Jan. 15, 1935. C. R. HEIM 1,987,850

APPARATUS FOR GRINDING AND LAPPING CYLINDRICAL MEMBERS

Filed May 14, 1931 3 Sheets-Sheet 1

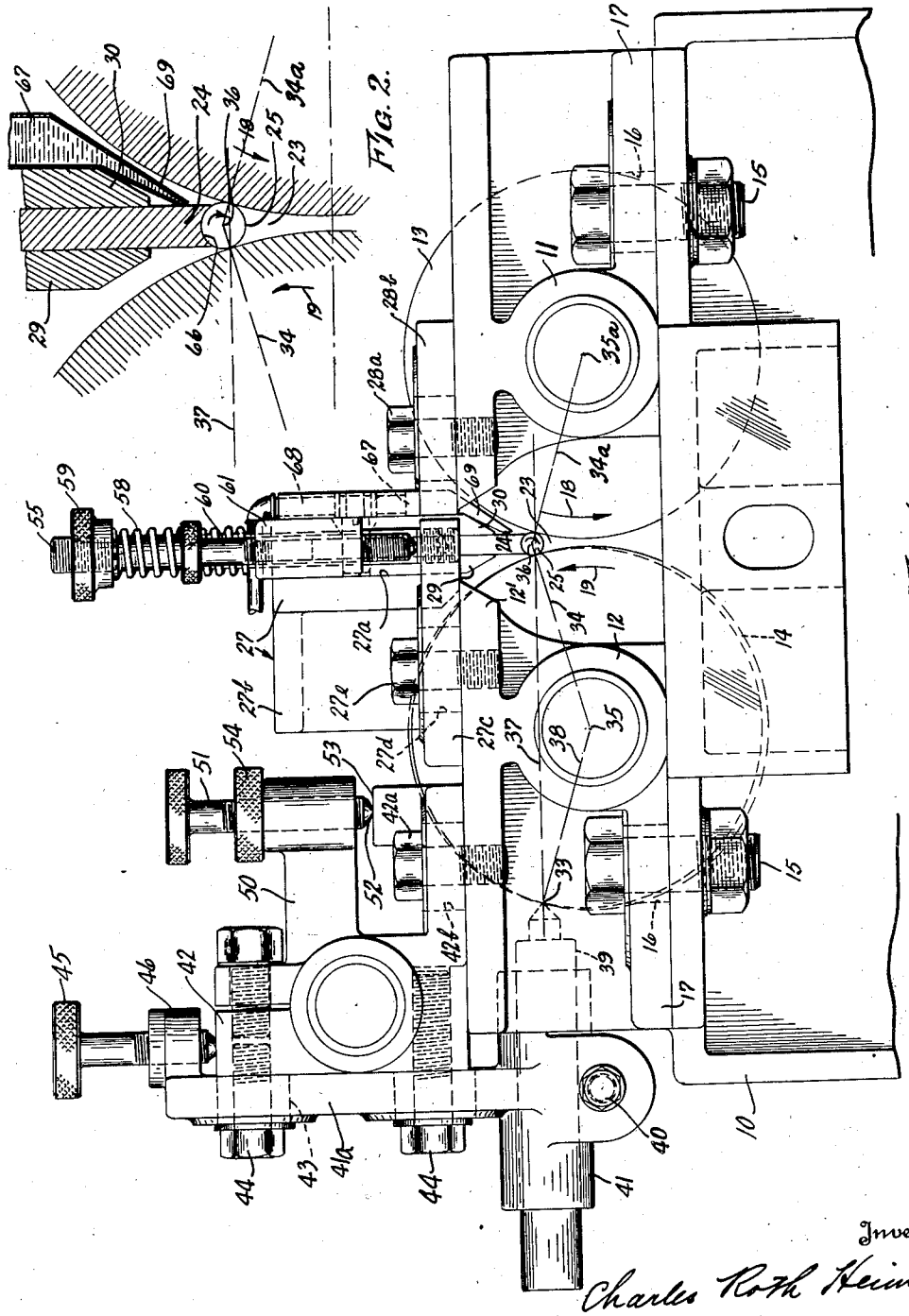


FIG. 1.

FIG. 2.

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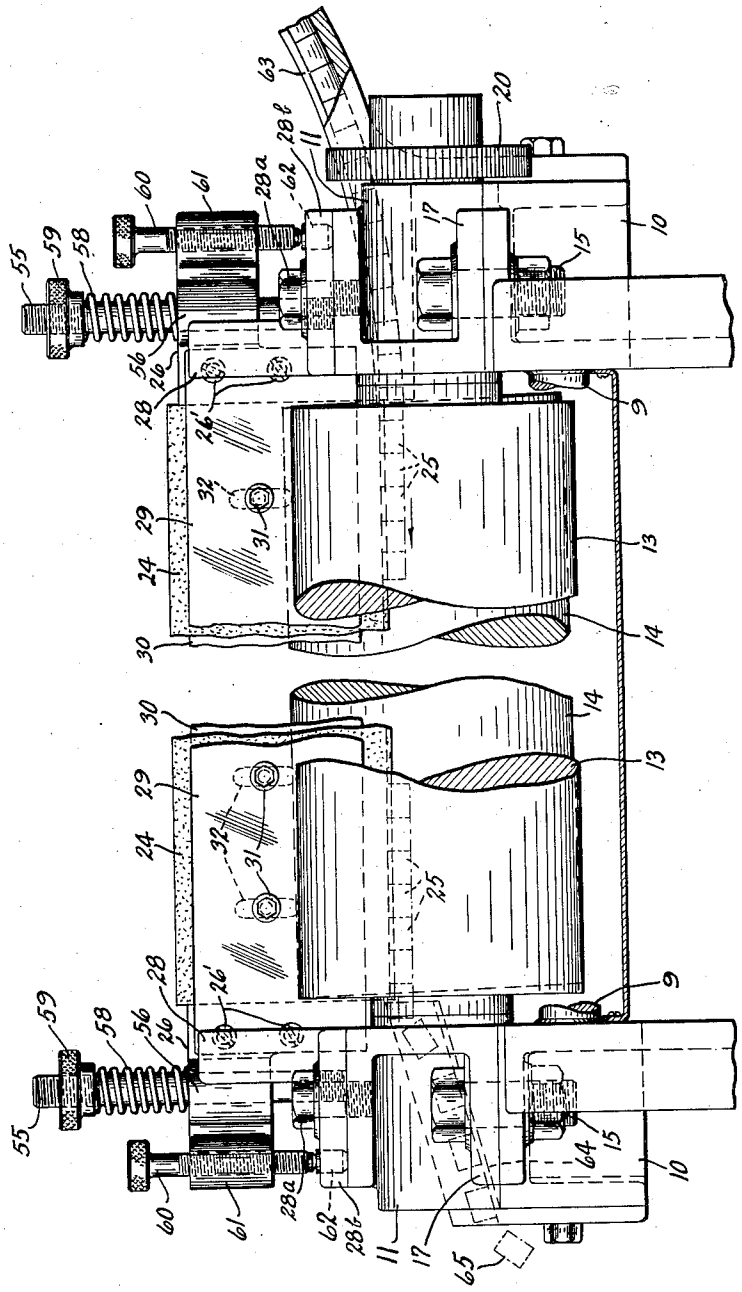


FIG. 3.

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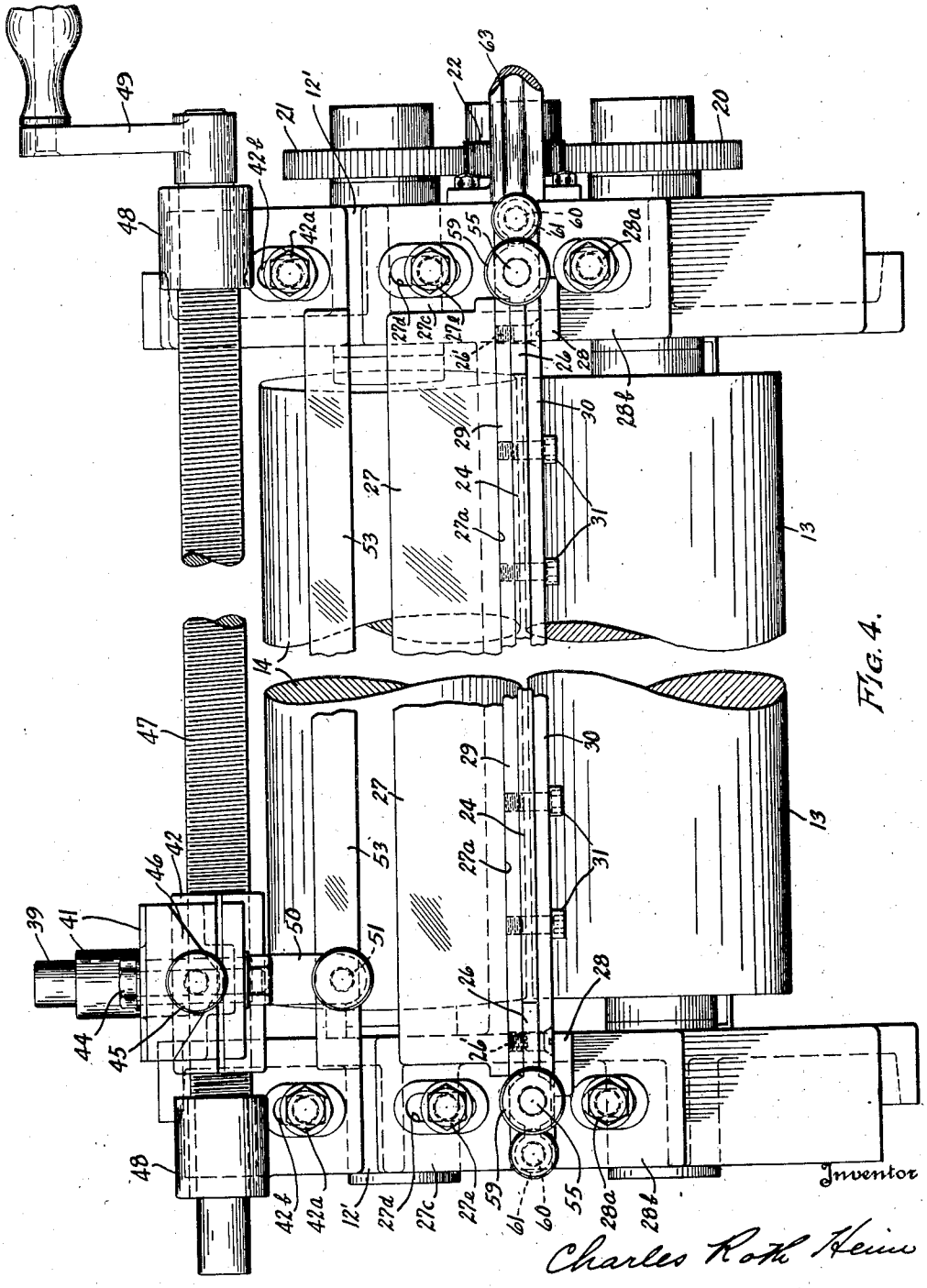


FIG. 4.

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1,987,850

APPARATUS FOR GRINDING AND LAPPING CYLINDRICAL MEMBERS

Charles Roth Heim, Mount Dora, Fla.

Application May 14, 1931, Serial No. 537,306

11 Claims. (Cl. 51—156)

This invention relates to a machine and method for grinding or lapping cylindrical parts such as rollers for roller bearings, wrist pins, or any other cylindrical element in which it is desired to secure a high degree of precision and fine finish, and has for an object to provide a machine in which the elements to be ground may be fed successively into and through the machine and ground with great accuracy and fine finish, rapidly and without the necessity of individually handling to mount them on centers, so that not only is the work finished perfectly cylindrical but there is a great increase in production.

It is also an object of the invention to provide a grinding device of this character in which the contact of the work with the grinding element is not a line contact as with rotating grinding elements, but by means of a stationary grinding element a concave or extended contact surface is used which more effectively rounds up the work.

A further object is to provide a grinder in which the work to be ground is simultaneously supported, rotated, and fed longitudinally of its axis by contact of its surface with a moving surface, and while the surface of the work is in engagement with the surface of a stationary grinding element.

The device is adapted for grinding or lapping almost any cylindrical part, such for example as steel, cast iron, brass, aluminum, glass, fibre, wood etc.

Centerless grinders have been constructed for grinding cylindrical elements in which the element to be ground rests on a stationary support with a wheel having an axis inclined with respect to the horizontal located at one side thereof to rotate the work and advance it longitudinally along the support together with a rotating grinding wheel on the opposite side of the support to grind the surface of the work as it is rotated and fed longitudinally. It is well known that in these types of grinders, if a high side is present on the work being ground it will have a tendency to cause a low spot on the opposite side of the cylinder, and likewise if a low spot appears on the work it tends to cause a high side on the opposite side of the cylinder, and while there has been means provided that tend to minimize this objection yet it is well known that this is one of the serious objections to the present type of centerless grinding. These objections have been eliminated from this improved grinder.

It is also well known that the regular center grinder, that is, a grinder in which the work is supported on centers, is limited in its precision and finish of work to the correctness of the centers on which the work is placed, the accuracy of the spindle of the live center, the correctness of the mounting of the grinding wheel, the parallel traverse of the table with relation to the grinding wheel, and other objections, all of which have been eliminated in the present grinder.

The basis of the present invention comprises work supporting and rotating means in combination with a non-rotating grinding or lapping element, the work rotating and supporting means being so constructed or arranged as to cause the work to rotate and feed longitudinally along the face of the grinding element, thus grinding or lapping the surface of the cylindrical element. Preferably there are two work supporting and rotating rolls placed side by side with active faces rotating in opposite directions so that the active face of one roll engaging the work moves upwardly on one roll and downwardly on the other, one of the rolls being positioned substantially horizontally while the axis of the other roll is somewhat inclined so that one end is higher than the other, thus providing a component or force for feeding the cylindrical work axially along the faces of the supporting rolls at the same time rotating the work about its own axis. Thus these two rolls form a throat between them in which the cylindrical work is supported, fed and rotated while its surface is in contact with an abrading or grinding element. In its broadest aspect the invention consists in rotating the work about its own axis while it is in engagement with the surface of a non-rotating grinding or lapping element and at the same time causing relative movement between the work and the grinding element in a direction longitudinally of the axis of the work.

A satisfactory embodiment of the invention is shown in the accompanying drawings in which

Fig. 1 is an end elevation looking toward the discharge end of the machine;

Fig. 2 is a detailed vertical section on a somewhat larger scale showing the work, the contacting portions of the work supporting and rotating rolls, together with the grinding element;

Fig. 3 is a front elevation of the machine with certain parts broken away to more clearly show the construction; and

Fig. 4 is a top plan view of the machine.

The machine shown may comprise a pair of supporting members 10 which may include supporting legs, not shown, and on which supports may be mounted suitable bearings 11 and 12 for the work supporting and feeding rolls 13 and 14.

The supports 10 may be rigidly connected together by tie rods 9. These bearings may be secured to the supports 10 by any suitable means such as the bolts 15 passing through the elongated slots 16 in the feet or bases 17 of these bearings resting on the supports so that the rollers 13 and 14 may be adjusted laterally toward and from each other to vary the distance between them and line them up, and set them in proper relation to each other and then secure them in this position. It is to be noted that one of the rolls 13 and 14 is mounted so that its axis is substantially horizontal. In the present case the roll 13 is so mounted, while the roll 14 is inclined to the horizontal, that is, one end of its axis is higher than the other end. Preferably this axis at one end is substantially on the level with the axis of the roll 13, while at the other end it is raised somewhat as indicated. However the same effect can be secured if the center at one end of the inclined roll is below the axis of the other roll. In the present instance the outlet or discharge ends of the rolls are substantially on the same level while the inlet end of the roll 14 is raised or elevated as indicated. Any suitable means may be provided for rotating the rolls as indicated by the two arrows 18 and 19. I have shown a pair of spur gears 20 and 21 connected to the shafts of the rolls 13 and 14 respectively and meshing with the intermediate gear 22, which may be driven from any suitable source of power, not shown, such for example, as an electric motor, or a belt from a power shaft.

Located at one side of the throat 23 between the rolls 13 and 14, preferably above it as shown, is a grinding or abrading element 24. This element may be in various shapes, but is preferably in the form of a plate mounted in an upright position and may comprise one or more sections carried in a suitable holder. As indicated this grinding element engages at its lower edge the peripheral surface of the cylindrical work element 25 to be ground as it is supported in the throat between the rolls 13 and 14.

This grinding element may be made of various materials depending on the class of work or material to be ground and also upon the finish desired. It may be made of cast iron, steel, emery, carborundum or any other material which is capable of giving the desired grinding or finishing effect desired on the work to be operated upon.

As indicated the grinding element or plate 24 may be supported by any suitable means. In the present instance it is clamped between two upright plates 29 and 30 extending the length of the rolls and supported by end members 26 to the opposite sides of which the plates 29 and 30 may be secured by screws 26'. The support for the grinding or lapping element is backed up and guided on its rear for vertical movement by the rigid frame or angle bar construction 27. The bar or frame has an upright wall 27*a* forming a guide and rigid backing or support for the holder for the grinding element and also includes a horizontal wall or rib 27*b* which gives it strength and stiffness laterally. It is mounted on the blocks 12' carrying the bearings 12 by means of feet 27*c* having elongated slots 27*d* through which extend screws 27*e*. At the opposite side the grinding element is guided by the upright wall 28 of a guide bracket mounted by means of screws 28*a* extending through elongated slots in the bases 28*b* of these brackets. By this arrangement the grinding element may be adjusted laterally to properly position it with respect to the rolls 13 and 14 and the work 25 carried by them. The element 24 is clamped between the upright plates 29 and 30 by suitable screws 31. It is preferred that the grinding element be provided with upright elongated slots 32 through which the screws 31 may pass so that the grinding element may be lowered between the plates to compensate for wear due to its grinding action on the work 25. It will be noted that this grinding element or plate is so positioned that its lower edge engages and acts on the surface of the work 25 as it is supported by the rolls 13 and 14 and rotated and fed longitudinally or lengthwise along the faces of the supporting rolls. Thus the work 25 is rotated against the face of the element 24 to give the grinding or lapping action and at the same time is given a longitudinal or axial movement along the face of the grinding element. The two rolls 13 and 14 may be termed either work supporting rolls or work supporting and feeding rolls.

The work 25 is fed longitudinally along the surfaces of the supporting rolls and the face of the grinding element by the action of the roll 14, although it is not necessary to use the arrangement illustrated, but in carrying out the invention any suitable means may be provided for advancing the work along the faces of the work supporting rolls and the face of the grinding means. Thus there are other ways to cause the work to feed forwardly such for example, as gravity, tapering of one or both rolls which will cause the work to feed toward the larger diameter of the rolls, and still other ways.

In the present instance the surface of the inclined roll 14 is turned by means of a suitable turning tool such as the diamond tool 33. This tool is mounted so that it may be adjusted to the proper position and moved longitudinally along the surface of the roll 14 parallel to the axis of the roll 13. It should however, be on the level of the line of contact between the surface of the work 25 and the surface of the roll 14. Thus if there is a line 34 drawn from centers 35 and 35*a* or axes of the rolls 14 and 13 to the center 36 or axis of the work 25 then a line 37 drawn through the points at which the lines 34 and 34*a* intersect the periphery of the work 25 and rolls 13 and 14 will be at the level at which the cutter 33 should be located. Thus if the tool 33 is moved longitudinally along the surface of the roll 14 on the level of the line 37 and on the opposite side of this roll and parallel with the axis of the other rolls 13, the roll 14 will be shaped to permit the work to move longitudinally in the throat between the two rolls 13 and 14 in a straight line, the line of contact between the work and the rolls 13 and 14 being a straight line, and the roll 14 will provide a longitudinal component or force to cause this longitudinal movement of the work and thus feed it longitudinally across the surfaces of the rolls and the face of the grinding plate 24. This action of tool 33 imparts a slight taper to the roll 14, due to the inclination of its axis and as the cutter 33 moves parallel to the axis of roll 13 from the lower end of the roll 14 toward the higher end it moves slightly nearer to the axis of the roll and the distance between line 37 and the center 35 becomes shorter. Therefore the lower or outlet end of the roll 14 is somewhat larger in diameter than the higher or inlet end.

The tool 33 may be mounted on any suitable means for retaining it at the proper level and for feeding it longitudinally of the roll 14. Thus

in the present instance the tool 33 is mounted in a suitable holder 39 clamped by a screw 40 in a split bearing 41. This bearing is in the bracket 41*a* vertically adjustable on a support 42. The bracket may have vertically elongated slots 43 to receive screws 44 threaded into the support 42 to clamp the bracket 41 in adjusted positions. After loosening the screws 44 bracket 41 and tool 33 may be raised or lowered by the adjusting screw 45 threaded into the lug 46 of the bracket and bearing at its lower end on top of the support 42. The support 42 is threaded on the rotatable threaded feed bar 47 mounted in suitable bearings 48 and may be rotated by any suitable crank 49. The support 42 also has an arm 50 carrying adjusting screw 51 threaded in it and having a hardened end 52 engaging the horizontal finished surface 53. The adjusting screw 51 may be locked in adjusted position by a lock nut 54. This screw 51 may be used to adjust the angularity of the support 42 and the tool 33. Thus by rotating the crank 49 while the roll 14 is rotated the tool may be carried longitudinally along the surface of the roll 14 and on the level of the line 37 parallel to the axis of the roll 13. The whole support 41 and 42 can be adjusted toward and from roll 14 by loosening screws 42*a* which extends through elongated slots 42*b*.

The grinding element 24 may press on the work 25 under it own weight and the weight of its supporting means 29 and 30, but it is preferred to provide adjustable means for varying the pressure of this grinding element against the work. Thus in the present instance the grinding element is guided for vertical movement, and upright studs 55 pass through the ears 56 on the members 26. The openings for these studs are somewhat larger than the studs to permit adjustment of the grinding element. Springs 58 embrace the studs 55 and engage the top of the lugs 56 and reacting against the adjustable nuts 59 tend to force the grinding element 24 downwardly against the work. Obviously by adjusting the nuts 55 up and down the force of the springs and therefore the pressure of the grinding element against the work may be varied as desired. Also this provides a yieldable mounting for the grinding element so that it may yield under irregularities in the work. Means are however preferably provided to limit the movement of the grinding element toward the work so that the work all leaves the machine having a uniform diameter. Thus the ears 56 also carry upright adjusting screws 60 threaded in the enlargement 61 and carrying lower rounded ends engaging a hardened plug or bearing 62 mounted in the base member 27*c*. Thus it will be evident that these screws 60 limit the movement of the grinding element toward the work, and that this limit of movement can be accurately determined according to the diameter it is desired to finish the work by adjusting the screws 60.

A suitable guide or chute 63 is provided for feeding the work to the space in the throat 23 between the rolls 13 and 14 and the grinding element 24. This is preferably inclined so the work is fed in by gravity, though the work may be placed in the chute by hand or from an automatic hopper not shown. Also at the outlet end there may be a guide or chute 64 to receive the finished work, indicated at 65 as being a short roll for roller bearings, as it is discharged from the outlet end of the rolls after being ground.

In operation the work such as the roller elements 65 are placed end for end in the feed chute 63 and pass down this chute under the action of gravity or other force to the inlet end between the rolls. As they pass into the space 23 between the rolls and the grinding element they are supported by the surfaces of the two rolls 13 and 14. As the active faces of the rolls move in opposite directions as indicated by the arrows 18 and 19 Fig. 1, it will be evident that the work 25 will be rotated clockwise as viewed in this figure and thus will be rotated in engagement with the lower edge of the grinding element 24. It will of course be obvious that by reversing the positions of the rolls and their direction of rotation the work will be rotated in the opposite direction. It is preferred that this lower edge of the grinding element be concave as indicated at 66 so as to have an extended grinding surface on the surface of the work being ground, as this tends to give greater accuracy and more uniformity to the finished work. The two rolls 13 and 14 not only support and rotate the work in contact with the grinding element 24, but as indicated above the inclined roll 14 also provides a horizontal component or force which feeds the cylindrical work longitudinally along the surfaces of the two rolls and along the face of the grinding or lapping element 24. This element will have a tendency to grind off any high spot or sides and make the work cylindrical. If the work is tapered or warped when it goes into the device it will be evident that the grinding element will have a greater pressure against the larger end or high side and therefore will attack and grind it down faster so that the work is cylindrical and straight when it leaves the machine. Thus this machine will not only round up and straighten work that is out of round or warped but it will grind tapered or warped work to a uniform diameter, and it has been found in actual practice that this machine will do this work to a degree of precision in which it is almost impossible to detect an error. As suggested above the concave surface of the lower edge of the grinding or lapping element 24 is of importance in securing great accuracy. This concave surface provides a relatively large contacting surface between the grinding element and the surface of the work so that if the work is out of round, warped, has high spots, or is tapered, the higher portions will engage the grinding or lapping element and will be ground off thus producing extremely round and straight work, and great accuracy with a very high degree of finish and luster.

If desired a cooling or grinding liquid may be fed to the work during the grinding operation. Any suitable means may be provided for this, but in the drawings I have shown a trough 67 to which the liquid may be pumped through a pipe 68 by any suitable pump not shown, and the trough may have downwardly tapered portions 69 to discharge the liquid on the side of the grinding element.

It is not necessary that the work supporting and feed rolls be rotated at an extremely high speed in order that the grinding or lapping means shall act successfully on the work pieces in grinding or rounding them up and straightening them, although I have found that with a high speed for the supporting and feed rolls it causes the work to rotate at a relatively high speed and more active grinding results.

While it is not absolutely necessary to provide a grinding lubricant or coolant, I have found that

by the use of a suitable grinding lubricant on certain kinds of work such as is used on other types of grinding machines there is a tendency to produce a finer degree of finish and the grinding action on the work is increased.

It will be evident that in grinding work of different diameters the rolls and grinding element may be adjusted accordingly and thus the cylindrical work will occupy positions at different heights with respect to the axes of the supporting rolls. Therefore in order to have the supporting roll having the inclined face function most efficiently on the cylindrical work as it is fed along the surfaces of the rolls and the grinding element, it will be desirable to turn or diamond the face of this inclined roll while the axis of the roll is inclined at the desired position so that the lines of work support or contact of the cylindrical work on both feed rolls will be parallel.

It is to be especially noted that in my improved device the contact or engagement between the surface of the work and the grinding element is not a line contact as is the case with rotating grinding elements, but by means of the stationary grinding element I can use a concave or extended contact surface which more effectively rounds up the work.

Having thus set forth the nature of my invention, what I claim is:

1. In a grinding machine or the like in combination, work supporting and feeding rolls adapted to support, rotate and axially feed cylindrical work in the throat between them, a normally stationary grinding element contacting with the work opposite to said throat, and means for rotating the rolls to feed the work axially along the grinding element.

2. In a grinding machine or the like in combination, a pair of rolls forming a throat adapted to support, rotate and feed cylindrical work axially along the peripheral surfaces of the rolls, a stationary grinding element engaging the revolving and advancing work directly opposite to said throat, and means for mounting the grinding element so that it may yield in a direction away from the work.

3. In a grinding machine or the like in combination, rolls forming a throat adapted to support, rotate and feed cylindrical work axially, a normally stationary grinding element adapted to engage the work while it is being fed and rotated, means yieldingly mounting the grinding element to permit it to move toward and from the work, and means for limiting its movement toward the work being ground.

4. In a grinding machine or the like in combination, rolls arranged side by side and adapted to support, rotate and feed cylindrical work along the throat between them formed by their curved side surfaces, a normally stationary grinding element having a concave face contacting a portion of the surface of the work and opposite to said throat, and means for rotating the rolls to turn and feed the work along the concave face of said element.

5. In a grinding machine or the like in combination, a pair of work supporting and feeding rolls arranged side by side and adapted to support and axially feed cylindrical work positioned in the throat between them formed by their curved surfaces, a stationary grinding element mounted to engage and grind the periphery of the work, and means for varying the pressure of the element on the work.

6. In a grinding machine or the like in combination, a pair of work supporting and feeding rolls arranged side by side and adapted to support and axially feed cylindrical work positioned in the throat between them, a normally stationary grinding element mounted to engage and grind the periphery of the work, means mounting the element to move toward the work, means tending to move the element toward the work, means for limiting its movement toward the work being ground, and means for varying the amount of pressure of the element on the work.

7. In a grinding machine or the like in combination, a pair of work supporting rolls adapted to support cylindrical work in the throat between the rolls, a normally stationary grinding element contacting with the work and located opposite said throat, and means for rotating the rolls, said rolls being constructed and arranged for advancing the work along the face of said element longitudinally of the axis of rotation of the work.

8. In a grinding machine or the like in combination, a pair of work supporting and feeding rolls, one of said rolls being substantially horizontal and the other roll having its axis inclined to the horizontal, said rolls being adapted to support cylindrical work in the throat between them, a normally stationary grinding element contacting with the work and located opposite said throat, and means for rotating the rolls.

9. In a grinding machine or the like in combination, work supporting and feeding rolls placed to provide a throat between them, a normally stationary grinding element positioned at one side of and opposite said throat having a concave face to contact with work in the said throat, said rolls being capable of advancing cylindrical work axially along said throat and the face of the grinding element and also forming means for supporting the work, and means for rotating the rolls.

10. In a grinding machine or the like in combination, a pair of work supporting and work rotating rolls placed to provide a throat between them, to support cylindrical work, stationary grinding means to contact the work supported in said throat and arranged opposite said throat, means for rotating the rolls to rotate the work, and means for shaping one of the rolls to cause the work to feed axially along the faces of the rolls and the grinding means.

11. In a grinding machine or the like in combination, a substantially horizontal cylindrical roll, a second tapered roll beside the first roll and having its axis inclined to the horizontal, said rolls being adapted to support cylindrical work in the throat between them, a non-rotating grinding element positioned opposite the throat to engage the work so supported, and means for rotating the rolls to rotate the work and feed it longitudinally along the grinding element.

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