearing race way.

5. In an apparatus for lapping race ways in bearing rings, including a centerless support adapted to support and rotate said ring, the combination of a bracket, an arm pivoted to said bracket and having a lapping unit on the end thereof, said arm being shiftable to an inactive position to permit removal of the ring, treating material in a continuous strip having a treating surface thereon, supporting means for said strip to position the same over a face of the lapping unit, means in engagement with said strip operated by the shifting of said arm to apply a fresh treating surface to said lapping unit, and means for oscillating said bracket to effect a transverse movement of said lapping unit in the race way and an axial movement of said ring relative to said support, to provide for the free following of said unit over the complete surface of said race way.

6. In apparatus for treating the surface of a ring having centerless support means for rotating and supporting a ring, and axis means for said support means, the combination of a treating unit in engagement with a surface of a ring on the support means having a hand grip portion at one end and a treating portion at the other end, upright means supporting said treating unit intermediate the ends thereof, with said treating portion spaced above the centerless support means and said unit extending in a direction substantially parallel to the axis means for said support means and toward said support means from a position spaced axially therefrom, and means providing relative oscillatory movement between said treating portion and the treated surface of a ring.

7. Apparatus for treating optionally the inside surface or outside surface of a ring, including a pair of axially supported driven rollers having their axes parallel but spaced apart radially in position to support and roll a ring on said rollers, an arm extending substantially parallel to the axes of said rollers and spaced vertically therefrom, said arm having a single treating member thereon positioned above said rollers to bear down optionally upon the inside surface or the outside surface of the ring for treating a surface, means for supporting said arm including pivot means extending generally transversely of the roller axes, a vertically movable support for said pivot means, and means reciprocatingly moving said movable support to provide relative oscillatory movement between said treating member and the treated ring.

8. Apparatus for treating the surface of a ring including a pair of axially supported rollers having their axes parallel but spaced apart radially in position to support and roll a ring on said rollers, vertically movable mounting means extending transversely relative to the axes of said rollers and positioned substantially intermediate lines extending in an axial direction from the roller axes, treating means pivotally mounted on said mounting means, said treating means having a treating portion thereon for bearing down against a surface of a ring on said rollers, means operatively connected with said treating means intermediate the mounting means and the treating portion for retaining said treating means on the ring while said mounting means is moved up and down to provide relative oscillatory motion between the treating portion and the ring, and means for moving said mounting means up and down.

9. In apparatus for treating optionally the inside surface or outside surface of a ring including rotary centerless support means having axis means, with said centerless support means adapted to support and roll a ring thereon, the combination of ring surface treating means having an extension thereon extending substantially parallel to the support means axis means spaced vertically therefrom, upright means supporting said treating means and spaced in a direction from the centerless support means corresponding to the axial line of said axis means, said extension having a single treating portion thereon small enough to fit within a ring to bear against the inside surface thereof and equally adapted to bear against the outside surface of said ring, means for raising and lowering said upright means with reference to said centerless support means to position said treating portion optionally upon the inside or outside surface of the ring, and means for continually moving said treating portion to shift the ring relative to said treating portion and to said centerless support means to treat the engaged surface on the ring uniformly.

10. In apparatus for lapping a surface including frame means and rotary supporting means for a work piece, the combination of means for
lapping said work piece including a lapping member spaced above the rotary supporting means, upright supporting means for said lapping means mounted on said frame for sidable movement in an up and down direction, means on said frame slidably mounting said supporting means, and an eccentric driving means in continuous engagement with said upright supporting means moving said upright supporting means up and down upon rotary movement of said eccentric driving means, and means operatively connected with said lapping means for maintaining said lapping member in engagement with the work piece and to cause relative pivotal movement of said supporting means upon the up and down movement of said supporting means.

11. Apparatus for lapping surfaces of rings including frame means, a plurality of centerless support means mounted on said frame means, and each such support means adapted to rotating and supporting a ring thereon, a lapping unit for each of said plurality of supporting means including a normally substantially horizontal extending arm having a lapping member at one end and a hand grip portion at the other end, mounting means for each lapping unit for pivotally mounting the arm of said unit intermediate the ends thereof, reciprocating means including an elongated substantially horizontally extending table common to all of said lapping units and supporting said mounting means thereon, and means operatively connected with said table to reciprocate the same in a substantially vertical direction, provide relative pivotal movement between an arm and its corresponding mounting means, and provide relative oscillatory movement between the lapping member of each lapping unit and a ring supported on the corresponding supporting means.

12. Apparatus for treating optionally the inside surface or outside surface of a ring, including a pair of rollers, an axis for each roller, means for supporting said axes so that they are relatively adjustable radially but maintained parallel in adjusted positions to accommodate rings of various diameters, a single driving means for both rollers including a driving pulley below said rollers rotatably mounted on a line extending vertically substantially intermediate the two axes, means for mounting said driving pulley, a belt operatively connecting said driving pulley and said two rollers, means for maintaining said belt taut irrespective of the relative radial position of said rollers including a member pivoted at one end and weighted at the other end, an idler pulley rotatably supported on said member intermediate the ends, with said belt extending under said idler pulley and with said idler pulley bearing down thereupon in a position substantially on said vertical line, means for treating a ring supported and rotated on said rollers and adapted to treat rings having inside and outside surfaces, with said surfaces varying in a radially spaced position from the rollers, said treating means including an arm spaced above said rollers and extending substantially parallel with the axes thereof, and vertically adjustable means supporting said arm to raise or lower the same to a position corresponding substantially to radial spacing of the treated surface of a ring with reference to the rollers.

13. An apparatus for treating a surface, the combination of centerless supporting means including a pair of axially supported driven rollers to support and roll thereon rings having an inside treatable surface or an outside treatable surface and adapted to be carried in the same position thereon for treating either surface, said treating means including a unit having a head at one end with a treating surface thereon, said head being of a size to fit within a ring to treat the inside surface thereof and said same head being optionally movable with said unit to a position above a ring to treat the outside surface thereof, means supporting said unit and having a portion permitting movement of said unit in a vertical direction relative to said rollers to move the head therewith to various selected vertical positions above said pair of rollers to treat corresponding selected ring surfaces, and means for moving said unit and the head therewith toward and away from a supported ring.

14. In ring treating apparatus having centerless support means for rotating and supporting thereon optionally a ring having an inside treatable surface or a ring having an outside treatable surface, the combination of a treating unit having a treating portion at one end with a treating surface thereon said centerless support means, said treating portion being a size such that the same portion fits within a ring to treat the inside surface thereof and is movable to a position above a ring to treat the outside surface thereof, said treating unit having a hand grip portion at the other end thereof to move said treating units and said treating portion therewith, and means spaced from said centerless support means in an axial direction supporting said treating unit intermediate the ends thereof including an adjusting portion to provide for vertical adjustment of said treating portion above said centerless support means to adjust said treating portion to various vertical positions corresponding to a ring surface being treated.

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