March 29, 1927. 1,622,527

E. F. MAAS

GRINDING MACHINE

Filed April 14, 1922 3 Sheets-Sheet 2

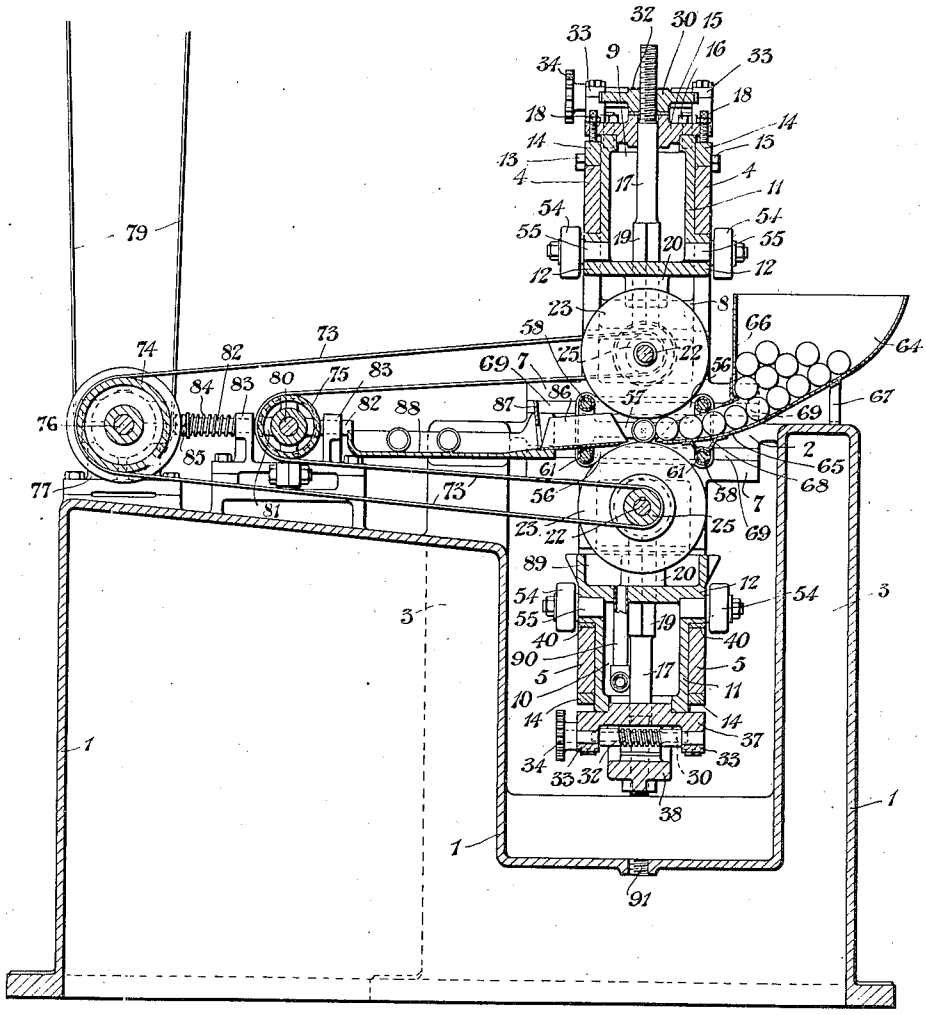


Fig. 2.

Inventor
Elov F. Maas.
By his Attorneys
Marks & Clerk

March 29, 1927. 1,622,527

E. F. MAAS

GRINDING MACHINE

Filed April 14, 1922 3 Sheets-Sheet 1

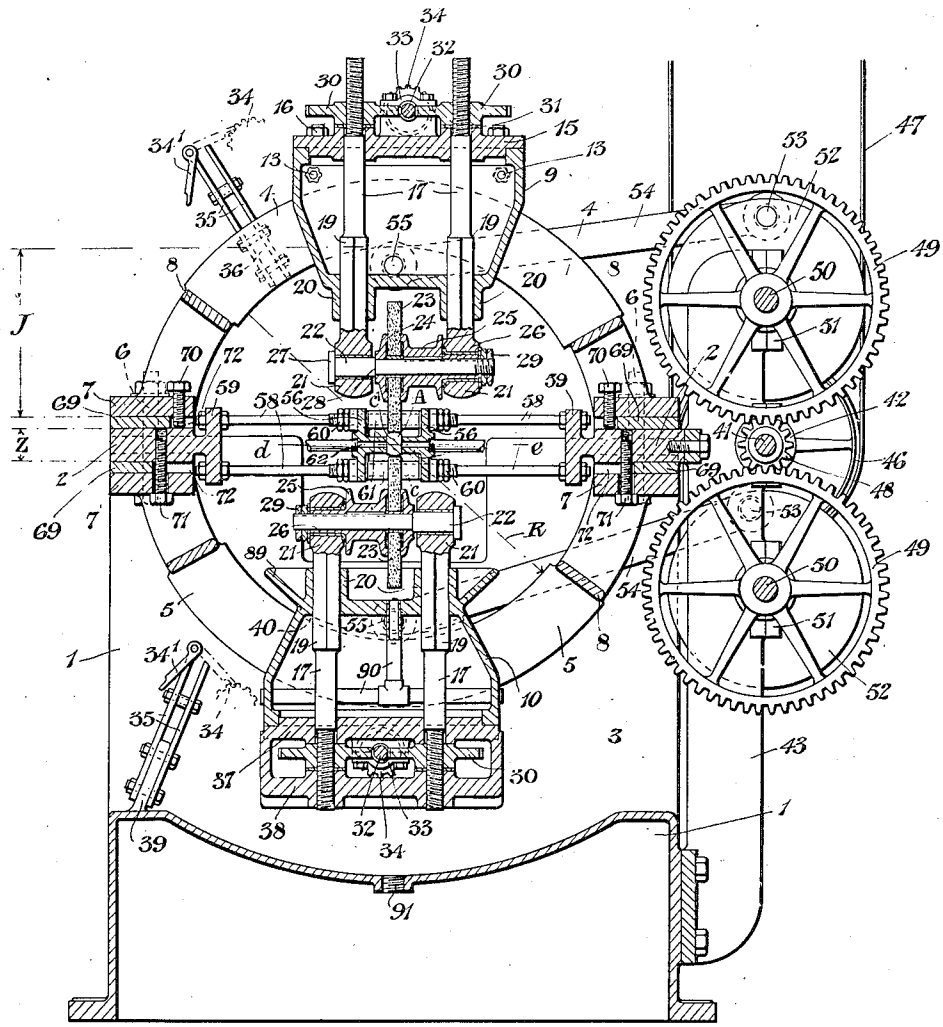


Fig. 1.

Inventor
Elov F. Maas.
By his Attorneys.
Marks & Clerk

March 29, 1927. 1,622,527

E. F. MAAS

GRINDING MACHINE

Filed April 14, 1922 3 Sheets-Sheet 3

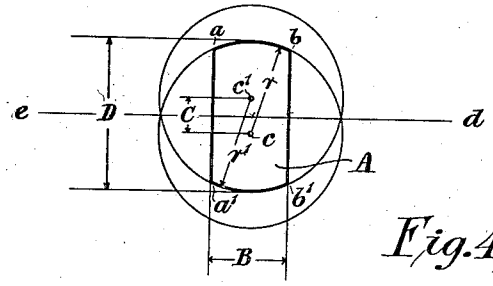



Fig.4.

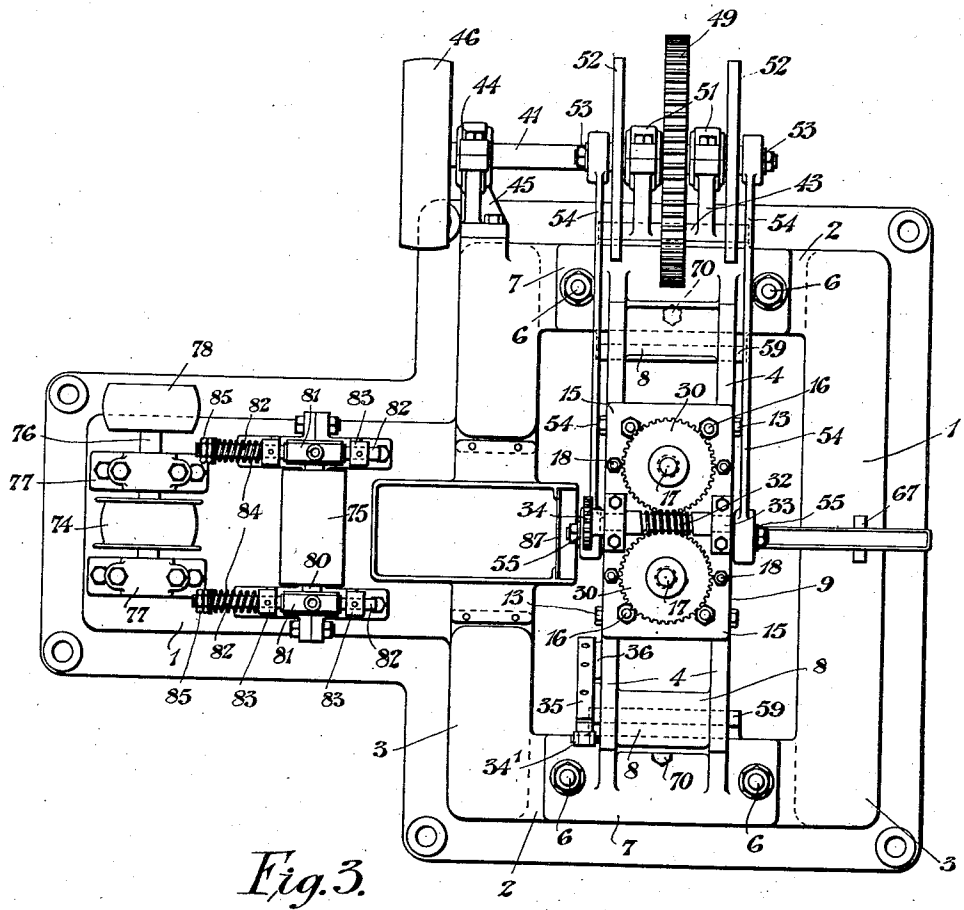



Fig.3.

Inventor
Elov F. Maas.
By his Attorneys
Marks & Clerk

Patented Mar. 29, 1927. 1,622,527

# UNITED STATES PATENT OFFICE.

ELOV F. MAAS, OF LONG BRANCH, NEW JERSEY.

## GRINDING MACHINE.

Application filed April 14, 1922. Serial No. 552,552.

The object of this invention is to provide a grinding machine capable of producing automatically an ellipsoidal surface upon an article, the machine being particularly designed for the production of ellipsoidal surfaces upon the rolling elements for use in disc roller bearings.

One form of machine constructed and operating in accordance with the present invention will be fully described and the distinctive features of the machine will appear clearly from this description and will be pointed out in the claims appended hereto.

This form of machine is illustrated in the accompanying drawings, in which:

Figure 1 is a vertical sectional view of the machine, the section being taken along a plane including the axes of the grinding wheels and rolling element being ground;

Figure 2 is a vertical sectional view of the machine, the plane of the section being at right angles to that of Figure 1 and including the grinding wheels and rolling element being ground;

Figure 3 is a plan view of the machine shown in Figures 1 and 2, and

Figure 4 is a diagram showing a form of rolling element capable of being ground by the machine illustrated in the preceding figures.

A rolling element or roller adapted to be ground by the present machine is indicated by the heavy lines in Figure 4. The figure representing the roller and indicated at A is bounded by two parallel straight lines representing the flat side faces of the roller and by two arcs $a$—$b$, $a'$—$b'$ representing the peripheral surface of the roller. These arcs form parts of circles having radii $r$ and $r'$ respectively and centers $c$ and $c'$ respectively, which are spaced apart as indicated. The peripheral surface or surface of revolution of the roller A is generated by the rotation of the circular arc $a$—$b$ not about its center $c$ but about an axis $d$—$e$ which is midway between the centers $c$—$c'$ and is parallel to a straight line joining the points $a$ and $b$. The peripheral surface of the roller is thus not spherical but ellipsoidal.

This kind of roller has three determining dimensions, namely, the diameter D, the width B and the distance C between the centers of curvature $c$ and $c'$. It will be seen that the radius $r$ or $r'$ is fixed when the diameter D and the distance C are given, the radius being equal to one-half of the sum of D and C.

The grinding machine according to the present invention is designed to have adjustments to enable it to operate upon rollers or like articles having different diameters, widths and distances between the centers of curvature, and the machine will now be fully described with reference to Figures 1, 2 and 3.

The machine comprises a supporting framework 1 which is designed to support all of the parts of the machine in proper operative relation. At opposite sides of the machine framework 1, Figure 1, are integrally or otherwise formed guide supports or webs 2 which, as shown more clearly in Figure 2, extend across the space between upstanding portions 3 of the framework, between which upstanding portions moves the lower wheel carriage hereinafter referred to.

Supported upon and suspended from the guide supports or webs 2 are the upper and lower circular guides 4 and 5 respectively, these guides being secured to the webs 2 by means of the bolts 6 passing through the flanges 7 of the guides and through the webs 2. Each guide, as clearly shown in Figures 2 and 3, comprises two spaced guide members connected rigidly together by integral webs 8, such webs being spaced apart sufficiently to allow of the required movement of the wheel carriages upon the guides 4 and 5 during the grinding operation.

The upper and lower wheel carriages are indicated respectively by the numerals 9 and 10, the wheel carriages being substantially similar in form, although differing slightly in detailed construction, as will be later pointed out.

The upper wheel carriage comprises a hollow body member 11 fitted between the spaced members 4—4 of the upper circular guide and having laterally projecting portions 12 at its lower portion, the upper surfaces of which are curved to contact with the lower surfaces of the guide members 4. At its upper part the body 11 of the wheel carriage, has secured thereto, as by means of studs 13, two bearing members or strips 14, the lower surfaces of which are curved to contact with the upper curved surfaces of the guide members 4. By this arrangement

it will be readily seen that the wheel carriage 9 is securely mounted upon the circular guide 4 so as to move in a circular path.

Secured to the upper part of the body 11 of the wheel carriage is a top plate or cover 15 held to the body by means of studs and nuts 16, this top plate or cover serving to support the wheel shaft supporting spindles 17, later referred to.

In order to accurately adjust the bearing members 14 to enable the wheel carriage to move freely upon its circular guide 4, and in case of wear, these bearing members may be adjusted toward the guide members 4 by means of square ended studs 18 carried by the top plate 15 and engaging the upper sides of the bearing members, these studs being provided with suitable locking nuts as indicated. It will be understood that the apertures in the bearing members 14 for the studs 13 are such as to permit of this adjustment.

The wheel shaft supporting spindles 17 are formed intermediate their ends with square portions 19 fitting corresponding apertures in bosses 20 at the lower part of the carriage body to prevent rotation of said spindles, and they are provided at their lower ends with heads 21 in which the wheel shaft 22 is supported. This shaft 22 has mounted thereon a grinding wheel 23 of suitable diameter and thickness, the wheel being firmly clamped and held between a disc 24 and a driving pulley 25 at opposite sides of the wheel, the pulley being suitably keyed to the wheel shaft. The driving pulley 25 has extending axially from one side thereof a sleeve portion 26 which is mounted in the head 21 of one of the spindles 17, and the wheel shaft is provided at one end with a head 27 and with an intermediate shoulder 28 engaging the disc 24, the shaft being threaded at its other end and having thereon nuts 29. With this construction when the nuts 29 are tightened on the wheel shaft the wheel 23 is firmly clamped between the disc 24 and pulley 25 and is thereby rotated with the pulley and shaft. By removing the nuts 29 the shaft 22 may be withdrawn, thereby enabling the wheel 23 to be removed and replaced while leaving the driving pulley 25 in place with its sleeve portion 26 bearing in the head 21.

The supporting spindles 17 at their upper ends pass freely through the top plate 15 and are provided at said ends with screw threads upon which are threaded nuts 30. These nuts at their lower sides bear against the upper side of the top plate 15 and thus support the spindles 17 and the wheel shaft carried thereby. If desired, suitable anti-friction discs or other devices 31 may be interposed between the nuts 30 and the top plate 15. It will be seen that by rotation of the nuts 30 on the threaded portions of the spindles 17 in one direction or the reverse, the spindles, which are held against rotation, may be raised or lowered to correspondingly raise or lower the grinding wheel shaft to thereby adjust the grinding wheel so that it may operate upon rollers or the like of different diameters.

Mechanism may be provided for effecting a fine adjustment of the spindles 17 in addition to the coarse adjustment provided by the nuts 30 on the threaded portions of the spindles. This mechanism comprises a worm or screw 32 supported in bearings 33 on the top plate 15, the nuts 30 being provided with teeth to engage opposite sides of this screw. On the projecting end of the screw spindle is mounted a ratchet 34 adapted at the limit of movement of the wheel carriage in one direction to be engaged by a pawl 34'. This pawl is pivotally mounted on one of two supporting plates 35 which are bolted to a lug 36 projecting from one of the guide members 4, the pawl being movable from an inoperative position indicated in full lines in Figure 1, to an operative position indicated in dotted lines, in which it rests on the upper end of the other plate 35 in such position as to engage the ratchet 34 and advance the same through a single tooth space. When the ratchet is thus turned it rotates the screw 32 and thereby the nuts 30 are rotated so as to lower the supporting spindles 17. By this means the grinding wheel may be adjusted to take up wear therein.

As above stated, the lower wheel carriage is similar in construction to the upper wheel carriage, excepting, of course, that it occupies a reverse position on the circular guide 5, the wheel shaft being carried at the upper ends of the supporting spindles 17. The detailed construction of the supporting spindles 17 and of the wheel shaft, wheel, and driving pulley therefor, are the same as described with reference to the upper wheel carriage, similar reference letters being applied to these parts.

It will be noted that the adjusting nuts 30 are on the lower threaded portions of the spindles 17 and the lower plate or member 37 corresponding to the top plate 15 of the upper wheel carriage, is provided with a portion 38 lying beneath the nuts 30 and upon which the nuts are supported, preferably by means of friction discs or other devices, whereby the spindles 17 and wheel shaft carried thereby are properly supported and are adapted to be raised or lowered by rotating the nuts 30 in one direction or the reverse. It will be understood that the threaded portions of the supporting members extend freely through the part 38 of the lower plate 37.

The worm or screw 32 of the lower wheel carriage is adapted to be actuated at the limit of movement in one direction of said

carriage by the pawl 34′ pivoted on one of the supporting plates 35, as described with reference to the upper wheel carriage, the lower supporting plates 35, however, being bolted to a projection 39 on the framework 1 of the machine.

The bearing members 14 of the lower wheel carriage are curved to engage the lower parts of the guide members 5 and preferably upper bearing strips 40 are provided between the upper surfaces of the guide members 5 and the projecting portions 12 of the lower carriage body.

The wheel carriages 9 and 10 are given a slow reciprocating motion over the circular guides 4 and 5 by the mechanism which is illustrated in Figures 1 and 3. This mechanism comprises a shaft 41 mounted in bearings 42 on a bracket member 43 which is secured to the machine framework 1 as illustrated clearly in Figure 1, and in a bearing 44 on a bracket 45 also secured to said framework. This shaft 41 is provided at its outer end with a pulley 46 connected by a belt 47 with a suitable overhead countershaft and is provided at its inner end with a pinion 48, Figure 1, meshing with two gear wheels 49 mounted on shafts 50 supported in bearings 51 in said bracket 43. Secured to each of the shafts 50 on opposite sides of the gear thereon are two crank discs 52 having crank pins 53 thereon. The crank pins 53 of the upper pair of discs 52 are connected to the outer ends of connecting rods 54, the inner ends of which are connected to pins 55 projecting from opposite sides of the carriage body 11 of the upper wheel carriage 9. Similarly the crank pins 53 of the lower pair of crank discs 52 are connected by the connecting rods 54 to laterally projecting pins 55 on the carriage body 11 of the lower wheel carriage 10. It will be seen that when the shaft 41 is rotated by the pulley 46 it will, through the pinion 48 and gears 49, rotate the shafts 50 and the crank discs 52 thereon, and the rotary motion of these discs will, by means of the connecting rods 54, be converted into reciprocatory motion of the upper and lower wheel carriages 9 and 10 upon the guides 4 and 5.

The motion of the wheel carriages may be such that they both swing toward the same side of the machine simultaneously, as shown in the drawings, or it may be such that the wheel carriages move in opposite directions and perform the grinding at points on the roller which are approximately diametrically opposite. The change from one motion to the other can be accomplished by resetting one of the gears 49 and its associated crank discs 52 so that the crank pins 53 on said discs are turned through 180 degrees. No specific difference in the operation of the machine or the mode of grinding will result from this change, although it may be considered preferable to let the grinding wheels swing to the same side of the machine simultaneously as this may result in a more satisfactory guiding of the roller between its supporting plates, which will be later described.

In Figures 1 and 2 the roller being ground is marked A and is of the form already described with reference to Figure 4. It will be understood that the rollers to be ground by the present machine have their plane sides previously ground so that the rollers will have the desired width before being placed in the machine, as no grinding of the plane sides takes place in this machine.

The rollers are guided and held in proper position during the grinding operation by means of plates 56 having inwardly projecting portions 57 between which the rollers pass. The plates 56 are mounted upon rods 58 which are mounted and secured at their outer ends in apertures in flanges 59 carried by the webs 2, four of these rods 58 being employed as clearly shown in Figure 2.

As previously stated, the present machine is arranged for adjustment so that it may operate upon rollers of different widths and for the purpose of such adjustment the central portions of the rods 58 are screw-threaded, nuts 60 being arranged on the screw-threaded portions at the outer sides of the plates 56 and spacing sleeves 61 are arranged on the rods between the plates 56. By selecting spacing sleeves of proper length and mounting the same on the rods 58 between the plates 56, and by then tightening the nuts 60 to hold the plates 56 against the ends of the sleeves, the adjacent surfaces of the parts 57 of the plates will be held at the proper distance apart to form guides for holding the roller properly in place while being ground and allowing the roller to pass between them without any unnecessary play. If desired, water, air, oil or other cooling medium may be introduced between the inner surfaces of the parts 57 and the flat sides of the rollers to serve the double purpose of cooling the rollers and preventing grinding dust from entering between the said surfaces, thereby insuring that no grinding shall take place on the flat sides of the rollers. This cooling medium may be introduced through a hose or the like connected to the outer ends of the passages 62 in the plates 56.

The rollers are delivered between the parts 57 of the plates 56 from a magazine 64, Figures 2 and 3, which is of such width as to accommodate the rollers and hold the same with their axes horizontal, as indicated in Figure 3, so that the rollers will roll down the forward or delivery portion 65 of the magazine by gravity and by pressure of the rollers in the magazine into the space between the parts 57 of the plates 56 in proper

position to be ground. The inner wall 66 of the magazine is shaped so as to prevent more than one roller at a time from passing onto the delivery portion 65 of said magazine. The magazine is supported by a bracket 67 from the framework of the machine and by a bracket 68 from one of the rods 58.

As pointed out above with reference to Figure 4, the arcs $a$—$b$, $a'$—$b'$, are struck from centers $c$ and $c'$ respectively, and in order that during the grinding operation the grinding wheels shall grind the peripheral surface of the roller in conformity with these arcs it is necessary that the grinding wheel carriages 9 and 10 shall move in arcuate paths struck from the said centers $c$ and $c'$. Therefore the curved surfaces of the guide members 4 and 5 are concentric with the center $c$ and $c'$ respectively, and since the grinding wheel carriages are constrained to move upon the said curved surfaces of the guide members it follows that the grinding wheels will move in arcuate paths about the centers $c$ and $c'$, and the peripheral surface of the rollers will be ground so that it will conform to a surface of revolution generated by the rotation of the circular arc $a$—$b$, as in Figure 4.

It has been stated above that the distance C between the centers of curvature $c$ and $c'$ varies with different sizes or diameters of rollers and provision is made for adjustment of the machine to enable the grinding wheels to operate upon rollers having different distances between the centers of curvature. This adjustment is effected in the machine being described by means of spacers or plates 69 inserted between the webs 2 and the flanges 7 of the guides 4 and 5 respectively. The greatest distance between the centers of curvature will naturally be obtained if the spacers are entirely omitted and the flanges 7 bear directly against the webs 2 and the distance may be gradually lessened by inserting spacers 69 of gradually increasing thickness between the webs 2 and flanges 7. In this way the distance between the centers of curvature may be gradually diminished down to zero or it may even be made negative. When the distance is reduced to zero the centers of curvature will, of course, coincide with the axis $d$, $e$ and the peripheral surface of the roller will be spherical.

The thickness of the spacers required to correspond with a particular distance C between the centers of curvature is determined by subtracting from the radius R, Figure 1, the distance J, one-half of the distance Z and one-half of the distance C between the centers of curvature. The distance R, minus J, minus one-half Z is a predetermined and known quantity for any particular machine.

To insert or remove the spacers the nuts on the four bolts 6 are loosened and the upper guide 4 is raised by means of the screws 70 threaded into the flanges 7 of said guide and bearing against the upper surfaces of the webs 2, the lower guide being lowered by loosening the screws 71 threaded in the webs 2 and having their heads engaging the lower surfaces of the flanges 7 of the lower guide. The bolts 6 are retained in place to serve as guides during this operation. Spacers of the desired thickness are then inserted between the webs 2 and the flanges 7 after which the screws 70 and 71 and the bolts 6 are adjusted to bring the flanges 7 into engagement with the spacers and to clamp the flanges, webs and spacers tightly in place. The spacers are provided with slots 72 to accommodate the screws 70 and 71.

The pulleys 25 of the grinding wheel shafts 22 are rotated by means of a single belt 73 which passes over these pulleys and over a driving pulley 74 and an idler pulley 75. The pulley 74 is mounted on a shaft 76 supported in bearings 77 on the machine frame 1, and secured to one end of this shaft is a pulley 78 driven by a belt 79 from a suitable overhead countershaft.

The idler pulley 75 is mounted on a shaft 80 mounted in bearings 81 which are self aligning so as to permit the angular positions of the idler shaft 80 resulting from the arcuate movement of the grinding wheel carriages and the different directions of the pull in the driving belt 73. The bearings 81 are also mounted for movement toward or from the axis of the pulleys 25 by means of projecting stems 82 guided in bearings 83 supported from the machine framework 1, coil springs 84 being arranged on the outer stems 82 between the outer bearings 83 and nuts 85 on said stems, which springs serve to maintain the proper tension in the driving belt 73.

It will be noted that the belt 73 drives the pulleys 25 and thereby the grinding wheels 23 in opposite directions, whereby during the grinding operation the roller being ground is rotated by the engagement of the grinding wheels therewith about its own axis. By this arrangement both grinding wheels contribute to keep the roller spinning while it is being ground and as the two wheels are turning in opposite directions there will be no tendency to either wedge the roller in between the wheels or to throw it out, the force of holding the roller between the wheels simply depending upon the amount of pressure exerted upon the roller being ground by the weight of the remaining rollers in the magazine.

When the roller has been ground to the desired diameter it will be automatically removed from between the grinding wheels in part by the action of gravity and in part

by the pressure of the remaining rollers in the magazine, and it will roll out from between the grinding wheels and the next roller in the magazine will be moved automatically into position between the grinding wheels by the pressure of the remaining rollers thereon.

The ground roller will pass along a guide member 86 to a gauge plate 87. This gauge plate contains an aperture just large enough to let a roller of the proper dimensions pass through. If the grinding wheels should have become worn so that the roller released from between the same is slightly too large it will be stopped by the gauge plate 87 instead of passing through the same, and the operator noticing this will adjust the grinding wheels toward each other a sufficient distance to compensate for the wear which has occurred. This is effected by means of the pawls 34′ previously mentioned which are set by the operator into the operative positions indicated in dotted lines in Figure 1, so that at the next outward swing of the wheel carriages 9—10, the pawls will engage and advance the ratchets 34 which, through the screws 32 and nuts 30, will advance the supporting members 17 carrying the grinding wheel shafts 22. This feeding mechanism is preferably put into operation to feed the ratchets 34 one tooth at a time until it is seen that the rollers released from between the grinding wheels will pass through the gauge plate 87, the operation of the machine then continuing until the grinding wheels again become worn. The roller or rollers stopped by the gauge plate are placed again in the magazine to be again ground in their turn.

Those rollers which pass through the gauge plate 87 are received by a pan or receptacle 88 from which they may be removed by the operator when a sufficient number has accumulated. The pan or receptacle 88 may be supported in any suitable manner from the framework of the machine and it preferably supports the gauge plate 87 and the guide member 86.

It will be understood from the detailed description of the machine given above that in the operation of the machine a number of rollers are placed in the magazine 64 and the foremost roller will be moved by gravity and the pressure of the remaining rollers into a position between the grinding wheels 23, which wheels are rotated in opposite directions about their axis and are at the same time moved in arcuate paths due to the movement of the wheel carriages 9, 10 upon the arcuate guides 4 and 5. The roller will thus be spun or rotated about its own axis while being ground by the grinding members and when it has been ground to the predetermined diameter it will be removed from between the grinding wheels partly by gravity and partly by the pressure of the remaining rollers, the next following roller taking its place. The ground roller thus released will pass through the gauge member 87 into the receiving pan 88.

The machine provides three essential adjustments in conformity with the three determining dimensions of the roller, as above mentioned, that is, the grinding wheels may be adjusted toward or from each other by means of the nuts 30 on the stems 17 to determine the diameter to which the roller is to be ground. Secondly, plates 56 are capable of adjustment toward or from each other by means of the spacing sleeves 61 and nuts 60 in accordance with the width of the rollers to the ground, the parts 57 of the plates being spaced a distance apart substantially equal to the width of the rollers to form a guiding means or passage for the rollers between the grinding wheels. Thirdly, the arcuate guides 4 and 5 are adjustable by means of the different sized spacers 69 in accordance with the distance C between the centers of curvature $c$ and $c'$ of the roller. In addition a fine adjustment of the grinding wheels toward or away from each other is provided by means of the ratchets 34 and pawls 34′, this adjustment being chiefly for the purpose of compensating for wear of the grinding wheels. In some cases only one of the wheels 23 may be a grinding wheel, the other being a plane wheel or rotating element which has substantially the same function, excepting that it does not assist in the grinding operation.

It is to be understood that this machine can be used for several different operations of grinding, namely: rough grinding, finish grinding, lapping and polishing. For these different purposes, different grades of wheels are to be inserted in the machine. These different wheels have all been referred to as grinding wheels in the specifications, even those performing the polishing operations.

It will be understood that suitable guard devices may be provided adjacent the various belts and gears and particularly adjacent the lower run of the belt 73 so as to prevent water or oil delivered through the passages 62 of the plates 56 from falling onto this belt. The upper part of the lower carriage 10 may be suitably shaped as indicated at 89 to receive this liquid, which is conducted therefrom by pipes 90 to the lower part of the framework 1 which is suitably shaped to receive it and from which it may be drained through an outlet 91.

It is to be clearly understood that while to enable the construction and operation of the machine to be clearly understood, it has been described in some detail, the invention is not restricted to the particular details of construction and operation therein set forth, as these may be modified to suit different requirements.

What I claim and desire to secure by Letters Patent is:—

1. The method of grinding rollers, which consists in introducing a roller in a direction transverse to the axis thereof between two peripheral surfaces, at least one of which is a grinding surface, rotating said surfaces in opposite directions at the grinding point at substantially the same peripheral speed, whereby said roller is rotated about its axis in engagement with said surfaces and is automatically discharged from between said surfaces when reduced to a predetermined diameter.

2. The method of grinding rollers, which consists in introducing a roller into a passage of substantially the same width as the roller between two peripheral surfaces, at least one of which is a grinding surface, rotating said surfaces in opposite directions at the grinding point at substantially the same peripheral speed, whereby said roller is rotated about its axis in engagement with said surfaces and is automatically discharged from between said surfaces when reduced to a predetermined diameter.

3. The method of grinding rollers, which consists in introducing a roller into a passage of substantially the same width as the roller so that the roller may feed by gravity through said passage into position between two peripheral surfaces, at least one of which is a grinding surface, rotating said peripheral surfaces in opposite directions at the grinding point at substantially the same peripheral speed, whereby said roller is rotated about its axis between said surfaces and is automatically discharged by gravity from between said surfaces when reduced to a predetermined diameter.

4. The method of grinding rollers, which consists in introducing the roller in a direction transverse to the axis thereof into position between two peripheral surfaces, at least one of which is a grinding surface, rotating said surfaces in opposite directions at the grinding point at substantially the same peripheral speed, whereby said roller is rotated about its axis in engagement with said surfaces, and introducing an additional roller or rollers in engagement with the first roller, whereby the first roller will be discharged from between said surfaces by the pressure of the succeeding rollers when reduced to a predetermined diameter.

5. The method of grinding rollers, which consists in introducing a roller between two peripheral surfaces, at least one of which is a grinding surface, rotating said peripheral surfaces in opposite directions at the grinding point at substantially the same peripheral speed, whereby said roller is rotated about its axis in engagement with said surfaces, and moving said surfaces back and forth in arc-shaped paths transversely to the plane of rotation of said roller.

6. The method of grinding rollers, which consists in introducing a roller between two peripheral surfaces, at least one of which is a grinding surface, rotating said surfaces in opposite directions at the grinding point at substantially the same peripheral speed, whereby said roller is rotated about its axis in engagement with said surfaces, and moving at least one of said surfaces back and forth in an arc-shaped path transversely to the plane of rotation of said roller.

7. A machine for grinding rollers, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting said elements with their axes in a common plane, means for rotating said elements in opposite directions at the grinding point at substantially the same peripheral speed, means for automatically introducing rollers in succession into the space between the peripheral surfaces of said rotating elements in a direction transverse to said common plane and with the axes of the rollers parallel to said plane, and means for guiding the rollers during their passage between said peripheral surfaces by engagement with the side faces of the rollers.

8. A machine for grinding rollers, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting said elements with the axes thereof in a common plane, means for rotating said elements in opposite directions at the grinding point at substantially the same peripheral speed, a magazine constructed to hold a series of rollers with their axes parallel to said common plane, said magazine lying in a plane transverse to said common plane, and being arranged to position the foremost roller of the series in the space between the peripheral surfaces of said elements, and means engaging the opposite side faces of said roller to hold the same in position while being ground between said surfaces.

9. A machine for grinding rollers and the like, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting and rotating said elements to move in opposite directions at the grinding point, means for giving said elements a reciprocating motion in a plane including the axes of said elements, means for introducing a roller between the adjacent surfaces of said elements, in a direction transverse to said plane, and means for holding said roller in place between said elements during the grinding operation by engagement with the side faces of said roller.

10. A machine for grinding rollers and the like, comprising in combination, two rotat-

ing elements, at least one of which is a grinding element, means for supporting and rotating said elements to move in opposite directions at the grinding point, means for introducing a roller between the adjacent surfaces of said elements, and holding means engaging opposite surfaces of said roller during the grinding operation and formed to conduct fluid to said surfaces of said roller.

11. A machine for grinding rollers and the like, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting and rotating said elements to move in opposite directions at the grinding point, means for introducing a roller between the adjacent surfaces of said elements, guide members positioned to engage the opposite side faces of said roller, a plurality of rods on which said guide members are supported, spacers on said rods between said guide members and nuts threaded on said rods and clamping said members against said spacers.

12. A machine for grinding rollers and the like, comprising in combination, a rotatable grinding element, means for supporting a roller, without centering same, with its axis in substantially the same plane as the axis of the grinding element, and with its peripheral surface in operative grinding relation to the peripheral surface of said element, means for supporting and rotating said element, and means for continuously reciprocating said element and its supporting means bodily in an arcuate path in a plane transverse to the plane of rotation of said element.

13. A machine for grinding rollers and the like, comprising in combination, a pair of oppositely rotating elements, at least one of which is a grinding element, means for positioning a roller between the adjacent peripheral surfaces of said elements, means for supporting said elements with their axes in a common plane, means for rotating said elements to move in opposite directions at the grinding point, and means for continuously reciprocating said elements in arcuate paths in said common plane.

14. A machine for grinding rollers and the like, comprising in combination, a pair of rotatable elements, at least one of which is a grinding element, means for supporting said elements, means for rotating said elements to move in opposite directions at the grinding point, means for positioning a roller between the adjacent peripheral surfaces of said elements, and means for moving said elements in arcuate paths in a common plane transverse to the planes of rotation of said elements each about a center of curvature lying in the median plane of said roller.

15. A machine for grinding rollers and the like, comprising in combination, a rotatable grinding element, means for rotating said element, means for supporting a roller in operative grinding relation to the peripheral surface of said element, arcuate guide means having a definite center of curvature, said guide means lying in a plane transverse to the plane of rotation of said element and supporting means for said element reciprocable on said guide means during the grinding operation.

16. A machine for grinding rollers and the like, comprising in combination, a rotatable grinding element, means for rotating said element, means for supporting a roller in operative grinding relation to said element, and arcuate guide means having a definite center of curvature, said guide means lying in a plane transverse to the plane of rotation of said element, supporting means for said element reciprocable on said guide means during the grinding operation, and means for adjusting the position of said guide means to vary the position of the center of curvature thereof.

17. A machine for grinding rollers and the like, comprising in combination, a rotatable grinding element, means for rotating said element, means for supporting a roller in operative grinding relation to said element, and arcuate guide means having a definite center of curvature, said guide means lying in a plane transverse to the plane of rotation of said element, supporting means for said element reciprocable on said guide means during the grinding operation, means supporting said arcuate guide means, and spacing members of different thicknesses insertable between said guide means and its supporting means to vary the position of the center of curvature of said guide means.

18. A machine for grinding rollers and the like, comprising in combination, a pair of rotatable elements, at least one of which elements is a grinding element, means for rotating said elements to move in opposite directions at the grinding point, means for introducing a roller between the peripheral surfaces of said elements, arcuate guide members having definite centers of curvature, supporting means for said guide means, supporting means for said rotating elements mounted on said arcuate guide members, means for reciprocating said element supporting means on said guide members, and means for adjusting said guide members toward or from each other to vary the relationship between the centers of curvature thereof.

19. A machine for grinding rollers and the like, comprising in combination, a pair of rotatable elements, at least one of which elements is a grinding element, means for rotating said elements to move in opposite directions at the grinding point, means for introducing a roller between the peripheral

surfaces of said elements, arcuate guide members having definite centers of curvature, supporting means for said guide means, supporting means for said rotating elements mounted on said arcuate guide members, means for reciprocating said element supporting means on said guide members and spacing members of different thicknesses insertable between said guide members to space the same apart different distances.

20. A machine for grinding rollers and the like, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting and rotating said elements to move in opposite directions at the grinding point, means for giving the rotating elements a reciprocating motion, means for introducing a roller between the adjacent peripheral surfaces of said elements, means for holding said roller in place between said elements during the grinding operation by engagement with the opposite side faces of said roller, and means for adjusting said rotating elements toward or from each other to grind rollers of different diameters.

21. A machine for grinding rollers and the like comprising in combination, two rotating elements, at least one of which is a grinding element, wheel shafts carrying said elements, members supporting each of said shafts, wheel carriages, each slidably supporting the supporting members of one of said wheel shafts, means for supporting said wheel carriages, and means for slidably adjusting said supporting members relatively to the respective wheel carriages, means for rotating said elements to move in opposite directions at the grinding point, means for introducing the roller between the adjacent peripheral surfaces of said elements, and means for holding said roller in place between said elements during the grinding operation.

22. A machine for grinding rollers and the like, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting and rotating said elements to move in opposite directions at the grinding point, means for introducing a roller between the adjacent peripheral surfaces of said elements, means for holding said roller in place between said elements during the grinding operation by engagement with the opposite side faces of said roller, and means adapted to be positioned to effect automatic adjustment of said rotating elements relatively to each other during the grinding operation.

23. A machine for grinding rollers and the like, comprising in combination, a rotatable grinding element, means for supporting a roller in operative grinding relation to said element, means for supporting and rotating said element, means for moving said element in an arcuate path in a plane transverse to the plane of rotation of said element, and means adapted to be positioned to effect automatic adjustment of said grinding element relatively to said roller supporting means during the grinding operation.

24. A machine for grinding rollers and the like, comprising in combination, a rotatable grinding element, means for supporting a roller in operative grinding relation to said element, means for supporting and rotating said element, means for moving said element in an arcuate path in a plane transverse to the plane of rotation of said element, and means adapted to be manually positioned and to thereafter automatically operate during the arcuate movement of said element to adjust the position of said element relatively to the roller supporting means.

25. A machine for grinding rollers and the like, comprising in combination, a pair of oppositely rotating elements, at least one of which is a grinding element, means for positioning a roller between the adjacent surfaces of said element, means for supporting said elements, means for rotating said elements to move in opposite directions at the grinding point, means for moving said elements in arcuate paths in a plane transverse to the planes of rotation of said elements, and means adapted to be positioned for automatic operation by the arcuate movement of said elements to adjust the same relatively to each other.

26. A machine for grinding rollers and the like, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting and rotating said elements in opposite directions at the grinding point and with their axes in the same vertical plane, means for passing a roller into and through the space between the peripheral surfaces of said elements with its axis parallel to said plane, and means for moving at least one of said elements in an arc shaped path in a plane perpendicular to the plane of rotation and including the axes of said elements about a center within the roller.

27. A machine for grinding rollers and the like, comprising in combination, two rotating elements, at least one of which is a grinding element, means for supporting said elements for rotation in substantially the same vertical plane about parallel vertically spaced apart axes, means for rotating said elements so that the adjacent portions of the peripheral surfaces thereof move in opposite directions, means for introducing a roller in the plane of rotation of said elements into the space between the peripheral surfaces of said elements and with its axis perpendicular to the plane of rotation,

said element supporting means including means for guiding said elements in arc shaped paths in a plane perpendicular to the plane of rotation of said elements and including the axes of said elements, means for effecting movement of said elements along said arc shaped paths, and means for receiving rollers automatically discharged from between the peripheral surfaces of said elements.

In testimony whereof I affix my signature.

ELOV F. MAAS.