April 8, 1952 R. H. CRAMER 2,591,784

ABRADING MACHINE

Filed Aug. 6, 1949 5 Sheets-Sheet 1

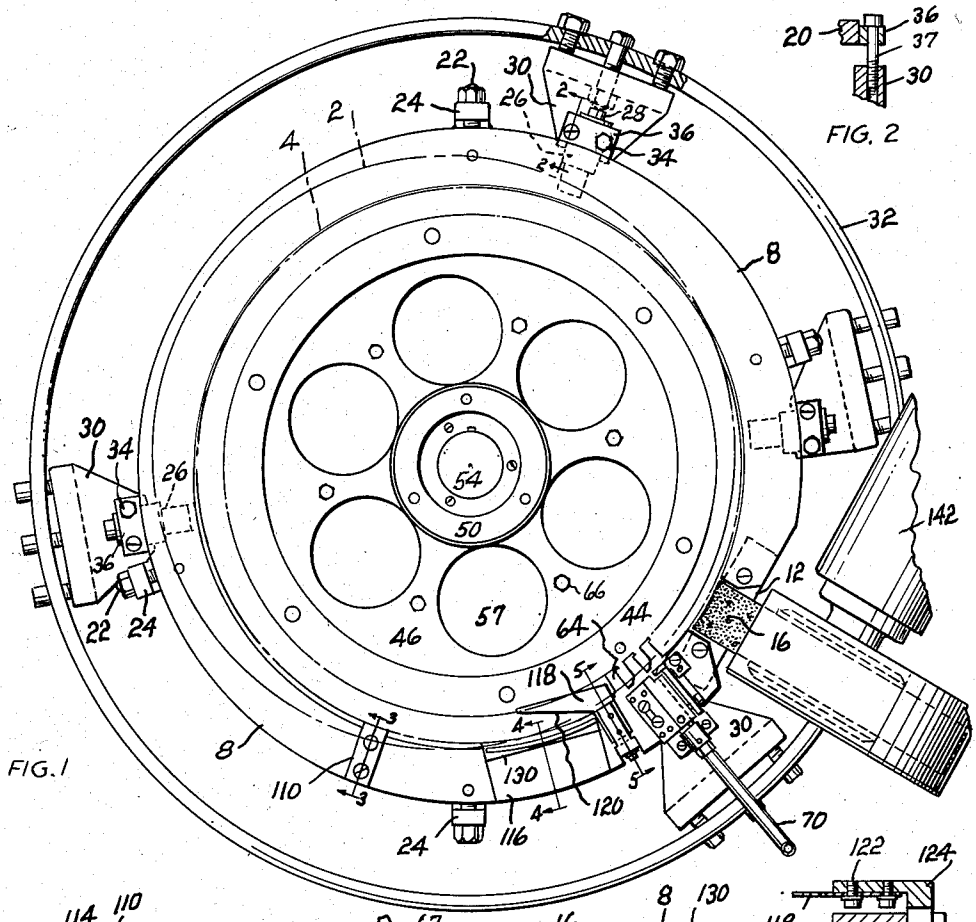


FIG. 1

FIG. 2

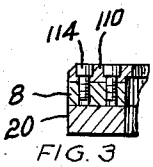


FIG. 3

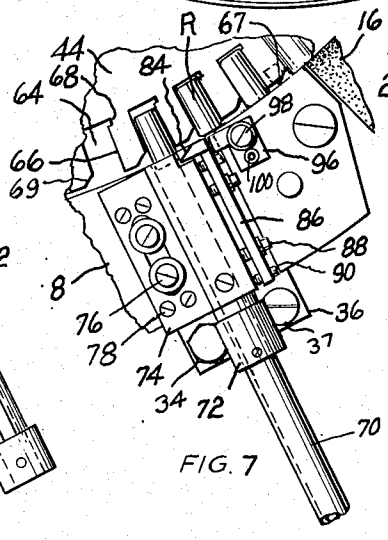


FIG. 7

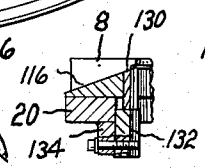


FIG. 4

FIG. 5

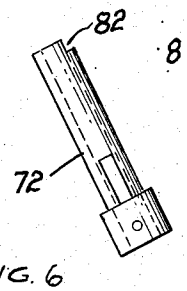


FIG. 6

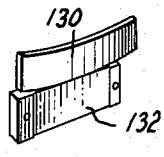


FIG. 8

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ABRADING MACHINE

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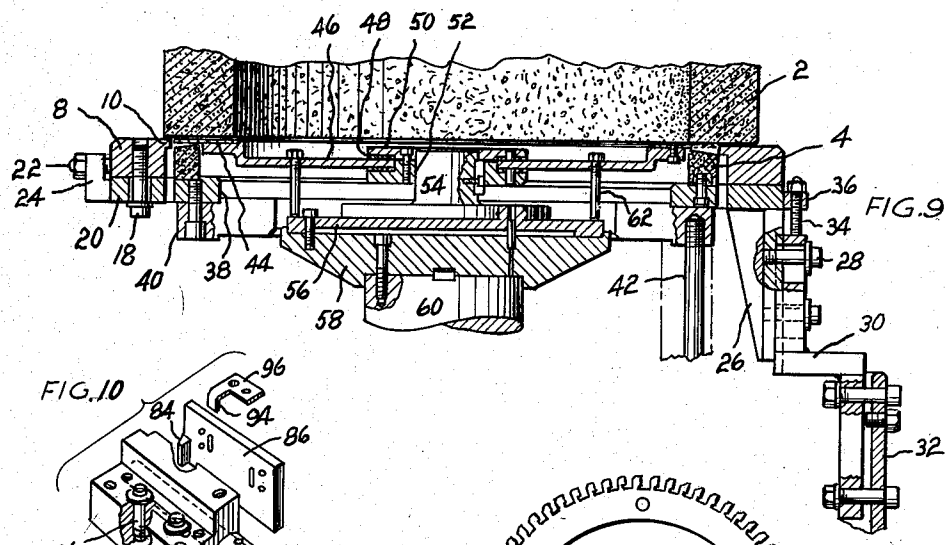


FIG. 9

FIG. 10

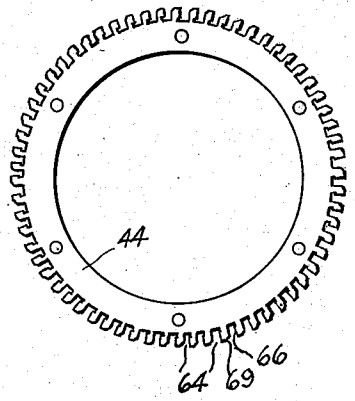


FIG. 11

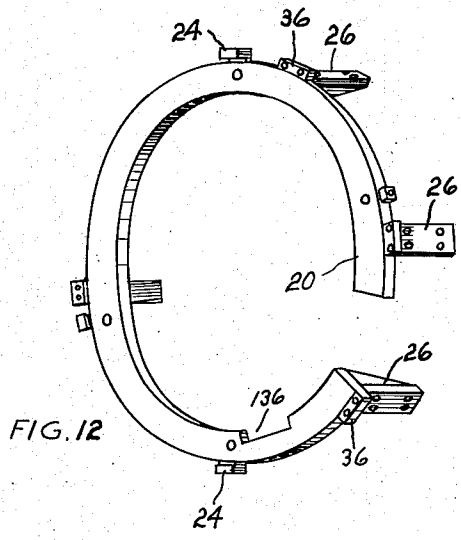


FIG. 12

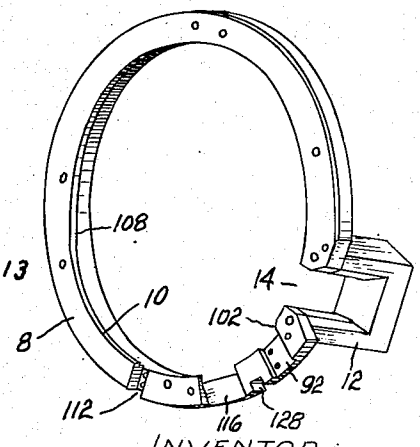


FIG. 13

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ABRADING MACHINE

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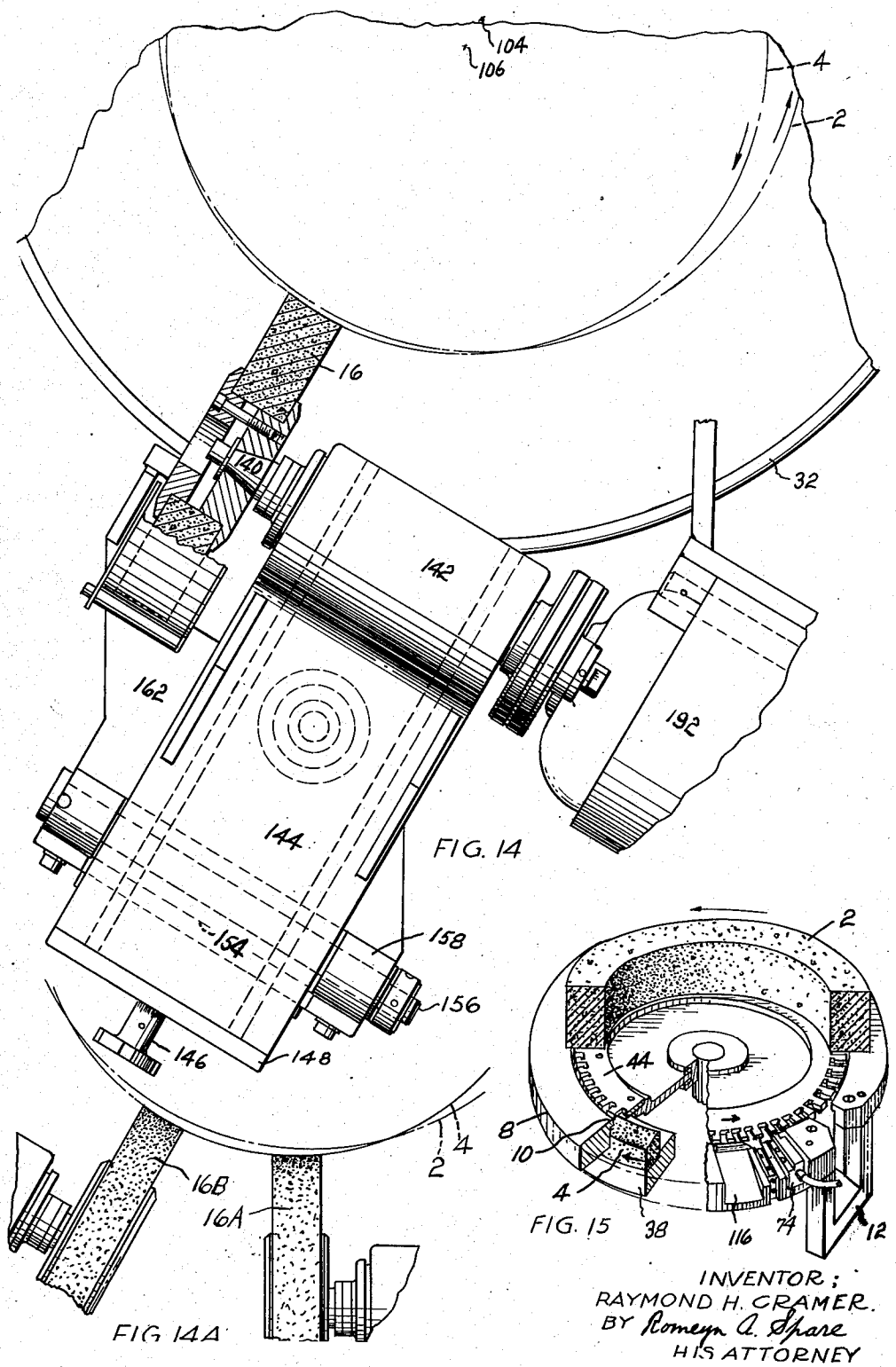


FIG. 14

FIG. 14A

FIG. 15

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ABRADING MACHINE

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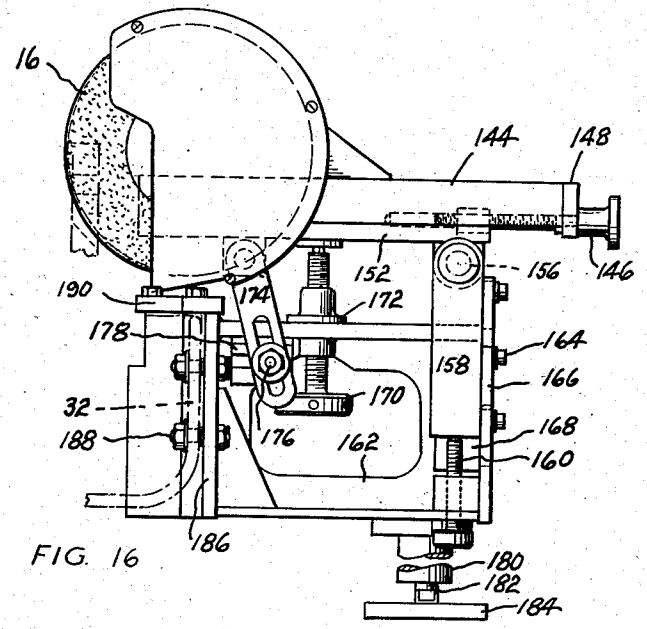


FIG. 16

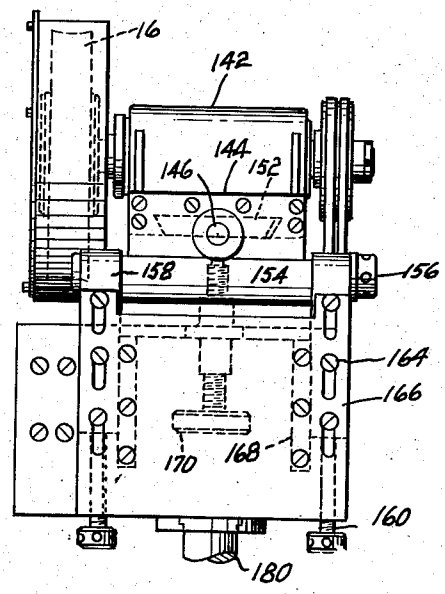


FIG. 17

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ABRADING MACHINE

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FIG. 18

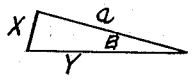
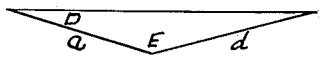


FIG. 19



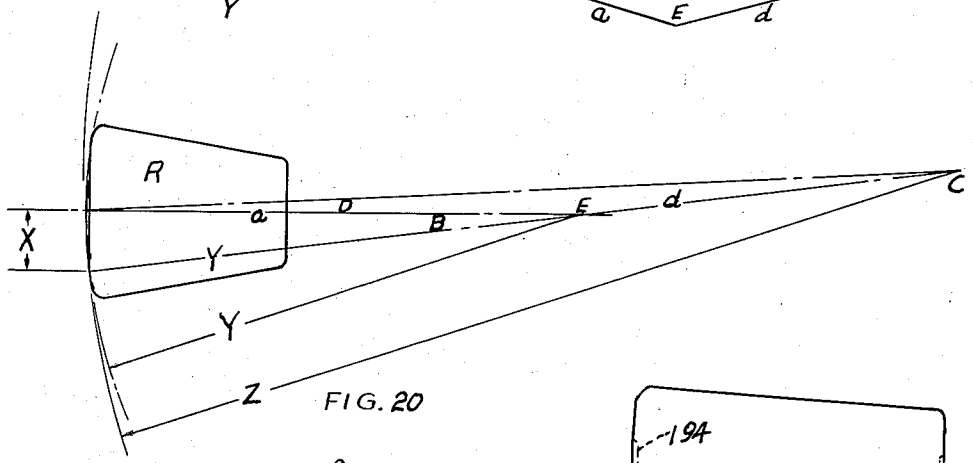


FIG. 20

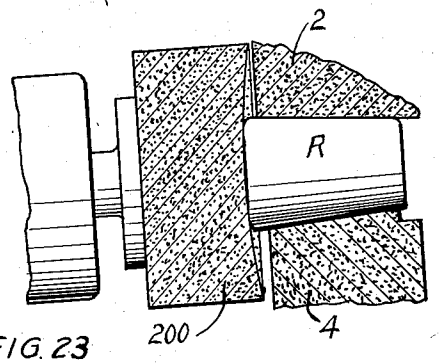
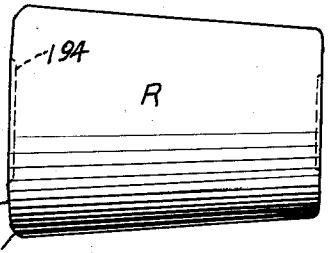


FIG. 23

FIG. 21



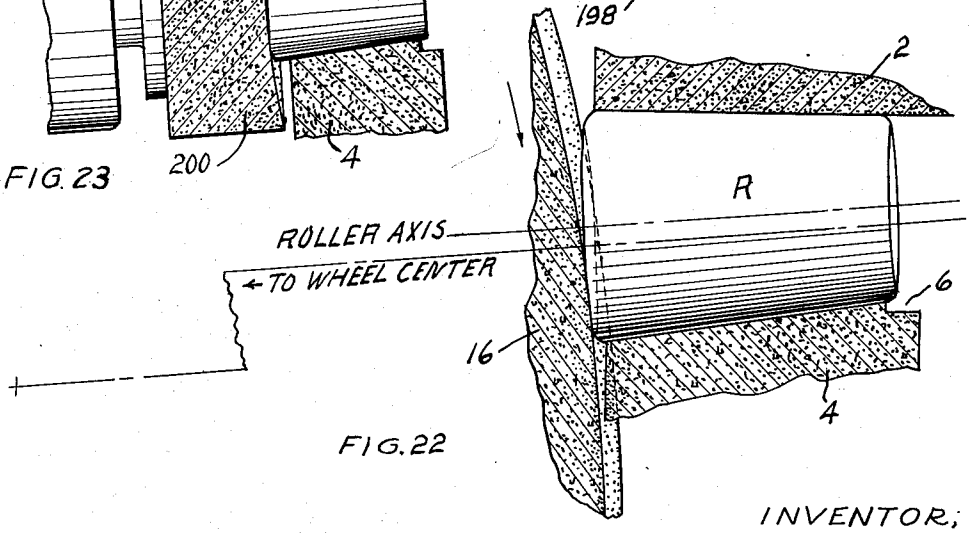


FIG. 22

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Patented Apr. 8, 1952

2,591,784

UNITED STATES PATENT OFFICE

2,591,784

ABRADING MACHINE

Raymond H. Cramer, Bloomfield, N. J., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application August 6, 1949, Serial No. 109,018

20 Claims. (Cl. 51—3)

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This invention relates to abrading machines. An object of the invention is to provide a machine for abrading, in one operation, the peripheral surfaces and the convex ends of tapered rollers to insure quality control. Another object is to provide a machine capable of abrading the peripheral surfaces and the rounded ends of tapered rollers of various sizes and wherein only a few elements require replacements or alteration when the sizes are changed. Another object is to provide a machine for grinding convexly curved surfaces on the ends of tapered rollers when the radii of those ends vary considerably with different sizes of rollers. Still another object is to provide a machine for these purposes which will not require a complete set of expensive parts for each size of roller to be treated but which can utilize all or nearly all of the same parts for several sizes of rollers. Yet another object is to provide an improved machine for lapping the peripheries of tapered rollers.

In the drawings,

Fig. 1 is a plan view with the upper lapping wheel removed.

Figs. 2, 3, 4 and 5 are sectional views on the corresponding section lines of Fig. 1.

Fig. 6 is a plan view of a loading sleeve.

Fig. 7 is a plan view of a portion of Fig. 1 enlarged.

Fig. 8 is a perspective view of a filler plate.

Fig. 9 is a cross sectional view of Fig. 1.

Fig. 10 is a perspective view of elements associated with the loading apparatus.

Fig. 11 is a plan view of a carrier ring.

Fig. 12 is a perspective view of a supporting ring.

Fig. 13 is a perspective view of a guide ring.

Fig. 14 is a plan view enlarged of a grinding wheel and its mounting.

Fig. 14A is a diagram.

Fig. 15 is a perspective view of important elements some being broken away.

Fig. 16 is a side elevation of the grinding wheel and its mounting.

Fig. 17 is an end view of Fig. 16.

Figs. 18, 19 and 20 are diagrams.

Fig. 21 is a view of one product roller enlarged.

Fig. 22 is a sectional view of roller engaging wheels in abrading position.

Fig. 23 is a modification similar to Fig. 22.

In commercial tapered roller bearings, one of the tapered race rings, usually the inner one, has a conical flange at the larger end and the ends of the tapered rollers bear against and are

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guided by this flange. A spherical surface or segment on the rollers is desirable, this surface usually having its center of curvature at the common apex of the conical bearing races and of the included angle of the rollers. Tapered rollers for the various sizes of bearings differ at least in diameter, in length, in the included angle and to a large degree in the radii of the convex ends. The performance and life of a bearing depend on the quality control and exact relation of the peripheries and ends of the rollers. In the present invention, certain compromises are adopted in the shape of the convex ends in order that the expense of a complete machine for every size of roller may be avoided. In grinding the ends of the various rollers, the surfaces are made nearly spherical but not quite though perfectly acceptable. During the abrading operation, the peripheries of the rollers are lapped and the ends are ground or ground and lapped in one operation.

The rollers are rotated on their axes between a conical regulating wheel and a flat lapping wheel. Both wheels serve for all sizes of rollers and the conical surface of the regulating wheel is merely dressed to adapt it for use with rollers of a different included angle. A carrier with roller pockets controls the travel of rollers in a substantially circular path through the machine and a different carrier is used if the included angle of the rollers is changed. As the rollers are lapped between the regulating wheel and the lapping wheel, their ends engage a guide ring which is interrupted for access of a concave grinding wheel which grinds the ends. This grinding wheel has the same transverse curvature for all rollers yet it grinds the convex ends of all rollers to near-spherical surfaces whose radii vary very considerably in the different runs of rollers. This is accomplished by skewing the pockets in the carrier to selected angles and by grinding the roller ends below center. Skewing tends to decrease the radius of the convex ends and the below center grinding tends to increase the radius until an acceptable near-spherical end is produced for each roller. Skewing the roller has other desirable results; it tends to hold the roller ends against the guide ring and it causes the lapping wheel to produce a very slight lengthwise curvature on the roller peripheries. This is advantageous in roller bearings because the peripheries of the rollers do not become overloaded near the ends where load tends to concentrate in use. Abrading the ends and the peripheries in one operation on one machine pro-

duces better rollers than when these operations are carried out separately. The accurate relation of the end of the roller to its peripheral surface is insured without change for error, and exact duplicates can be produced.

First outlining generally the functions of some important elements, tapered rollers are fed successively small end first into pockets of a rotary carrier and between an upper lapping wheel and a lower regulating wheel which rotate on vertical axes eccentric to one another and in different directions at different speeds. The carrier carries the rollers bodily in a substantially arcuate path while a fixed guide or cam ring engages the ends of the rollers and holds them in the carrier pockets. At one point in the arcuate travel the guide ring is interrupted and a grinding wheel which is concave engages the ends of the rollers. After travel for nearly a complete circle, a stripper blade cams each finished rolled from between the wheels.

An upper or lapping wheel 2 (Figs. 9 and 22) has its lower surface flat and horizontal to rest on the peripheries of the rollers R while the lower or regulating wheel 4 has its upper surface slanting or conical and at an inclination to the horizontal equal to the included angle of the rollers. The regulating wheel has a little notch 6 at its inner periphery to allow the rollers to overhang the conical surface slightly and so wear it evenly. Surrounding the lower wheel for nearly the whole circumference is a fixed guide ring 8 having a projecting guide rib 10 which, for the most part, is arcuate internally with its center of curvature concentric with the axis of the regulating wheel. A U-shaped bracket 12 is attached to the guide ring before a gap 14 is cut therein. The bottom of the bracket has a slanting surface which with the gap allows a concave grinding wheel 16 to have access to the ends of the rollers. The guide ring is adjustably fastened by screws 18 to a fixed supporting ring 20, the latter having oversize holes for the screws to provide for exact centering of the guide ring by horizontal screws 22 passing through a series of lugs 24 upstanding from the supporting ring. The latter has series of supporting brackets or legs 26 each of which is clamped in vertically adjusted positions by screws 28 passing through slots in an angular bracket 30 which is clamped by screws to the apron or guard 32 which usually surrounds the lower portion of a lapping machine. Vertical adjustment of the ring 20 is aided by vertical screws 34 threaded in lugs 36 in the ring 20 and resting on the brackets. Closely adjacent screws 37 are threaded in the bracket as shown in Fig. 2.

The lower or regulating wheel is secured by screws to a ring 38 which is in turn secured by screws to a lower ring 40 which is rotated by vertical rods 42 forming part of a drive mechanism, not shown. Extending between the wheels is a carrier 44 in the form of a ring secured to a dished carrier plate 46 which is frictionally driven through friction discs 48 interposed between an upper washer 50 and a lower washer 52 which are clamped against the friction discs by screws. The lower washer is splined to a vertical stud 54 upstanding from a disc 56 which is fastened by screws in a recess of a plate 58 in turn fastened by screws and keyed to a rotating shaft 60. Since rollers of different diameters are to be treated by the machine, the carrier has a small vertical adjustment which is effected by a series of bolts 62 threaded in the carrier plate 46 and riding on

the disc 56. The carrier plate is provided with a series of large openings 57 (Fig. 1) to lighten it and provide for access to screws below it. The carrier has a series of pockets 64 cut in its periphery. These pockets are non-radial or skewed and their opposite sides make the same angle with one another as the included angle of the rollers. In operation, the rollers bear (Fig. 7) against the leading sides 66 of the pockets and overhang little notches 68. Pressure and wear on these sides occur because the upper wheel tends to advance the rollers much faster than the carrier which holds the rollers back and controls bodily travel. The opposite side of each notch has a bevelled surface 69 to facilitate entry of the rollers. A dressing diamond 67 is mounted on the carrier between two notches.

The tapered rollers are fed small end first in a stream through an inclined tube 70 to a loading sleeve 72 which is clamped in the bore of a loading bracket 74 by a set screw. The bracket is adjustable radially and vertically of the guide ring 8. Screws 76 pass through a slot in the bracket and are threaded in the guide ring. Other screws 78 are threaded in the bracket and bear on the guide ring to effect the vertical adjustment. The bracket has a cut-out at one corner and the loading sleeve has a similar registering cut-out at 82. This is to allow the roller to move laterally out of these members if it is not entirely entered into its pocket in the carrier. Each roller is compelled to enter its pocket by a little cam surface 84 on a lug projecting laterally from a vertical cam plate 86. This plate is adjustably mounted on the side of the loading bracket by screws 88 passing through slots in the plate and threaded in the bracket and by screws 90 threaded in the plate and bearing on the bracket. The bracket is mounted in a radial notch 92 (Fig. 13) on top of the guide ring. Since lateral adjustment of the cam plate towards or from the bracket will vary the space between the plate and the adjacent wall of the notch 92, a lug 94 on a filler plate 96 is provided to substantially fill the space. This plate is clamped on the guide ring by a screw 98 after a little pivotal adjustment around the screw as allowed by a pin 100 fixed in the guide ring and entering an oversize hole in the filler plate. As the rollers are cammed into their pockets and pass the lug 94, they are or may be still further advanced by a little bevel or cam face 102 on the guide ring.

After the ends of the rollers are ground by the grinding wheel 16, they are retained in the pockets by the arcuate rib on the guide ring against which they are urged by a combination of factors, such as the skewing of the pockets and the eccentricity of the wheel axes. Fig. 14 indicates that the central plane of the grinding wheel is in line with the axes of the other two wheels, the axis of the upper wheel being at the point 104 and the axis of the lower wheel being at the point 106 and the outside radius of the upper wheel being the larger. The upper wheel has the fastest rotation and rotates anticlockwise at say 105 R. P. M.; the lower wheel rotates clockwise at say 17 R. P. M. while the carrier rotates anticlockwise at say 1½ R. P. M. The carrier axis and the lower wheel axis are concentric. The guide rib 10 is concentric with the last two axes for the most part, especially from the region of the grinding wheel for a little over one half a circle. Beyond this point, the guide rib is relieved as shown best at 108 in Fig. 13 to let the rollers begin to move

outwardly of the carrier pockets. Since the lower or regulating wheel is used in the lapping of rollers of different included angle, the inclination of its conical surface is dressed to the desired angle. Any suitable dressing device movable across the wheel at selected inclinations to the horizontal may be used and to this end, a segment 110 (Figs. 1 and 3) of the guide ring is made removable from a radial notch 112 thereof, the segment being secured by screws 114 when in place. This segment is removable in order that a dressing diamond can be moved up the inclined face of the wheel 4 from a point radially outside of the wheel. The lapping wheel 2 and the carrier plate 46 can be raised if necessary to make room for the diamond and its holder.

As the rollers approach the loading device, they are discharged down an inclined chute or notch 116 (Figs. 1 and 5) by a stripper cam or blade 118 having a cam face 120 facing outwardly. This blade is slotted for radial adjustment by screws 122 which secure it to the horizontal leg of an angle bracket 124 whose vertical leg is secured by screws 126 in a notch 128 of the guide ring. The bracket is slotted for vertical adjustment of the stripper blade. For convenience of machining portions of the guide ring, it is internally cut out in the region of the inclined notch and since outcoming rollers might hang up by their larger ends in this space, it is afterwards closed up by an arcuate filler 130 welded to the top of an internally arcuate plate 132 bolted to a lug 134 hanging from the supporting ring 20. The plate 132 enters a notch 136 in the supporting ring.

The grinding wheel 16 is concave with a transverse curvature whose center is at the common axis of the lower wheel and the carrier. It is carried on a spindle 140 journalled in a head 142 forming part of a slide 144 which is adjustable by a hand screw 146 journalled for rotation in a plate 148 attached to the slide and threaded in a nut 150 on a dovetailed guide plate 152 having ways. The guide plate has a depending sleeve 154 which is pivoted on a pivot stud 156 journalled at the top of a pair of vertically adjustable pivot blocks 158 which are vertically adjustable by screws 160 threaded in blocks on a main supporting bracket 162 made of welded parts. The pivot blocks are clamped in adjusted position by screws 164 passing through slots in an upright web 166 of the main bracket. Guide bars 168 are fixed to this upright web one alongside of each pivot block. The purpose of pivoting the wheel slide is to locate it in an inclined plane parallel to the axis of the roller being ground. The purpose of the vertical adjustment of the pivot blocks and pivot is to select the height of this inclined plane so that grinding wheel will engage the ends of the rollers a selected distance below center. The pivoting adjustment of the slide and its guide plate is effected by a hand screw 170 threaded in a nut 172 carried by the supporting bracket and engaging the guide plate. After adjustment, the position is maintained by a pair of slotted links 174 each pivoted to the guide plate, the slot of each link receiving a clamping T-bolt 176 whose head is received in a channel on a depending lug 178 of the main bracket.

The main bracket 162 has some vertical adjustment as a whole from the floor by a tall jack body 180 engaged by a jack screw 182 resting on a foot plate 184. The bracket has a vertical web 186 arching around the apron and secured to it by bolts 188 and set screws, the apron being vertically slotted for the bolts. The main bracket also has an overhanging supporting flange 190 provided with vertical adjusting screws engaging the top of the apron. The grinding wheel is enclosed in a guard having a side cover. The wheel spindle is belt driven from a motor 192 suitably mounted on the apron 32.

Fig. 14A shows a modification wherein two wheels 16A and 16B will act successively on the ends of the rollers in the region where the upper and lower wheels are most nearly in peripheral registration. These wheels 16A and 16B may be of different grit for rough and finish grinding or for end grinding followed by lapping or honing. In the machine illustrated in Fig. 1, the end grinding or lapping occurs just after peripheral lapping begins and long before it ends. Certain reversals are contemplated by which the rollers will travel clockwise instead of anticlockwise thus performing most of the peripheral lapping before the ends of the rollers are treated. To accomplish this, the directions of rotation of the upper and lower wheels and of the carrier are reversed accompanied by changing the relative locations of the feeding and ejecting mechanism.

In Fig. 21 a tapered roller R is shown greatly enlarged. Such rollers become centrally recessed as at 194 in manufacture prior to grinding thus leaving an annular land 196 between the central recess and the corner radius 198. Portions of this land surface bear on the usual flange of inner race rings of roller bearings and the roller is guided thereby. The land surface preferably should lie in the surface of a sphere whose center is at the apex of the included angle of the roller. It can be so ground but since rollers for different bearings differ in included angle and dimensions, an expensive machine for each size of roller would be needed unless advantages are taken of certain suitable acceptable approximations and compromises. This is done in the present instances by skewing the carrier pockets a calculated amount which tends to reduce the radius of the roller ends and by grinding the roller end below center in its skewed position to increase the radius somewhat.

Fig. 22 shows the roller in abrading position and with the concave abrading wheel 16 engaging the land below the axis of the roller and on the advancing half of the roller. The dressing diamond of Fig. 7 acts across the roller axis. Fig. 23 shows an alternative form of abrading wheel 200 whose end face is formed as a segment of a sphere whose radius of curvature corresponds to that of the concavity of the wheel 16. This wheel may be coaxial with the axis of the roller or below it and will have a natural lapping action. It can act in place of the wheel 16 or after it as in the case of the wheel 16B in Fig. 14A.

Figs. 18, 19 and 20 are diagrams indicating how the angle of skew is selected, the included angle of the roller and its diameter being exaggerated. From the product drawing of the roller, the apex distance Y of the included angle is known and the radius Z is that of the guide ring and the grinding wheel concavity. The distance X is the perpendicular distance from the mean diameter of the land 196 to the axis a of the roller. From these known quantities the small angle D which is the desired angle of skew can be calculated with the aid of the two triangles. From the

smaller or right triangle, angle B is first determined its sine being

$$\frac{X}{Y}$$

and the base $a=\sqrt{Y^2-X^2}$. In the larger triangle, the side a is now known and the side d is $Z-Y$. Angle E is the supplement of angle B. Angle D, the desired angle is then found by formula, its tangent being

$$\frac{d \sin E}{a-d \cos E}$$

The purpose of determining the angle of the pockets is to locate the rollers so that the concave abrading wheel will center its operation upon the annular land 196 at the mean diameter. The more the roller is tilted, the sharper its end curvature becomes. The smaller the included angle of the roller, other things being equal, the greater is the apex distance and the point E more nearly approaches the center C of the carrier. The less the roller is tilted, the less its end surface departs from a spherical surface. The departure from a spherical surface is not unduly large for practical use and it can be minimized by lowering the end abrading wheel until gauging of a preliminary ground roller shows it is within the desired tolerances. For many roller sizes, the tilted angle will range from an angle considerably less than one degree to a little over one degree. The surface of the annular land 196 may be defined as a surface of revolution generated by revolving an arc about the axis of the roller, the radius of the arc being the distance Z, this radius moving in the surface of a cone and the center of the arc moving in a circle about the roller axis.

With the various wheels in rotation, the rollers are fed successively into the pockets of the carrier and between the upper and lower wheels which turn the rollers on their axes, the carrier controlling bodily travel. As the rollers are cammed into their pockets, their peripheries begin to be lapped. As the rollers pass the concave wheel, their ends are ground or lapped and thereafter peripheral lapping is continued until the rollers leave the pockets. As above mentioned, the order can be reversed to do most of the peripheral lapping before the rollers ends are treated and these ends can be treated by a plurality of wheels acting in succession. By treating both peripheries and ends in one machine at one set-up, the relations of these surfaces can be accurately maintained for production of quality rollers, something that would not be possible with separate machines. Rollers of various dimensions can be reliably produced with little duplication of machine parts, the calculated skewing of the pockets being largely responsible for this economy.

I claim:

1. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, an abrading wheel having a concave surface externally of said space and curved about the axis of the regulating wheel, and means for causing the abrading wheel to produce a convex curvature on the ends of the rollers differing from the curvature of said wheel surface, said means comprising a carrier having roller pockets slightly inclined to radii of the carrier to hold the rollers tilted for contact at one side of their axes with the concave wheel surface.

2. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, an abrading wheel having a concave surface externally of said space and curved about the axis of the regulating wheel to abrade the ends of the rollers to convex shape, and means for causing the rollers to travel bodily in the tapered space with their axes slightly tilted with respect to radii of the regulating wheel in order to present their ends at one side of said axes to the concave surface, and the axis of said abrading wheel being located below the roller axes.

3. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, an abrading wheel having a concave surface externally of said space and curved about the axis of the regulating wheel to abrade the ends of the rollers to convex shape, a guide of generally arcuate form extending from the opposite sides of the concave wheel around the tapered space to engage the ends of the rollers and guide the rollers for peripheral lapping, and a driven carrier having roller receiving pockets slightly inclined to radii of the carrier in a direction to cause the small ends of the rollers to lead the larger ends.

4. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, an abrading wheel having a concave surface externally of said space and curved about the axis of the regulating wheel to abrade the ends of the rollers to convex shape, a guide of generally arcuate form extending from the opposite sides of the concave wheel around the tapered space to engage the ends of the rollers and guide the rollers for peripheral lapping, and a driven carrier having roller receiving pockets slightly inclined to radii of the carrier, and means for inserting tapered rollers successively into the tapered space at one point in its circumference and removing abraded rollers at another point.

5. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, the lapping wheel being larger than the regulating wheel and having its axis of rotation in a different line, the peripheries of said wheels being in substantial registration at one portion of the circumference, an abrading wheel having a concave surface at said portion and curved about the axis of the regulating wheel to abrade the ends of the rollers, and a guide of generally arcuate form extending from the opposite sides of the concave wheel around the tapered space to guide the rollers for peripheral lapping between the lapping wheel and the regulating wheel.

6. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, the peripheries of said wheels being in substantial registration at one portion of the circumference, an abrading wheel having a concave surface at said portion and curved about the axis of the regulating wheel to abrade the ends of the rollers, a guide of generally arcuate form extending from the opposite sides of the concave

wheel around the tapered space to guide the rollers for peripheral lapping between the lapping wheel and the regulating wheel, and a driven carrier for controlling the bodily travel of the rollers, the carrier having roller receiving pockets inclined to its radii at a calculated angle to cause the concave wheel to produce a different curvature on the ends of the roller than the curvature of the concave wheel.

7. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, one wheel being smaller than the other and having its axis eccentric to the axis of the other to place the peripheries in substantial registration at a portion of their circumference, an abrading wheel having a concave surface at said portion and curved about the axis of the smaller wheel to abrade the ends of the rollers, and a guide of generally arcuate form extending from the sides of the concave wheel around the tapered space to guide the rollers for peripheral lapping between the lapping wheel and the regulating wheel.

8. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, one wheel being smaller than the other and having its axis eccentric to the axis of the other to bring the peripheries into substantial registration at a portion of the circumference, an abrading wheel having a concave surface at said portion and curved about the axis of the smaller wheel to abrade the ends of the rollers, a guide of generally arcuate form extending from the sides of said concave wheel around the tapered space to guide the rollers for peripheral lapping between the lapping wheel and the regulating wheel, and means for inserting rollers successively into the tapered space at one point in the circumference and removing them from an adjacent point.

9. In a machine for abrading the peripheries and ends of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, one wheel being smaller than the other and having its axis eccentric to the axis of the other to bring the peripheries into substantial registration at a portion of the circumference, an abrading wheel having a concave surface at said portion and curved about the axis of the smaller wheel to abrade the ends of the rollers, a guide of generally arcuate form extending from the sides of the concave wheel around the tapered space to guide the rollers for peripheral lapping between the lapping wheel and the regulating wheel, and a driven carrier having roller pockets between the last mentioned wheels for controlling the bodily travel of the rollers.

10. In a machine for abrading the ends and the peripheries of tapered rollers, a lapping wheel and a regulating wheel arranged one above the other and having their adjacent faces relatively tapered to receive tapered rollers therebetween, a guide ring extending about the tapered space and having a gap, an abrading wheel having a concave surface entering the gap to engage the ends of the rollers, a carrier having roller pockets open towards the guide ring and the concave surface of the abrading wheel, means for rotating the carrier to control the bodily travel of the rollers along the guide ring and said concave surface, and the pockets being slightly inclined with respect to radii of the carrier to cause the ends of the rollers to engage the concave surface at one side of their axes of rotation.

11. In a machine for abrading the ends and the peripheries of tapered rollers, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, a guide ring extending about the tapered space to engage the ends of the rollers, said guide ring having a gap, abrading wheels entering the gap for successive action on the ends of the rollers, and means for causing the rollers to travel bodily in an arcuate path inside of the guide ring.

12. In a machine for abrading the convex ends of tapered rollers which vary in their apex distance and diameter, a pair of wheels rotating in opposite directions one above the other and having opposed surfaces relatively inclined to form a tapered space to receive the peripheries of the rollers for rotation around their axes, one wheel being larger than the other and having its axis of rotation in a different line, an abrading wheel at the outside of said tapered space and having a concave surface curved about a center at the axis of the smaller wheel, a driven carrier having pockets for the rollers to control their passage across the concave surface, the pockets being inclined to radii of the carrier at a calculated small angle depending on the included angle and diameter of the rollers to cause the roller ends to engage said concave surface at one side of their axes for production of a near spherical surface with a slightly sharper curvature than that of said concave surface.

13. In a machine for abrading the convex ends of tapered rollers which vary in their apex distance and diameter, a pair of wheels rotating in opposite directions and having opposed surfaces relatively inclined to form a tapered space to receive the peripheries of the rollers for rotation around their axes, an abrading wheel at the outside of said tapered space and having a concave surface curved about the axis of one of the wheels, a driven carrier having pockets for the rollers to control their passage across the concave surface, the pockets being inclined to radii of the carrier at a calculated small angle depending on the included angle and diameter of the rollers to cause the roller ends to engage said concave surface at one side of their axes for production of a convexity with a sharper curvature than that of said concave surface, and the axis of said abrading wheel being located below the roller axes to make said curvature less sharp.

14. In a machine for abrading the peripheries and ends of tapered rollers in one operation, a lapping wheel and a regulating wheel for rotating the rollers on their axes and lapping the peripheries thereof, means for causing the rollers to travel bodily between the wheels, a concave abrading wheel engaging the ends of the rollers to produce convex ends on the rollers during their rotation and bodily travel, and means for positioning the concave wheel to make contact with the end of the rollers below their axes and in a region nearer to one of those wheels which engage the roller peripheries than to the other of those wheels.

15. In a machine for abrading the peripheries and ends of tapered rollers in one operation, a lapping wheel and a regulating wheel for rotating the rollers on their axes and lapping the peripheries thereof, means for causing the rollers to

travel bodily between the wheels, a concave abrading wheel engaging the ends of the rollers to produce near spherical surfaces, and means for making the same concave wheel serve for abrading different curvatures on rollers of different dimensions and taper, said means comprising a device for making the rollers engage the concave wheel at only one side of their axes at a given instant.

16. In a roller abrading machine, a lapping wheel and a regulating wheel spaced apart to engage the peripheries of rollers therebetween, means for causing the rollers to travel bodily in the space with their axes slightly tilted with respect to radii of the regulating wheel, and an abrading wheel having a convex surface externally of said space and curved about the axis of the regulating wheel to engage the ends of the tilted rollers at one side of their axes and thus produce a curved surface of smaller radius than that of the convex wheel surface.

17. In a roller abrading machine, a lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, one wheel being smaller than the other and having its axis eccentric to the axis of the other, a guide of generally arcuate form extending around the greater portion of the tapered space to engage the ends of the rollers and guide the rollers in a generally arcuate path, and a driven carrier for controlling bodily travel of the rollers, the carrier having roller pockets inclined at a small angle of the order of one degree to radii of the carrier to cause the peripheries of the rollers to be minutely crowned lengthwise as they travel between the wheels.

18. In a machine for abrading the peripheries and ends of tapered rollers, an abrasive lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, means for rotating the lapping wheel and regulating wheel, the lapping wheel being driven many times faster than the regulating wheel and abrading the peripheral surfaces of the rollers, an abrading wheel having a concave surface externally of said space and curved about an axis to abrade the ends of the rollers to convex shape, and mechanism causing the rollers to travel bodily in said space at a speed many times faster than that of the regulating wheel rotation and across said concave surface to simultaneously grind the peripheries and ends of the rollers in a single operation.

19. In a machine for abrading the peripheries and ends of tapered rollers, an abrasive lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, means for simultaneously rotating the lapping wheel and regulating wheel at different speeds from each other, an abrading wheel having a concave surface externally of said space and curved about the axis of the regulating wheel to abrade the ends of the rollers to convex shape, and a guide of generally arcuate form extending from the opposite sides of the concave wheel around the tapered space and engaging the ends of the rollers and guiding them for peripheral lapping, said lapping wheel having a speed of rotation many times greater than that of the regulating wheel to abrade the peripheries of the rollers.

20. In a machine for abrading the peripheries and ends of tapered rollers, an abrasive lapping wheel and a regulating wheel spaced apart and defining a tapered annular space for tapered rollers therebetween, mechanism to simultaneously rotate the lapping wheel and the regulating wheel at different rates and in opposite directions with respect to each other, an abrading wheel having a concave surface externally of said space and curved about the axis of the regulating wheel to abrade the ends of the rollers, a guide generally arcuate in form and extending from the opposite sides of the concaved abrading wheel around said tapered space and guiding the rollers for lapping of their peripheries, and a carrier driven in the same direction as the lapping wheel at a slower speed than either of said wheels for controlling bodily travel of the rollers, said carrier having roller-receiving pockets, the lapping wheel being rotated at a rate of speed many times greater than that of the regulating wheel to peripherally abrade said rollers.

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