Oct. 3, 1939. B. A. KEARNS 2,175,057

SPINDLE RECIPROCATING MECHANISM FOR GRINDING MACHINES

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Fig. 1

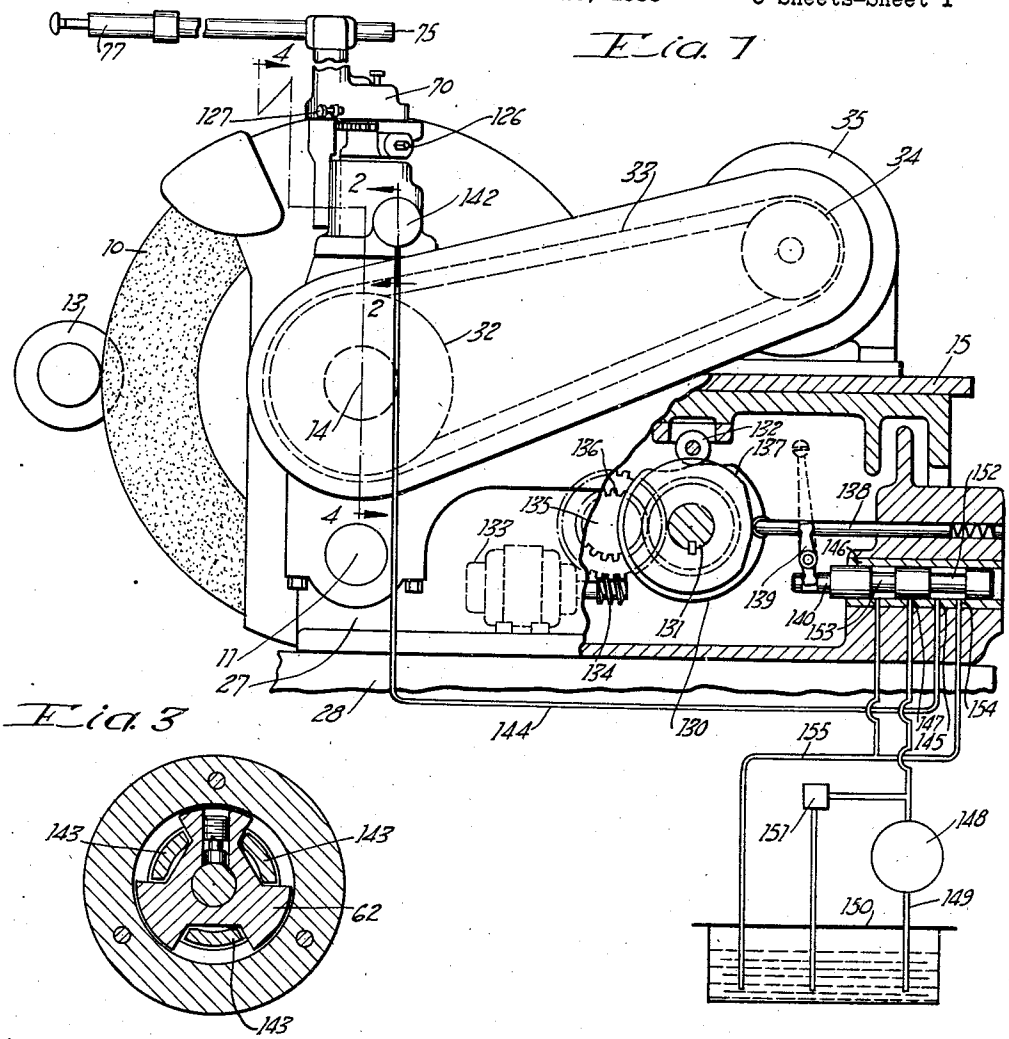


Fig. 3

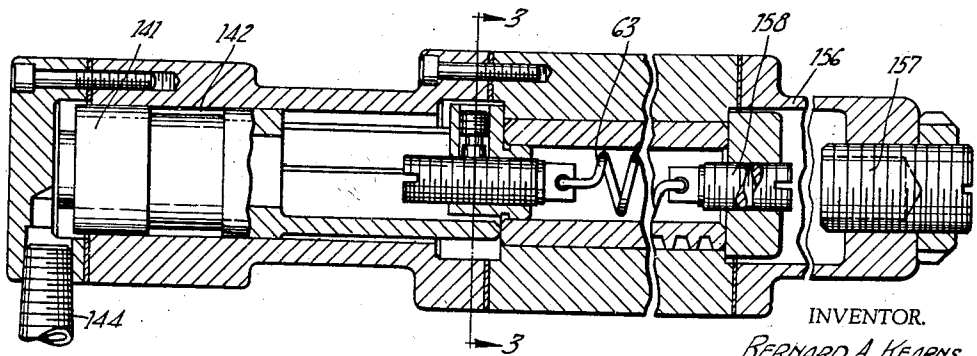


Fig. 2

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SPINDLE RECIPROCATING MECHANISM FOR GRINDING MACHINES

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Fig 5

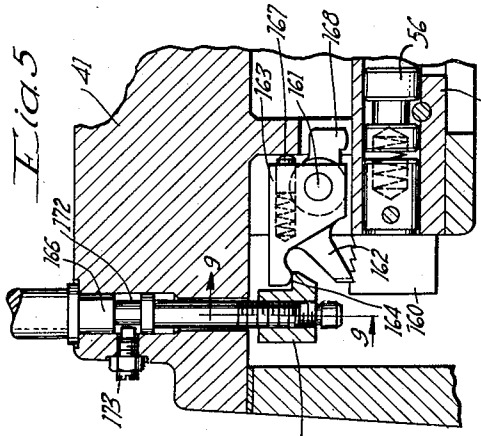
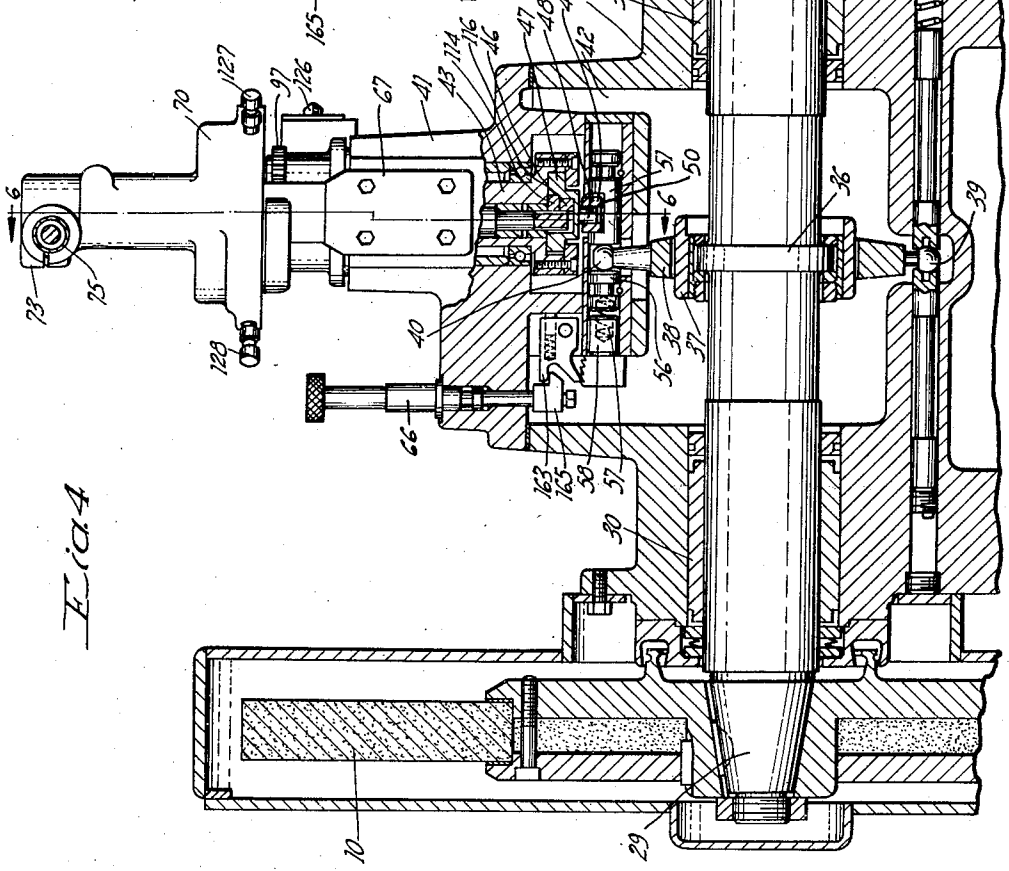


Fig 4



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SPINDLE RECIPROCATING MECHANISM FOR GRINDING MACHINES

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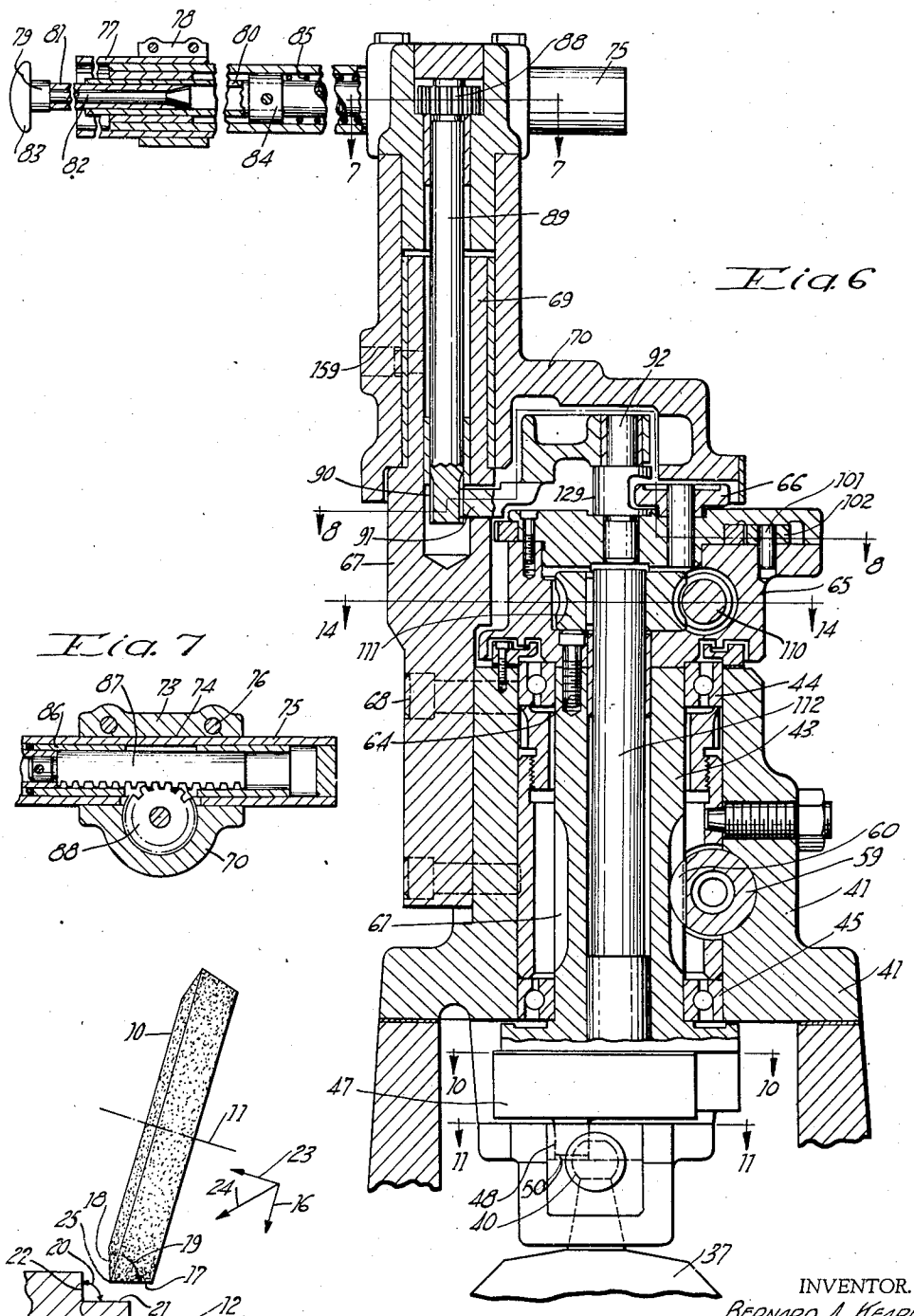


Fig. 6

Fig. 7

Fig. 13

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SPINDLE RECIPROCATING MECHANISM FOR GRINDING MACHINES

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Fig. 8

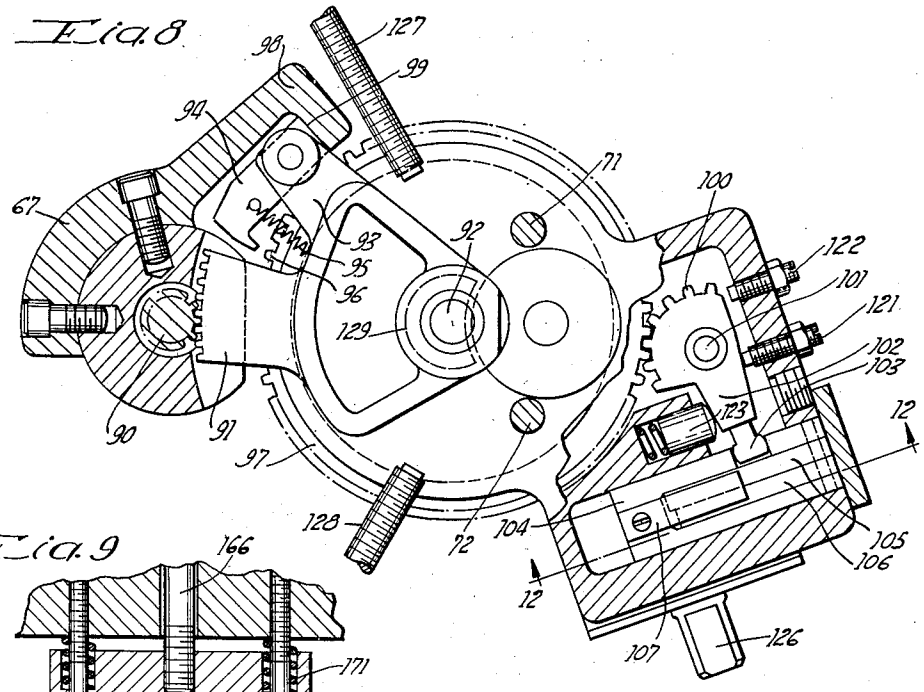
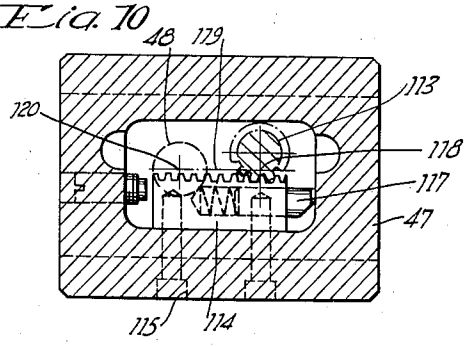


Fig. 9

Fig. 10



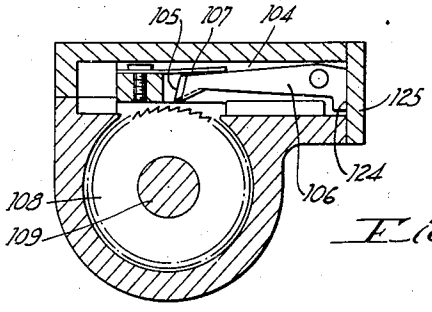
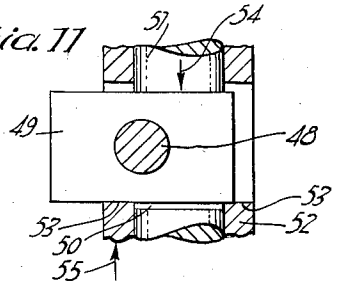


Fig. 12

Fig. 11



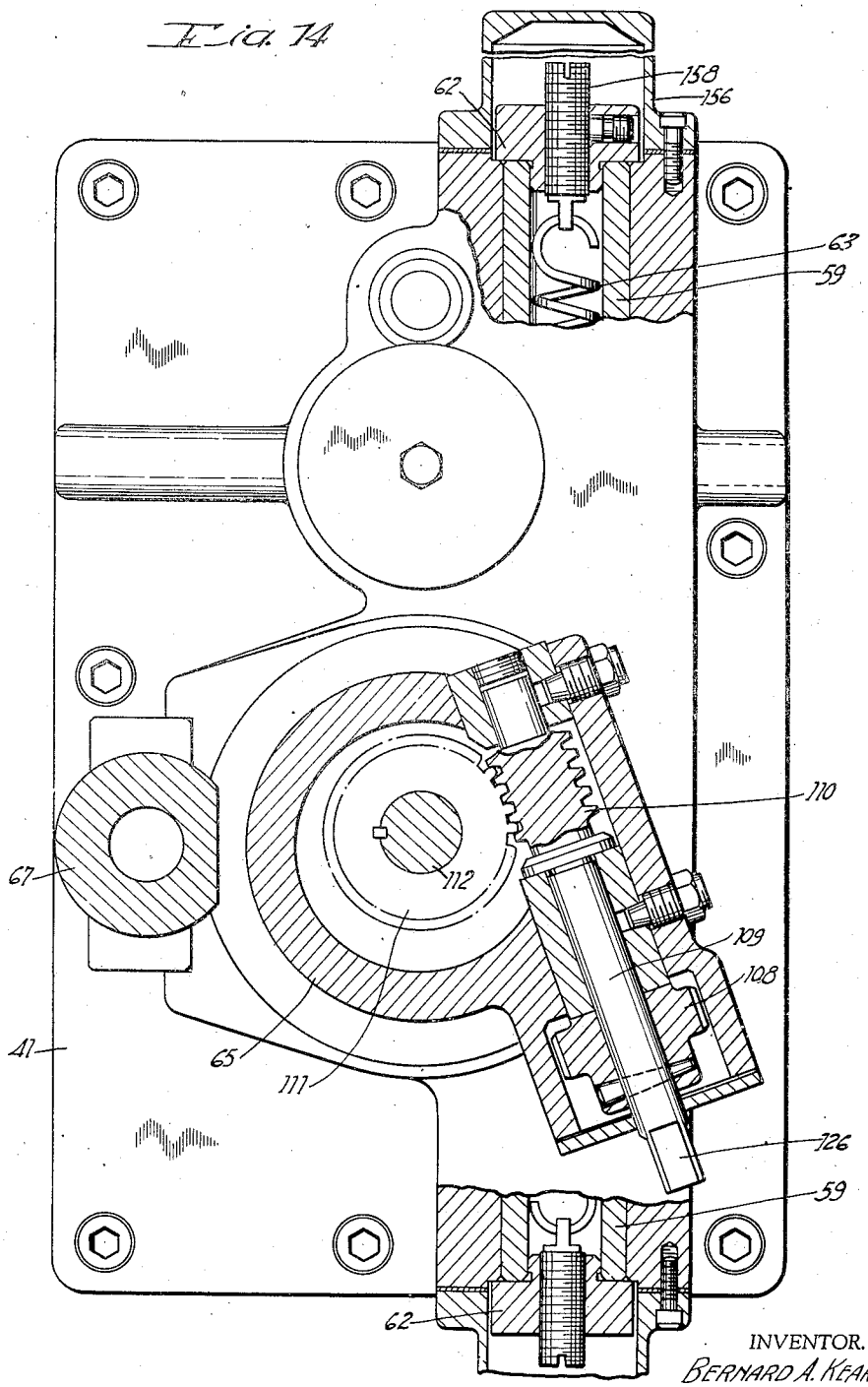
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Fig. 14



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UNITED STATES PATENT OFFICE

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SPINDLE RECIPROCATING MECHANISM FOR GRINDING MACHINES

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Application March 28, 1938, Serial No. 198,440

13 Claims. (Cl. 51—34)

This invention relates to grinding machines and more particularly to an improved spindle reciprocating mechanism therefor.

One of the objects of this invention is to provide a new and improved mechanism for axially feeding the spindle of a grinding wheel, either manually or automatically.

Another object of this invention is to provide a mechanism of the character described which may be conveniently operated manually by the operator to effect continuous reciprocation, or automatically actuated to perform a single stroke.

A further object of this invention is to provide a mechanism which is especially suitable for finish grinding a square shoulder on a work piece at the same time that the diameter is finished.

An additional object of this invention is to provide a mechanism which is especially useful for shoulder grinding work and which is adjustable so that compensation may be made for wheel wear.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification considered in conjunction with the accompanying drawings illustrative of one embodiment thereof, but it will be understood that any modifications may be made in the specific structural details within the scope of the appended claims without departing from or exceeding the spirit of the invention.

Referring to the drawings in which like reference numerals indicate like or similar parts:

Figure 1 is a side elevation of a grinding wheel head unit showing the application of this invention thereto.

Figure 2 is a detail section on the line 2—2 of Figure 1 showing the spindle actuating piston.

Figure 3 is a detail section on the line 3—3 of Figure 2.

Figure 4 is a vertical section through the grinding wheel spindle as viewed on the line 4—4 of Figure 1.

Figure 5 is an enlarged detail of a ratchet stop mechanism.

Figure 6 is an enlarged vertical section through the actuating mechanism for the spindle as viewed on the line 6—6 of Figure 4.

Figure 7 is a detail section on the line 7—7 of Figure 6.

Figure 8 is a section on the line 8—8 of Figure 6.

Figure 9 is a detail section on the line 9—9 of Figure 5.

Figure 10 is a detail section on the line 10—10 of Figure 6.

Figure 11 is a detail section on the line 11—11 of Figure 6.

Figure 12 is a detail section on the line 12—12 of Figure 3.

Figure 13 is a diagrammatic view showing the relationship between a grinding wheel and a work piece.

Figure 14 is an enlarged section on the line 14—14 of Figure 6.

One of the items which adds to the cost of manufacturing multiple diameter work pieces is the operation of finishing the internal corners formed by two intersecting surfaces. A common example of this is the internal corner formed by a shoulder at one end of a cylindrical surface. If the cylindrical surface is to serve as a bearing member, and the shoulder as a lateral guide, it will be apparent that a part mounted on the cylindrical surface must have unhindered utilization of that surface in order that the shoulder may serve as a guide. It is therefore essential that no superfluous material be left in the corners by the manufacturing processes. Heretofore, an extra machining operation was usually necessary in order to remove this material.

This invention is directed to a mechanism for so manipulating the grinding wheel that it will not only simultaneously finish grind the two intersecting surfaces but will also produce a square corner between the two surfaces in such a manner that subsequent finishing operations are unnecessary.

Briefly, this is accomplished by supporting a grinding wheel indicated by the reference numeral 10 in the diagrammatic sketch, Figure 13, for oscillation about an axis 11 which is arranged at a slight angle with respect to the axis of rotation 12 of the work piece 13. If the axis of rotation 11 is arranged below the axis of rotation 14 of the grinding wheel, as shown in Figure 1, it will be apparent that as the grinding wheel support 15 moves about the axis 11, that the grinding wheel 10 will move toward and from the work piece 13. On account of the angular relationship of the axes 11 and 12, the grinding wheel will not move toward the work along a path perpendicular to the axis 12 but along a path indicated by the reference numeral 16 in Figure 13 which is perpendicular to the axis 11 and therefore slightly inclined with respect to the axis 12. This means that the grinding wheel can be trued to provide a first grinding surface 17, and a second grinding surface 18, having an included angle of intersection 19 which is equal

to the angle of intersection 20 of the cylindrical surface 21 of the work and the face 22.

In addition, the grinding wheel is provided with a movement parallel to its axis of rotation and in a direction indicated by the arrow 23 in Figure 13. If the movement along the path 16 and the one along the path 23 are executed simultaneously there will be a resultant movement along the path 24. It will be noted that if the grinding wheel can follow the path 24 in moving toward the work piece, that the corner 25 of the grinding wheel will move directly toward the internal corner 26 of the work piece, and in so doing will simultaneously grind both the cylindrical surface 21 and the face 22. The mechanism for reciprocating the grinding wheel either manually or automatically, whereby this and kindred results may be obtained, will now be described, the manual control mechanism being described first.

In Figure 1 of the drawings, the reference numeral 27 indicates generally a grinding wheel support unit, which may be mounted on a fixed support, such as 28, with the axis of the grinding wheel parallel to the axis of the work, as when grinding cylindrical surfaces having shoulders at each end; or inclined to the axis of the work as suggested in connection with Figure 13.

The grinding wheel 10 is supported on the end of a spindle 29, Figure 4, which is antifrictionally journaled at spaced points 30 and 31 in the housing 15. The end of the spindle opposite to the grinding wheel is provided with a driving pulley 32 which, as shown in Figure 1, may be connected by a plurality of belts 33 to a driving pulley 34 secured to the end of the armature shaft of the motor 35. Thus the spindle is adapted to be power rotated by means self-contained in the housing 15 and movable therewith.

The spindle 29 has an intermediate collar 36, which is antifrictionally connected to a ring 37, the ring being pivotally connected at diametrically opposite points to a lever 38 which is pivotally supported at 39 in the housing 15 and operatively connected at the outer end 40 to a reciprocating mechanism. It should now be apparent that as the end 40 of the lever 38 is moved in the plane of Figure 4, that the grinding wheel spindle will be axially moved.

The mechanism for reciprocating the spindle is more particularly shown in Figure 6, and is entirely contained in a housing 41 which is adapted to be mounted and secured over the top of an opening 42 in the support 15, and automatically operatively interconnected with the end 40 of the lever 38 upon assembly.

There is a vertical sleeve 43 which is antifrictionally supported at 44 and 45 in the housing 41. The end of this sleeve, as shown in Figure 4, is provided with a guideway 46 in which slides a pin carrying slide 47. A pin 48 carried by this slide fits in a block 49, as shown in Figure 11, the block fitting in a cross slot 50 formed in a plunger 51. This plunger is surrounded by a sleeve 52 which has a portion cut away to form shoulders 53, and means are provided whereby the plunger 51 is continuously urged in the direction of arrow 54, and the sleeve 52 is continuously urged in the direction of arrow 55 whereby any lost motion between the plunger 51 and the sleeve 52 is eliminated.

The end 40 of lever 38 fits between the end of plunger 51, and the end of a second plunger 56 which is urged in one direction by a spring 57 interposed between the end of the plunger and a plug 58 fixed in the end of the sleeve 52. It is this spring which continuously urges the parts shown in Figure 11 in opposite directions. It will be apparent that if the pin 48 is located eccentrically to the axis of rotation of the sleeve 43, that when the sleeve is rotated the pin will cause movement of lever 38 by means of the mechanical connections just described.

No positive stops are provided for limiting the movement of the spindle, the length of movement being controlled by oscillating the pin 48, 90° to each side of a center position. Therefore the axis of eccentricity of the pin is made to normally lie in a plane perpendicular to the axis of rotation of the spindle in order to determine the center position. The movement of the spindle in each direction from this center position will then depend upon the length of the effective radius of eccentricity. Therefore, means are provided for centralizing the pin, and thereby the spindle in this center position. This aids in work set-up, because a work piece having an annular groove and opposing shoulders to be ground, may be positioned with the center of an annular groove in the plane of this center position.

By adjusting the eccentricity of the pin to make the radius equal to one-half of the desired width of the groove, the grinding wheel may be moved into the center of the groove and then oscillated to grind the shoulders.

This centralizing mechanism comprises an elongated sleeve 59, Figures 6 and 14, upon the periphery of which are cut rack teeth 60 which intermesh with gear teeth 61 cut in the periphery of the sleeve 43. The sleeve 59 has cap members 62 mounted in each end and interconnected by a spring 63 which passes through the center of the sleeve. The cap members are sufficiently large in diameter to overlap the sleeve and engage a part of the housing 41. The sleeve is made of the proper length so that when both cap members are in engagement with the housing there is no lost motion between the sleeve and the caps. It will now be apparent that when the member 43 is rotated to reciprocate the spindle, that the sleeve 59 will also move thereby moving one of the caps with it, causing elongation of the spring 63. This provides the necessary force to return the parts to a central position.

The upper end of the sleeve 43 has secured to it as by screws 64, a rotatable housing 65 which carries an eccentric roller 66 on its upper side.

The fixed housing 41 has an upstanding bracket 67 attached to one side, as by screws 68, and the upper end of this bracket has an elongated tubular portion 69 which forms a vertical bearing for a crank housing 70. This crank housing carries two pins 71 and 72 which, as shown in Figure 8, depend into engagement with opposite sides of the roller 66 whereby upon rotation of the crank, the roller 66 is picked up and moved to rotate the sleeve 43. The upper end of the housing 70 has a boss 73, as shown in Figure 7, through which is formed a bore 74 for receiving an operating lever 75. The boss 73 is split on one side and clamping bolts 76 serve to draw the two parts together and clamp the lever 75 in proper longitudinal position.

The lever 75 consists of a tube, on one end of which, as shown in Figure 6, is mounted a second telescoping tube 77. A split collar 78 serves to clamp the parts together and at the same time permit telescoping adjustment to carry the length of the operating lever. It will be noted that the operating lever 75 extends toward the operator's

position on the side of the work opposite to the grinding wheel 10, as more particularly shown in Figure 1. When the operator oscillates the lever 75, he will rotate the crank housing 70 and thereby, through the pin and roller connection, rotate the housing 65 and the sleeve 43 integrally connected therewith, whereby the pin 48 eccentrically carried on the lower end of the sleeve 43 will move in an arc about the axis of rotation of the sleeve 43 and cause axial movement of the grinding wheel spindle in either direction from its normal central position.

When the grinding wheel is used to grind both the diameter and two shoulders at opposite ends of an annular groove in a work piece, it will be apparent that it is necessary to true the sides of the wheel as well as the peripheral surface in order to maintain square corners on the work piece. It will be obvious that as the sides of the wheel are trued away, the width of the wheel grows smaller whereby a greater stroke becomes necessary in order to move the sides of the wheel into contact with the shoulders and grind the width of the groove to the same size. Since the stroke of the grinding wheel is dependent upon the eccentricity of the pin 48, it will be obvious that the stroke can only be changed by varying the eccentricity of this pin. Means have therefore been provided whereby the eccentricity of this pin may be varied, and this mechanism is so contrived that it may be actuated from the operator's position by means of a plunger 79 located in the end of the lever 75.

It is to be understood that the eccentricity of the pin will be a minimum when the grinding wheel is new and that as the grinding wheel wears away, the plunger is actuated to increase the eccentricity of the pin. This plunger is frictionally held in the end of a tube 80 and may be axially adjusted relative thereto whenever the outer telescoping sleeve 77 is adjusted relative to the lever 75 so that the plunger 79 always projects beyond the end of the tube 77. The plunger 79 comprises a tube 81 which is split on the inner end and has a taper ended draw bar 82 which is threaded in the end of the head 83 so that as the draw bar is pulled axially by rotating the head 83, the end of the tube 81 will be expanded within the tube 80 and frictionally locked.

The tube 80 carries a collar 84, and a spring 85 is mounted between this collar and a fixed sleeve 86 carried within the member 75. The end of the sleeve 80 has a tubular rack member 87 attached to the end thereof, as shown in Figure 7, in intermeshing relation with a pinion 88. The pinion 88 is keyed to the upper end of a shaft 89, as shown in Figure 6, and the lower end of this shaft is reduced in diameter and provided with pinion teeth 90 which intermesh with a gear segment 91.

Referring to Figure 8, the gear segment 91 is supported for free rotation on the end of an upstanding pin 92. The segment 91 carries a radial arm 93 in the end of which a pawl 94 is pivotally mounted. A spring 95 normally urges this pawl into engagement with teeth 96 of a ring gear 97. The housing 67 has an L-shaped portion 98 surrounding the pawl and providing a shoulder 99 which is adapted to engage the heel of the pawl so that when the segment 91 is moved clockwise to its extreme position, the pawl 94 will be out of engagement with the gear teeth. Upon axial movement of the plunger 79 toward the right, as viewed in Figure 6, the pinion 88 will be rotated and thereby through the pinion 90 will cause movement of the gear segment 91 in a counterclockwise direction whereby the heel of the pawl will move away from the shoulder 99 and the spring 95 will cause engagement of the pawl with the gear teeth thereby rotating the gear 97.

The gear 97 meshes with a gear segment 100 which is supported for free rotation on the pin 101 carried by the housing 65. The segment 100 has a radial arm 102 which fits into a slot 103 of a slide 104. The slide 104 carries twin pawls 105 and 106 which are normally urged into engagement by a leaf spring 107 with teeth on the periphery of a ratchet wheel 108. The ratchet wheel 108, as shown in Figure 14, is pinned to the end of a shaft 109 which carries a worm 110. This worm meshes with a worm wheel 111 keyed to the upper end of shaft 112. The shaft 112, as shown in Figure 6, passes directly through the center of the sleeve 43 and is provided on the lower end with pinion teeth 113, as more particularly shown in Figure 10. These pinion teeth mesh with a short rack bar 114 which is fastened by bolts 115 to the slide 47.

A second rack bar 116 is mounted in the slide directly under the rack bar 114 and continuously urged in one direction by a spring pressed plunger 117 so as to take out lost motion between the pinion 113 and the slide 47. In Figure 10, the axis of rotation of the sleeve 43 is indicated by the reference numeral 118, and it will be noted that the rack bar moves parallel to a radial line 119 passing through the center 118 and the center 120 of the pin 48. Since the pinion 113 is fixed in space, it will be apparent that upon its rotation that the slide 47 will be moved in a direction to vary the effective eccentric radius of the pin 48.

The amount of change that can be effected in the eccentricity of the pin for a given stroke of the plunger 79 may be made very small and is determined by the setting of two set screws 121 and 122, shown in Figure 8. These set screws are threaded in the side of the housing 65, one above and one below the center of pin 101, whereby the set screw 121 limits the rotation of lever 102 in a counterclockwise direction, and the set screw 122 limits the rotation in a clockwise direction. A spring pressed plunger 123 normally urges the lever 102 in a counterclockwise direction against the set screw 121 thereby returning the ratchet pawls 105 and 106 into position for the next stroke. As the slide 104 returns these pawls to the position shown in Figure 12, the heels 124 of these pawls engage a plate 125 thereby rotating the pawls in a clockwise direction a sufficient amount to disengage them from the ratchet wheel. This makes it possible to reset the mechanism when a new grinding wheel is placed in the machine, because the shaft 109 which carries the ratchet wheel 108 projects beyond its housing, as shown in Figure 14, and is provided with a square end 126 to which may be applied a suitable crank for rotating the shaft 109 in a clockwise direction to effect retraction of the pin 48 toward the center 118.

If so desired, a pair of positive stops may be provided for limiting the oscillating movement of the crank housing 70 by providing a pair of stop screws 127 and 128 which are threaded into the housing 70 and in such position that as the housing rotates about the center of the bearing 69, the ends of the screws will alternately contact on opposite sides of the enlarged diameter 129 of pin 92. Conventional power operable means may be utilized to effect the movement of the grinding wheel toward and from the work

and the rate of this movement may be controlled by a suitably formed cam 130 which, as shown in Figure 1, is supported on a rotatable shaft 131 in adjacent relation to the under side of the support 15 whereby the support may be provided with a roller 132 for contacting the periphery of the cam. The cam may be actuated by a motor 133 having a reduction worm and worm gear drive indicated generally by the reference numeral 134 to a shaft 135. The shaft 135 may be connected to the shaft 131 through spur gearing indicated generally by the reference numeral 136. The cam may be so shaped and driven at such a rate that one revolution of the cam will effect a complete cycle of the grinding wheel toward and from the work.

It may be desirable to effect automatic lateral movement of the grinding wheel in timed relation to the automatic infeeding movement and if this is desired, a second control cam 137 may be applied to the shaft 131 and provided with a spring urged follower 138 which has a lever connection 139 to a control valve 140.

For purposes of illustrating one manner of obtaining automatic control, mechanism has been disclosed herein for effecting automatic lateral movement of the grinding wheel for work that falls under the class illustrated in Figure 13. In this case, it is only necessary to move the wheel laterally in one direction until the shoulder has been ground to the desired dimension after which the wheel is retracted and a new work piece substituted.

This movement may be effected by a piston 141 which, as shown in Figure 2, may be slidably mounted in a cylinder 142 attached to the end of the housing 41 and in axial alignment with the sleeve 59. In order not to interfere with the spring centering means for the sleeve, the cap member 62, as shown in Figure 3, may be cut away to permit the fingers 143 integral with the end of the piston 141 to pass through and engage the end of the sleeve. Thus, upon admission of fluid pressure to the end of cylinder 142, the sleeve 59 will be moved and thereby through the rack and pinion connection with the sleeve 43, the pin 48 may be moved in a direction to shift the grinding wheel in a direction towards the shoulder 22 of the work.

The end of the cylinder 142 is connected by a channel 144, as more particularly shown in Figure 1, to a port 145 of the control valve 146 which contains the valve plunger 140. This valve may have a pressure port 147 which is supplied from a suitable source of pressure, such as a pump 148, having an intake 149 through which fluid is withdrawn from a reservoir 150. The pump may be provided with a relief valve 151. The plunger 140 has two annular grooves 152 and 153 whereby when the plunger 140 is shifted to the left, the port 147 will be connected to port 145 and pressure fluid will flow to the end of cylinder 142. When the plunger 140 is shifted to its right hand position, the port 145 will be connected to an exhaust port 154 which is connected by a return channel 155 to reservoir 150. Thus, the admission of fluid pressure to the cylinder 142 may be automatically controlled from the cam 137 and the rate of flow may be governed in accordance with the amount that the pressure port 147 is opened.

In order to limit the movement of the sleeve 59, the opposite end of the housing 41 may be provided with a cup shaped member 156 in which is threaded an adjustable stop screw 157 axially aligned with the screw 158 threaded in the end of the cap member 62 and holding one end of the spring 63. By adjusting the stop screw 157, the movement of the sleeve 59 may be adjusted to thereby determine the throw of the spindle actuating pin 48.

In order to prevent interference from the mechanism shown in the upper part of Figure 6 with power rotation of the sleeve 43, the pin 72, shown in Figure 8, may be withdrawn, whereby upon rotation of the housing 65 which is integrally connected with the sleeve 43, there will be no feed-back motion transmitted to the crank arm 70, and this may be locked in position by a set screw 159 which is threaded in the housing and engageable with part of the fixed bearing 69. Additionally, the stop screw 128 may be backed away or removed to prevent interfering with the motion.

As previously mentioned, the grinding wheel 10, shown in Figure 13, will have the face 18 as well as the face 17 periodically trued, which means that for the same starting position of the grinding wheel, the distance between the face 18 of the wheel and the face 22 of the work will gradually increase thereby normally requiring a greater stroke in order to effect the desired contact between these surfaces so that the work may be ground. In order to keep this waste movement down to a minimum, means have been provided for limiting the return stroke to a maximum predetermined amount. The mechanism for accomplishing this is shown more particularly in Figure 5. The end of the movable sleeve 52 is provided with a toothed block 160 and over this block and pivotally mounted on a pin 161 are pawls 162.

The teeth on the block 160 are spaced a sufficient distance apart to permit a maximum reciprocating movement of a desired amount, such as $\frac{1}{16}$ of an inch or $\frac{3}{32}$ of an inch, after which one of the pawls will engage a tooth so as to reduce the return movement. In other words, the stop screw 157, shown in Figure 2, limits the movement of the sleeve 59 in one direction, and although the spring 63 tends to return the parts in the other direction, the pawls 162 limit this return. Thus the stroke of the piston 149 is gradually reduced so that the starting position of the lever 38 gradually shifts toward the left, as viewed in Figure 4, but the actual stroke effected for the reduced movement of the piston is compensated for by the plunger 79 which increases the eccentricity of the pin 48 whereby the linear movement of the pin 48 in an axial direction parallel to the grinding wheel spindle can be made substantially the same although its angle of movement is reduced.

Attention is invited to the fact that when the grinding wheel is trued, it is desirable that it return to the same position each time for truing and therefore means have been provided for releasing the pawls 162 so that the spring 63 can centralize the parts for truing. In addition, it is desirable that no inadvertent movement of the cutter spindle take place during truing and therefore means have also been provided for locking the sleeve 52. This mechanism comprises a lever arm 163 integral with the pawls and engaging a shoulder 164 on a bar 165. This bar has a threaded engagement with the end of a vertical plunger 166. The lever arms 163 are continuously urged in a counter-clockwise direction by a spring pressed plunger 167 which

also serves to hold the pawls in engagement with the teeth on the member 160. The lever arm 163 is also provided with an arm 168 which, upon clockwise rotation, will engage the sleeve 52 and lock the same.

For the purpose of merely releasing the pawls from engagement with the teeth on member 160, the plunger 166 is simply pulled up the desired distance, and when the pawls have become disengaged from the teeth, the spring 63, shown in Figure 14, will centralize the actuating pin. If it is desired to lock the parts for any period of time, the plunger 166 is rotated, and since the member 165 is held against rotation by two guide screws 169 and 170, as shown in Figure 9, the member 165 will be permanently held in an upward position, which will be limited by the clamp arm 168 engaging the sleeve 52. As shown in Figure 9, the member 165 will be permanently held in an upward position which will be limited by the clamp arm 168 engaging the sleeve 52.

As shown in Figure 9, springs 171 may be provided for urging the return of the member 165 when it is merely lifted. In order to limit the axial movement of member 166, it is provided with a groove 172 into which is threaded the end of a limiting screw 173, there being sufficient lost motion between the end of the screw and the groove to permit a limited axial movement of the plunger.

There has thus been provided an improved mechanism for the purposes described whereby the spindle of a grinding machine may be manually reciprocated during power infeeding thereof toward a work piece, and that additional means have been provided whereby the spindle may be moved by power in synchronous relation to an infeed cycle, and that improved means have been provided to make the necessary adjustments and compensations for wear and truing of the grinding wheel.

What is claimed is:

1. In a grinding machine having a support, a spindle rotatably mounted on said support, and a grinding wheel attached to said spindle, the combination of means for effecting axial reciprocation of said spindle during rotation thereof, including a rotatable member, a shifter carried thereby disposed eccentric to the axis of rotation of said member, means operatively connecting the shifter with said spindle, whereby upon rotation of said member, said spindle will be oscillated, and means to vary the effective eccentricity of the shifter with respect to the axis of rotation of the member, whereby the axial movement of said spindle for a given angle of rotation of said member is varied.

2. In a grinding machine having a fixed support, an oscillatable support mounted on said fixed support, a spindle journaled in said oscillatable support and having a grinding wheel attached thereto, the combination of means carried by said oscillatable support for reciprocating the grinding wheel spindle during rotation thereof and during movement toward a work piece, including an oscillatable member, power means for effecting successive oscillations of said member during the grinding operation, a pin located eccentrically to the axis of oscillation, means operatively connecting the pin for axial movement of said spindle, and axially arranged means within said oscillatable member and movable relative thereto for adjusting the eccentricity of said pin to thereby vary the throw thereof for a given angular movement of said member.

3. In a machine tool having a fixed support, an oscillatable support mounted thereon, and a grinding wheel spindle journaled in said oscillatable support and having a grinding wheel attached thereto for movement toward and from a work piece upon movement of said oscillatable support, the combination of a housing carried by said oscillatable support, a manually operable control lever pivotally mounted on said housing for oscillation by the operator, motion transmitting connections carried by said housing for transmitting the motion of said lever to said spindle for effecting a limited axial movement thereof, said means including an adjustable eccentric, and means carried by said control lever and movable axially thereof for increasing the effective throw of said eccentric connection.

4. In a grinding machine having a grinding wheel, a spindle therefor, and a support for moving the grinding wheel toward and from a work piece, the combination of means carried by said support for effecting lateral movement of the grinding wheel while in engagement with a work piece to grind shoulders thereon, including a housing carried by said support, a rotatable sleeve in said housing, motion transmitting connections from said sleeve to said spindle, means for oscillating said sleeve, including a roller eccentrically connected to the upper end of said sleeve, a crank arm supported for rotation about an axis parallel to the axis of oscillation of said sleeve and having a pair of depending members engaging opposite sides of said roller, and manually operable means for oscillating said crank arm.

5. In a grinding machine having a grinding wheel, a support, and a spindle for supporting said wheel for rotation relative to said support, the combination of means for reciprocating said spindle while the grinding wheel is in engagement with said work, including a reciprocable plunger operatively connected to said spindle, a crank arm engaging said plunger, manually operable means for oscillating said crank arm, and means normally maintaining said crank arm in a plane perpendicular to the axis of said plunger, including a tubular member, caps engaging opposite ends of said tubular member and fixed parts of the housing, and resilient means passing through said tubular member and connected at opposite ends of said cap members.

6. In a mechanism for effecting oscillation of a grinding wheel, a housing for supporting said grinding wheel spindle, a plunger reciprocably mounted in said housing for movement parallel to the axis of said spindle, a pair of parallel rotatable members mounted in said housing, a crank connection for transmitting rotary motion from one of said members to the other, one of said members carrying a crank pin engaging said plunger, a slide supporting said pin, means to adjust said slide to vary the eccentricity of said pin, including shafts extending axially through each of said members, ratchet means connecting one of said shafts to the other, and manually operable means for actuating one of said shafts.

7. In a grinding machine having a grinding wheel spindle journaled therein, and a grinding wheel attached to said spindle for rotation thereby, the combination of means for oscillating said spindle for effecting lateral movement of the grinding wheel into opposite engagement with shoulders on a work piece, including a housing, a sleeve rotatably mounted in said housing and

having an adjustable crank arm operatively connected to said spindle, a second sleeve rotatably mounted in said housing and having a motion transmitting connection to the first named sleeve, means for varying the effective length of said crank arm, including a shaft passing through said first sleeve, a second shaft passing through said second sleeve, a gear, ratchet means operable by the shaft in said second sleeve for effecting a predetermined amount of rotation of said gear, and a second ratchet means operable by said gear for imparting rotation to the shaft mounted in the first sleeve.

8. In a mechanism for effecting axial movement of a grinding wheel spindle and attached grinding wheel supported for rotation and radial movement toward a work piece, the combination of a rotatable sleeve, an eccentric pin carried by said sleeve and operatively connected to said spindle, fluid operable means connected to said sleeve for effecting one direction of rotation thereof, and thereby one direction of axial movement of said spindle, manually operable means inlcuding a shaft passing through said sleeve for adjusting the eccentricity of said pin, and resiliently operable means for returning said sleeve when fluid pressure is removed from said fluid operable means.

9. In a mechanism for effecting axial movement of a grinding wheel spindle and attached grinding wheel supported for rotation and radial movement toward a work piece, the combination of a rotatable sleeve, an eccentric pin carried by said sleeve and operatively connected to said spindle, fluid operable means connected to said sleeve for effecting one direction of rotation thereof, and thereby one direction of axial movement of said spindle, manually operable means including a shaft passing thrqugh said sleeve for adjusting the eccentricity of said pin, resiliently operable means for returning said sleeve when fluid pressure is removed from said fluid operable means, and means for limiting the return movement effected by said resiliently operable means when the advancing movement exceeds a predetermined amount.

10. In a mechanism for effecting axial movement of a grinding wheel spindle and attached grinding wheel supported for rotation and radial movement toward a work piece, the combination of a rotatable sleeve, an eccentric pin carried by said sleeve and operatively connected to said spindle, fluid operable means connected to said sleeve for effecting one direction of rotation thereof, and thereby one direction of axial movement of said spindle, manually operable means including a shaft passing through said sleeve for adjusting the eccentricity of said pin, resiliently operable means for returning said sleeve when fluid pressure is removed from said fluid operable means, and automatically operable means for shortening the return movement when the advancing movement exceeds a predetermined amount.

11. A mechanism for reciprocating the grinding wheel spindle of a grinding machine, including a rotatable member carrying an adjustable crank pin, motion transmitting connections connecting said pin for movement of the spindle, fluid operable means for rotating said member in one direction, resiliently operable means for rotating the member in an opposite direction, means carried by the member for increasing the eccentricity of said pin, ratchet means for decreasing the return movement of said spindle when the advancing movement exceeds a predetermined amount whereby the length of movement of said spindle will remain within prescribed limits, and manually operable means for releasing said ratchet means to permit full return movement of said spindle.

12. A mechanism for reciprocating the grinding wheel spindle of a grinding machine, including a rotatable member carrying an adjustable crank pin, motion transmitting connections connecting said pin for movement of the spindle, fluid operable means for rotating said member in one direction, resiliently operable means for rotating the member in an opposite direction, means carried by the member for increasing the eccentricity of said pin, ratchet means for decreasing the return movement of said spindle when the advancing movement exceeds a predetermined amount, manually operable means for releasing said ratchet means to permit full return movement of said spindle, and clamping means operable by said manually operable means for holding the spindle in a fixed position during truing operations on the grinding wheel.

13. A mechanism for effecting synchronized lateral and axial movement of a grinding wheel spindle of a grinding machine, comprising an oscillatable support for supporting the grinding wheel spindle, power operable means for moving said support in one direction to feed the grinding wheel toward the work, including a power driven shaft, a cam carried by said shaft and peripherally engaging said support, means carried by the support for moving the spindle axially, including a fluid operable member, motion transmitting connections from said member to said spindle, additional means for returning said member, a source of fluid pressure, a control valve variably positionable for determining the rate of flow from said source to said member, and a cam driven by said shaft for controlling the extent of variable positioning of said valve and thereby the rate of axial movement of said spindle.

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