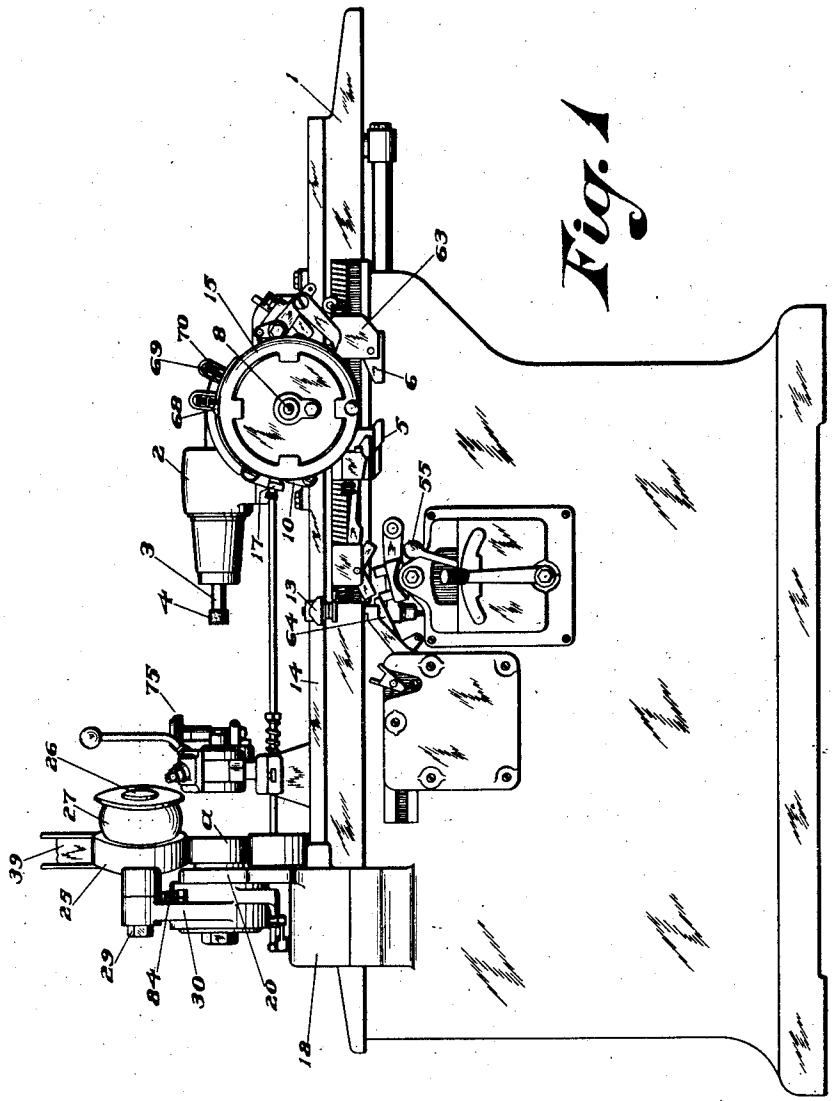
Nov. 8, 1932. W. J. GUILD ET AL 1,887,154

GRINDING MACHINE

Filed April 3, 1928 3 Sheets-Sheet 1

Fig. 1



Inventor

Waldo J. Guild

Alfred P. Burns

By Wm. H. Kenyon Jr.

Attorney

Nov. 8, 1932. W. J. GUILD ET AL 1,887,154

GRINDING MACHINE

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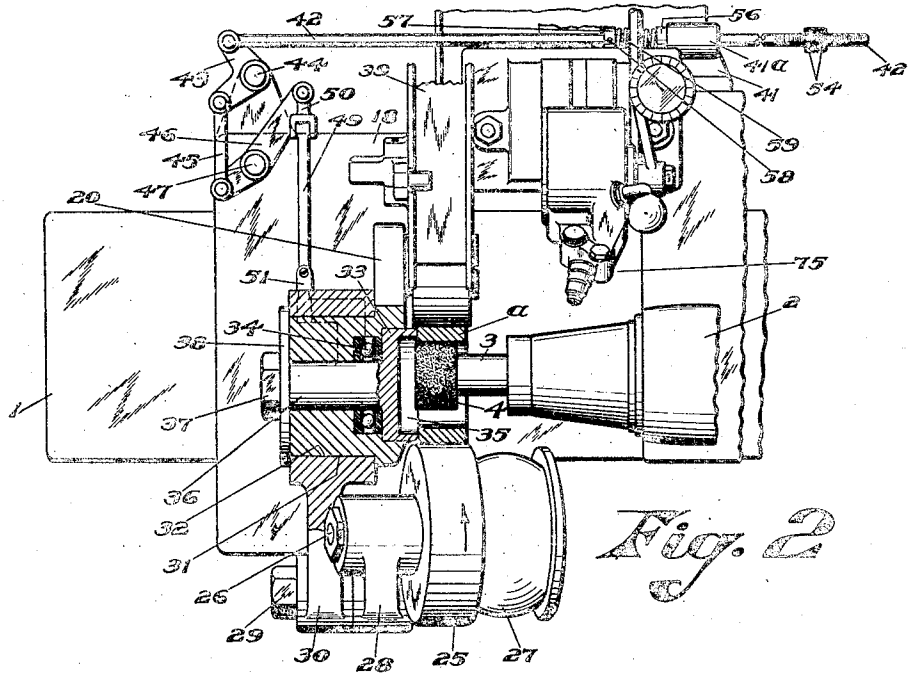


Fig. 2

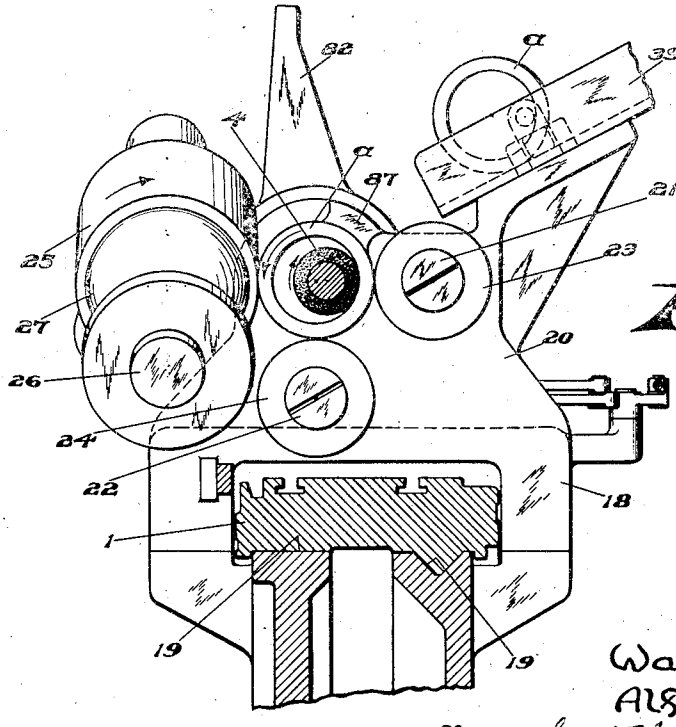


Fig. 3

Inventor

Waldo J. Guild

Alfred P. Burns

By Geo. H. Kennedy Jr.

Attorney

Nov. 8, 1932. W. J. GUILD ET AL 1,887,154

GRINDING MACHINE

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Fig. 4

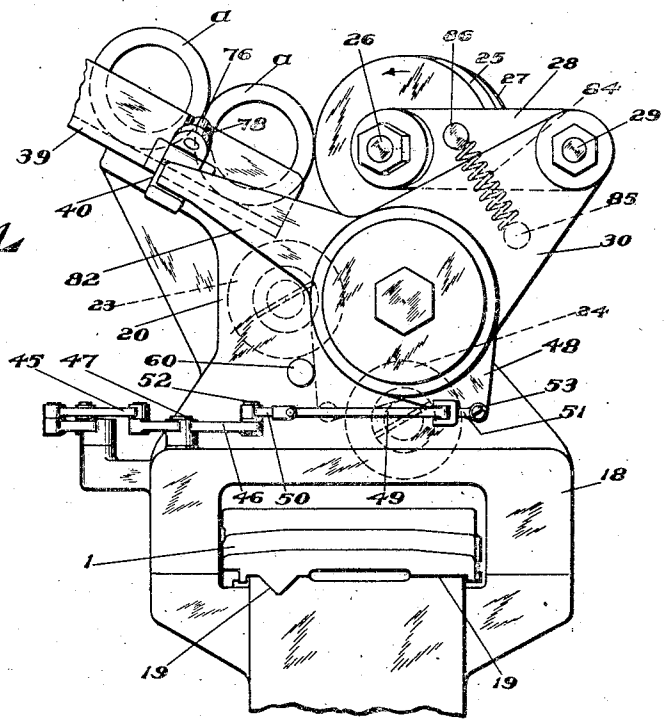


Fig. 5

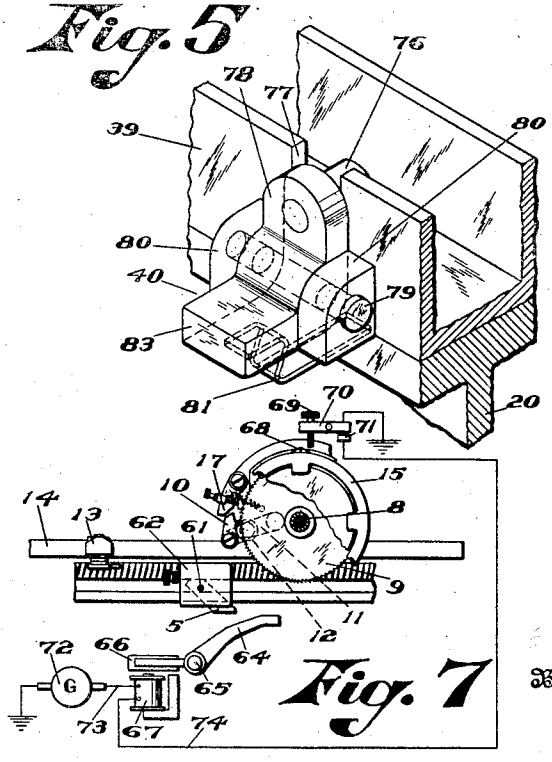


Fig. 7

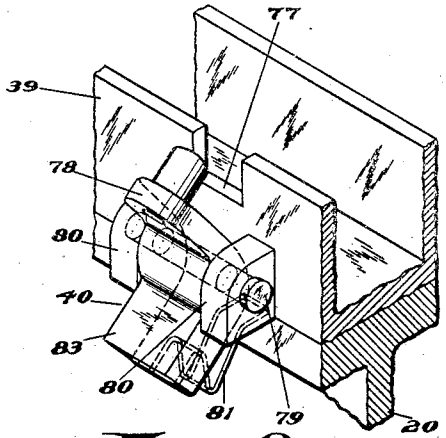


Fig. 6

Inventor

Waldo J. Guild

Alfred P. Burns

By Geo. B. Kennedy Jr.

Attorney

Patented Nov. 8, 1932 1,887,154

UNITED STATES PATENT OFFICE

WALDO J. GUILD AND ALFRED P. BURNS, OF WORCESTER, MASSACHUSETTS, ASSIGNORS TO THE HEALD MACHINE COMPANY, OF WORCESTER, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

GRINDING MACHINE

Application filed April 3, 1928. Serial No. 267,009.

The invention, which is an improvement on an invention of Carle J. Highberg, as shown in a copending application Serial No. 266,287 filed March 31, 1928, relates to internal grinding machines and particularly to the work-holding and work rotating mechanism thereof. As in the case of said Highberg application, the present invention is shown applied to an automatic internal grinding machine in which the grinding operation is automatically terminated when each workpiece has been ground to the desired internal diameter, and said present invention utilizes the "centerless" work-holding means of the Highberg invention.

More specifically the present invention provides novel means to place the workpieces in grinding position and a novel arrangement of the work rotating roller in relation to the stationary rollers. The present invention further provides means for exerting an end thrust upon the workpiece being ground, and a rotatable back plate to receive this end thrust; these means in combination constituting means to hold the workpiece in rigid axial position while it is being ground and enabling all flanges on the rollers to be dispensed with.

The main object of these improvements is to simplify the action of the centerless work-holding means and the mechanism for placing workpieces in grinding position, and to secure greater precision in grinding. A further object resides in the providing of a single pressure roller located on the horizontal plane of the grinding spindle, this feature being shown in the Highberg application, but being the invention of ourselves.

Other objects and advantageous features of the invention will appear from the following detailed description, taken in connection with the accompanying drawings, in which:—

Fig. 1 is a front elevation of an internal grinding machine showing the invention applied thereto.

Fig. 2 is a fragmentary view partly in plan and partly in section, illustrating the work-holding and work rotating means and the magazine.

Fig. 3 is a sectional view on the line 3—3 of Fig. 1, showing the work-holding and work rotating mechanism in elevation.

Fig. 4 is an elevation of the left hand side of the machine.

Figs. 5 and 6 are fragmentary views of the magazine together with the escapement mechanism shown in two positions.

Fig. 7 is a schematic view illustrating the automatic means for causing the carriage to travel to the idle position, fragments of the cross feed mechanism and the carriage controlling parts being shown in conjunction with a wiring diagram.

Like reference characters refer to like parts throughout the drawings.

Referring first to Fig. 1 an internal grinding machine is shown having a reciprocatory table or carriage 1 by the reciprocation of which the grinding traverse is produced, the said table in this instance supporting a wheel head 2 in which is journalled the usual spindle 3 carrying the grinding wheel 4. The spindle driving means which causes the rapid rotation of the grinding wheel 4 is not herein disclosed, as such is well known in this art and any suitable form thereof may be provided. Similarly, the aforesaid reciprocating motion of the table 1, to cause the rotating wheel 4 to make the required interior traverse of a workpiece, may be imparted in any well known manner, but, as illustrative of a specific embodiment of such, reference should be had to United States Letters Patent No. 1,582,468, granted April 27, 1926 to Heald and Guild, which shows fluid pressure actuating and reversing mechanism to produce the aforesaid traverse, and automatic means to stop the grinding table or carriage when the grinding wheel is fully separated from the work, the table 1 of the present invention being shown in this position in Fig. 1. Said table 1 provides a pair of spaced adjustable dogs 5 and 6 which are adapted to alternately engage and move a reversing member 7, these parts constituting the controlling means of the aforesaid actuating and reversing mechanism.

In this embodiment of the invention the wheel head 2 is carried by a cross slide, not shown, which is mounted on ways for move-

ment transverse to the line of reciprocation of the table 1, as is the ordinary practice in internal grinding machines. A cross feed screw to move the aforesaid cross slide is indicated by the numeral 8 and, referring to Figs. 1 and 7 said cross feed screw is intermittently actuated in the following manner:—a ratchet wheel 9 is either directly or through the medium of reduction gearing connected to the screw shaft 8, and an actuating pawl 10 is normally out of engagement with said ratchet wheel, but when moved upwardly will engage and move it. The pawl 10 is carried on the end of a pivoted member 11, which also provides a roller 12 that rides on and is raised by an adjustable cam member 13 at the end of each working stroke of the table 1 that carries the grinding wheel inwardly of a workpiece. The cam member 13 is mounted on a bar 14 attached to any stationary part of the machine and can be moved longitudinally thereof and then clamped in any desired position. The cross feed screw 8 can also be actuated from a hand wheel 15 since, as aforesaid, the pawl 10 is normally out of engagement with the ratchet 9, being held thus by a spring, not shown, there being a cam member 17 which forces it toward the ratchet wheel only when the said pawl is raised.

Referring to Figs. 1, 2, 3 and 4, a bridge 18 is attached to the machine frame and spans the ways 19, 19 which support the table 1 thus allowing said table to move thereunder. This bridge 18 provides an upwardly extending frame portion 20 which supports the work-holding and work rotating means and the work magazine. Extending horizontally from the right hand face of the frame portion 20 are a pair of studs 21 and 22 upon which are mounted for rotation a pair of rollers 23 and 24 respectively, these rolls constituting tangential supports for the workpieces to be ground. As shown in Fig. 3, the axis of rotation of the roll 24 is in the same vertical plane as the axis of a workpiece *a* when in a grinding position, so that the point or points of tangency will lie directly beneath the center of the workpieces.

The third tangential support for the workpieces comprises a large roller 25, to which rotation is imparted and which therefore rotates the workpieces *a*, said roller being moved into and out of work-holding position to allow ground workpieces to be discharged from the machine and unground workpieces to be placed in grinding position. To that end the roller is journalled on a shaft 26 and suitable means such as a pulley 27 formed integrally therewith is provided to rotate said roller, there being a belt, not shown, running to the pulley 27 from any suitable source of power. The shaft 26 is held by an arm 28 which is pivotally mounted on a bolt or stud 29 provided by an oscillatory member 30, said member 30 being mounted for oscillation on the frame portion 20 by means of a projecting cylindrical portion 31 provided by the latter and an internal cylindrical bearing surface 32 provided by the former. The axis of oscillation of the member 30 coincides with the axis of rotation of the workpiece *a*.

In order that each workpiece may be held from longitudinal movement as it is being ground, the axis of rotation of the roller 25 is inclined with respect to the axis of workpiece rotation. That is to say, assuming the axis of rotation of the workpiece to be horizontal, the axis of the roller 25 and consequently the shaft 26, when said roller is in work-holding position, is inclined to the horizontal and, assuming the roller 25 to be revolving in the direction of the small arrow shown thereon, the right hand end (viewing the machine from the front) is lower than the left hand end thereof. This inclination of the driving roller 25 gives the workpieces an end thrust to the left, which causes them to press against a positioning device 33 provided to hold them successively in grinding position. This positioning device 33 comprises a rotatable member, the end thrust on which is taken by ball bearings 34, said member being undercut at 35 to allow the grinding wheel 4 to pass slightly beyond the edge of each workpiece. The positioning member 33 provides a shaft portion 36 which extends through the frame portion 20; this shaft, the positioning member 33, and the oscillatory member 30 are all held in place on the frame 20 by means of a bolt 37 and a large washer 38. The axis of rotation of the positioning member 33 is, of course, the same as the axis of rotation of the workpiece.

Referring now to all the figures, annular workpieces *a* to be ground may be stacked one behind the other in a trough shaped magazine 39, the trough of the magazine being inclined as shown, and the workpieces being stacked therein so that they will roll towards the work-holding means as best shown in Fig. 4. An escapement device 40 is provided so that the workpieces will be released one at a time, and only when desired, the construction and actuation of this device being hereinafter described. The magazine 39 may be attached to any stationary portion of the machine, being herein shown mounted on the frame portion 20.

At the completion of the grinding operation on each successive workpiece, the roller 25 is moved from the position shown in Figs. 2 and 3 to the position shown in Figs. 1 and 4, thus allowing the ground workpiece to drop out of the machine into any suitable receptacle, not shown. Thereafter said roller 25 moves back to its original and normal position, and in so doing guides a fresh workpiece *a*, which has been released by the escapement device 40, into grinding position,

tangent to the rolls 23 and 24 and the roller 25. This movement of the roller 25 is accomplished through oscillation of the member 30, and the upward movement of the roller 25 occurs coincidentally with and is brought about by movement of the table 1 to the position of Fig. 1, in which the grinding wheel is withdrawn from the grinding position. The return movement of the roller 25 is occasioned by the return of the table 1 to the position where the grinding wheel 4 is given its working traverse in relation to a workpiece *a*, it being understood that the fresh workpiece has reached the grinding position by the time the wheel 4 starts to enter it.

The mechanism for imparting oscillations to the oscillatory member 30 in response to movement of the table 1 to remove and replace workpieces in grinding position will now be described. Referring to Figs. 1 and 2, the table 1 has fastened to the rear thereof a short bracket 41, which provides a hub portion 41*a* with a longitudinal hole. Through said hole extends a long longitudinally extending rod 42, which is supported at the left hand end by a bell crank lever 43, and is otherwise unsupported except by the hub portion 41*a*. The bell crank lever 43 is pivoted at 44 to the bridge 18, and besides being connected to the rod 42, is connected by a link 45 to one end of a lever 46 which is pivoted at 47 to the bridge 18. The other end of the lever 46 is connected to a depending arm 48 provided by the oscillatory member 30, and as the lever 46 swings in one plane and the oscillatory member 30 swings in a plane at right angles thereto, this connection is made by means of a link bar 49 connected by pivot pins in different planes to short links 50 and 51; the link 50 being pivotally connected at 52 to the lever 46, and the link 51 being pivotally connected at 53 to the arm 48.

During the greater part of the travel of the table 1 to carry the grinding wheel 4 away from a ground workpiece, the hub portion 41*a* simply slides over the rod 42 without effect thereon; finally, however, and just before the table is brought to a stop, the right hand end of said hub portion strikes one of a pair of adjustable nuts 54, 54 on the threaded end of said rod, and thus moves the same through a limited distance. Such movement, by reason of the lever and linkage connections just described, swings the oscillatory member 30 to move the roller 25 up to the magazine 39, where it remains till the operator of the grinding machine starts it in operation again, as by the manual moving of a control lever 55 which causes the table 1 to move to the left. On such return movement of the table 1, the hub portion 41*a* again passes over the rod 42 without effect thereon until it comes in contact with a loose collar 56 mounted on said rod, which is spaced from a collar 57, fastened as by a pin 58 to said rod, by a stiff coil spring 59. The spring 59 is strong enough to resist compression until the linkage mechanism has caused the oscillatory member 30 to lower the roller 25 to work-holding position; a new workpiece *a* has arrived at such position just prior to the entrance of the grinding wheel 4 into it, and the additional movement of the table 1 to cause such entrance merely causes compression of the spring 59, the member 30 being prevented from moving beyond the position shown in Fig. 3 by a stop pin 60 which is engaged by the depending arm 48, said stop pin being shown in Fig. 4.

The machine of the present invention provides automatic means to cause the table or carriage 1 to move to the inoperative position shown in Fig. 1 at the completion of a particular grinding operation; such may be set in operation by any kind of gage or caliper mechanism, or it may be controlled from the cross feed actuating mechanism as shown, for example, in U. S. Letters Patent No. 1,682,673 to Taylor, granted August 28, 1928. The present drawings disclose a control of the latter sort, and the essential elements thereof, so far as they relate to the present invention, will now be pointed out. Referring to Figs. 1 and 7, the left hand table dog 5, unlike the right hand table dog 6, is a pivotally mounted dog, being supported by a pin 61 provided by a carrying block 62 adjustably positioned, as is the block 63 of the dog 6, to the table or carriage 1. Below the dog 5 and in the path thereof is a lever arm 64, which is pivotally mounted on a stud 65; one end of the lever arm is adapted, when raised, to cause the dog 5 to lift up and be carried clear of the reversing member 7, while the other end of said lever arm incorporates an armature 66. Said armature 66 lies just above an electromagnet 67 which, when energized, draws the armature downwardly and consequently raises the right hand portion of the arm 64.

The hand wheel 15, or some part connected thereto or to the ratchet wheel 9 carries a cam member 68. In the path of this cam member is an adjustable screw 69 carried by a contact making lever 70. This lever, when moved by the cam, closes an electric circuit at 71 and causes an electric current to flow through the magnet 67 from a generator 72 or any other suitable source, the current passing by way of a conductor 73 from the generator to the magnet, by way of a conductor 74 from the magnet to the contact points at 71, the other lead of the generator and the lever 70 being both grounded.

In the grinding of any given workpiece the grinding wheel is caused to cut deeper and deeper by the intermittently actuated

cross feed mechanism described hereinbefore; at any desired position of such mechanism the cam 68 can be caused to engage and move the lever 70, thus closing the circuit described and raising the lever arm 64. Raising of this arm causes the dog 5 to be lifted clear of the reversing member 7 on the next subsequent travel of the carriage 1 to the right, and said carriage therefore, continues its movement uninterrupted until it is stopped by the means shown in the aforesaid patent to Heald and Guild, or by any other means. In the copending application of Taylor referred to there is shown a compensating mechanism which, in conjunction with a dressing mechanism such as shown at 75 controls the cross feed mechanism in relation to the size of the grinding wheel, so that workpieces uniform in size are produced; such compensating and dressing mechanism is desirably incorporated into the present machine, but having nothing to do with the present invention, will not be described herein.

Referring now to Figs. 3, 4, 5, and 6, upward movement of the roller 25 occasioned by outward travel of the carriage 1 as described, releases a workpiece *a* in the magazine 39 by operation of the escapement 40. The latter comprises a pin 76 projecting through a slot 77 in the side of the magazine and normally engaging one of the workpieces *a* by contact with its inner periphery. The pin 76 is mounted on the front face of a block 78, said block being pivotally mounted on a pin 79 extending between ears 80, 80 provided on the side of the magazine 39. A spring device 81 holds the block 78 normally in the position shown in Fig. 5; movement of the oscillatory member 30 to the position shown in Fig. 4 causes an arm 82 formed integrally with said member 30 to engage and depress a horizontally projecting portion 83 of the block 78, thus withdrawing the pin 76 from engagement with a particular workpiece *a* and allowing, therefore, all of the workpieces *a* to move downwardly in the trough of the magazine 39.

The parts are shown in this position in Fig. 4, the bottom workpiece being prevented from falling out of the magazine by the roller 25. When, as the table 1 moves to carry the grinding wheel 4 back into grinding position, the oscillatory member 30 swings clockwise, Fig. 4, the arm 82 releases the block 78 and the pin 76 engages the inside of the next succeeding workpiece *a*. The workpiece that has been released follows the roller 25 downwardly, resting partly on said roller and revolving by reason of the revolution of said roller. A spring 84, connected to pins 85 and 86 provided by the oscillatory member 30 and the arm 28 respectively, tends to hold the roller 25 close to the axis of workpiece rotation, and consequently, since the points of tangency of the rollers 25 and 23 with the workpiece are in a straight line with the latter's centre when the roller 25 has reached its lowest position, the workpiece *a* that is moving downwardly cannot enter the grinding position till the roller has substantially ceased moving. When said roller has reached its lowest position the workpiece is forced into place by the pressure on it caused by the rapid rotation of the roller 25; this allows the workpieces to be held in grinding position by spring pressure without the provision of any separate means to move the roller 25 away from the roller 23 to allow the workpiece to enter. The pressure of the spring 84 can be a considerable pressure, as when the parts reach the straight line position described, and illustrated in Fig. 3, the wedging effect of the workpiece to separate the rollers is very great indeed. It should be noted that each workpiece, as it descends, is supported by the roller 23, whose surface is cylindrical and whose axis is horizontal, and by point contact with the moving roller 25, and each workpiece is literally snapped into grinding position and held there. In this manner possibility of a workpiece jumping out is minimized. In order to prevent the workpieces from striking the projecting edge of the positioning device 33, owing to the longitudinal thrust imparted by the roller 25, a surface 87 flush with the front edge of said positioning device is provided by the frame portion 20, and this surface 87 acts as a guide and assists in maintaining the axis of the moving workpiece horizontal.

To set the machine in operation the operator has only to load the trough magazine 39 with a plurality of workpieces, the lowermost of which will rest against the roller 25, thus to hold all of them in position in the magazine. The table 1 being then in the position of Fig. 1 and the driving roller 25 being raised as shown, the machine is started by shifting the main control lever 55. This causes a single workpiece *a* to be guided down into grinding position as already described. The grinding wheel immediately enters the workpiece and starts to grind it; the longitudinal thrust which the traversing grinding wheel imparts to the workpiece is taken, in one direction by the positioning device 33, and in the other direction by the force generated by the rotation of the inclined roller 25, such force being, of course, a function of the pressure of the spring 84.

The workpiece is now automatically ground to the required internal diameter, and when such diameter is attained, the table 1 runs outwardly in response to lifting of the pivotally mounted dog 5, as described. The roller 25 then moves upwardly, releasing the ground workpiece *a* from grinding position, and releasing another workpiece *a* in the magazine 39. The ground workpiece will drop out of the machine because it is still ro-

tating, and the friction on the roller 24 and consequent retardation of said roller tends to cause the workpiece to move to the left, Fig. 3, and as it is directly over the axis of said roller 24, a slight amount of movement suffices to cause it to drop out. During each particular grinding operation the pressure of the grinding wheel 4 is taken by the roller 23, and as the axis of rotation of this roller is on a level with the axis of workpiece rotation, accurate positioning of the roller 23 will result in accurately ground workpieces.

It should be observed that instead of providing the means set forth in the aforesaid patent to Heald and Guild to stop the table 1 in its outward position when a particular workpiece is finished, an additional table dog could be provided which would swing the reversing member 7 over and start the table inwardly again. Such simple addition to the machine here shown would make the machine completely automatic, so that the operator would not have to start the machine again after each grinding operation, except for the fact that the cross slide mechanism would need retraction to allow the wheel 4 to enter a new workpiece. But the latter may also be provided, and an exemplary embodiment thereof is shown in the copending application of Carle J. Highberg, Serial No. 99,287, filed April 2, 1926, now Patent No. 1,840,841, granted January 12, 1930, and it should be understood that the present machine can be made completely automatic by the incorporation of this table reversing dog and automatic wheel retraction mechanism, both of which are shown in said application.

We claim:—

1. In a grinding machine, the combination with a plurality of workholding and rotating rolls, of a driving roll that is skewed with respect to the axis of the other rolls, whereby to give said workpiece a longitudinal thrust, means to back up the workpiece to hold it stationary against said thrust, and a grinding wheel having a reciprocatory traverse relative to the work, said work being thus held in rigid longitudinal position, without the necessity of any flanges on the rollers, against the tractive effect of the traversing grinding wheel.

2. In a grinding machine, the combination with a grinding wheel, and means to reciprocate it, of a plurality of rolls for holding a workpiece in grinding position, and a rotatable back plate for taking the longitudinal thrust of the grinding wheel in one direction.

3. In a grinding machine, the combination with a grinding wheel, and means to reciprocate it, of a plurality of rolls for holding a workpiece in grinding position, a rotatable back plate for taking the longitudinal thrust of the grinding wheel in one direction, and means for taking the thrust of said grinding wheel in the other direction to hold the workpiece in position.

4. In a grinding machine, the combination with a plurality of stationary rolls acting as work rests, and a roll which is adapted to be moved to insert and discharge workpieces from the machine, of means for holding said movable roll to an angular position of substantially 180° from the nearest stationary roll on one side, whereby a workpiece can just enter the grinding position.

5. In a grinding machine, the combination with a plurality of stationary rolls acting as work rests, and a roll which is adapted to be moved to insert and discharge workpieces from the machine, of means for holding said movable roll to an angular position of substantially 180° from the nearest stationary roll on one side, whereby a workpiece can just enter the grinding position, a magazine, and means for moving said movable roll from said position to said magazine, to guide a workpiece into grinding position.

6. In a grinding machine, the combination with a plurality of stationary rolls acting as work rests, and a roll which is adapted to be moved to insert and discharge workpieces from the machine, of means for holding said movable roll to an angular position of substantially 180° from the nearest stationary roll on one side, whereby a workpiece can just enter the grinding position, and means for rotating said movable roll to force the workpiece into grinding position between the nearest stationary roll and the movable roll.

7. In a grinding machine, work holding and rotating means comprising a plurality of rolls one of which is rotated to rotate the workpiece, a rotating grinding wheel and means to feed said grinding wheel in cutting relation to a workpiece, the axis of one of said rolls being located in the plane of the advance of the axis of said grinding wheel, whereby to directly take all the cutting thrust of said grinding wheel.

8. In a grinding machine, work holding and rotating means comprising a plurality of rotatable rolls, and one rotating and driving roll, a rotating grinding wheel and means to feed said grinding wheel in cutting relation to a workpiece, the axis of one of said rotatable rolls being located in the plane of the advance of the axis of said grinding wheel, whereby to directly take all the cutting thrust of said grinding wheel, the point of tangency of said rotating roll being located in the same plane, so that the said rotatable roll located in said plane will also take the compression force holding said workpiece in grinding position.

9. In a grinding machine, the combination with a grinding wheel and means for causing it to advance in cutting relation to a workpiece, of work holding and rotating means comprising a rotatable roll whose axis is lo-

cated in the plane of advance of the axis of said grinding wheel, a rotating roll which has a point of tangency to the workpiece also located in said plane, and a third roll which is rotatable, and means for rotating the rotating roll in a direction to give the workpiece a slight thrust towards the said third roll, whereby the first mentioned roll takes all the thrust occasioned by the advance of the grinding wheel and the compression holding the workpiece in position, and the workpiece is prevented from emerging from the work holding means by the direction of rotation given to the rotating roll.

10. In a grinding machine, a pair of freely rotatable rolls mounted on parallel axes, a third driven roll mounted so that tangent points on all three rolls define a circle with the driven roll 180° from one of the other rolls, and means to drive the driven roll so as to thrust a workpiece towards that one of the freely rotatable rolls that is less than 180° from the driven roll, whereby to hold a workpiece resiliently in position and rotate it.

Dated this 14th day of February, 1928.

WALDO J. GUILD.
ALFRED P. BURNS.