Sept. 5, 1939. W. H. WOOD 2,171,902

GRINDING WHEEL TRUING APPARATUS

Filed May 4, 1938 3 Sheets-Sheet 1

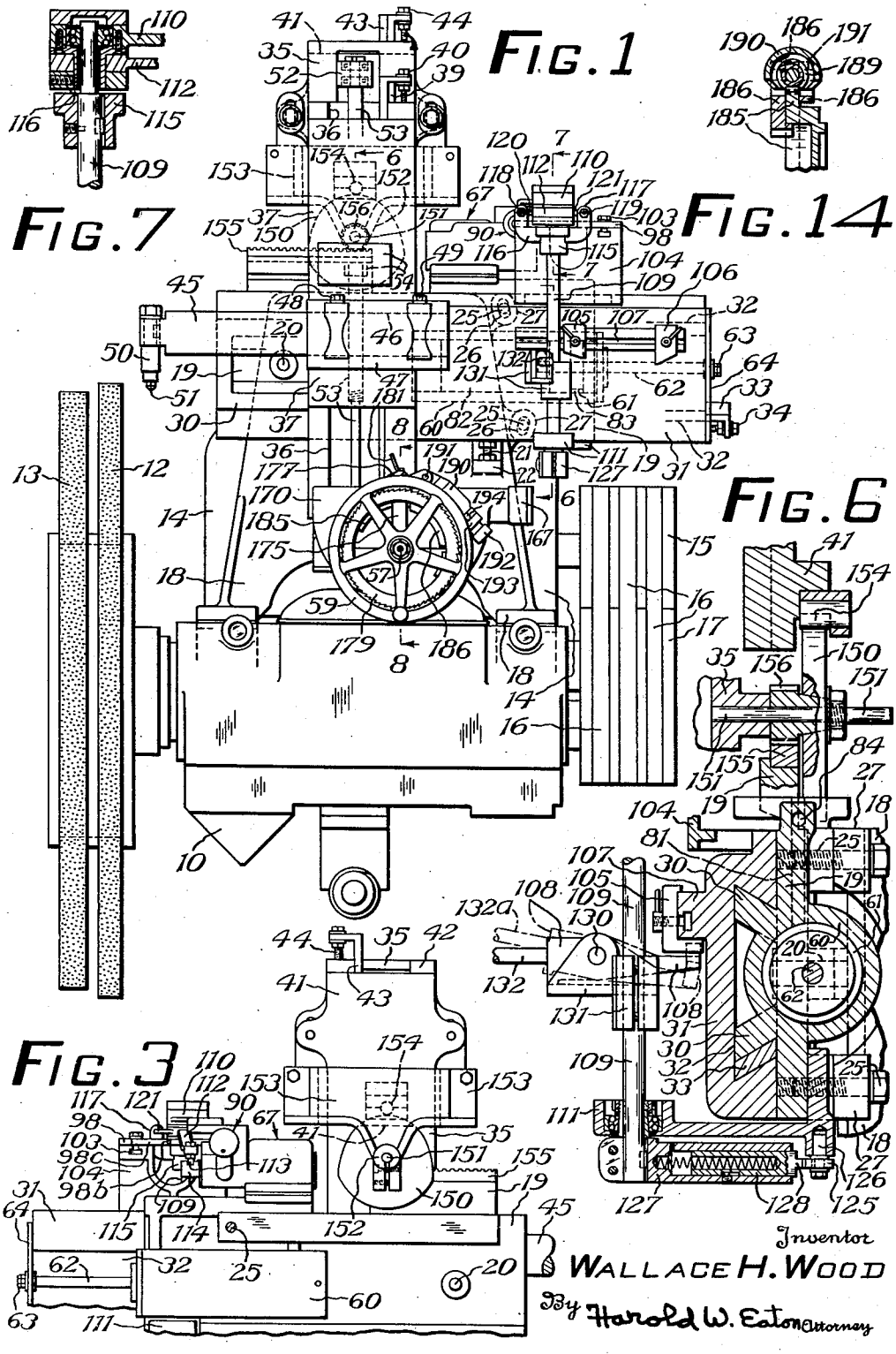


FIG. 1

FIG. 7

FIG. 14

FIG. 6

FIG. 3

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GRINDING WHEEL TRUING APPARATUS

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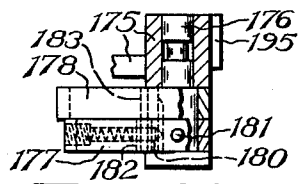


FIG. 11

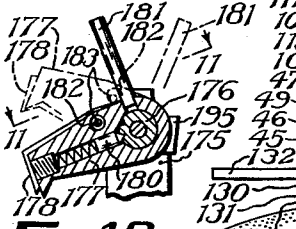


FIG. 10

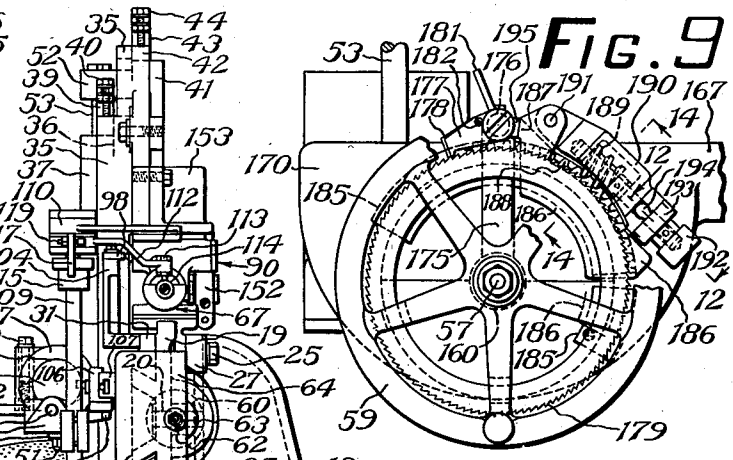


FIG. 9

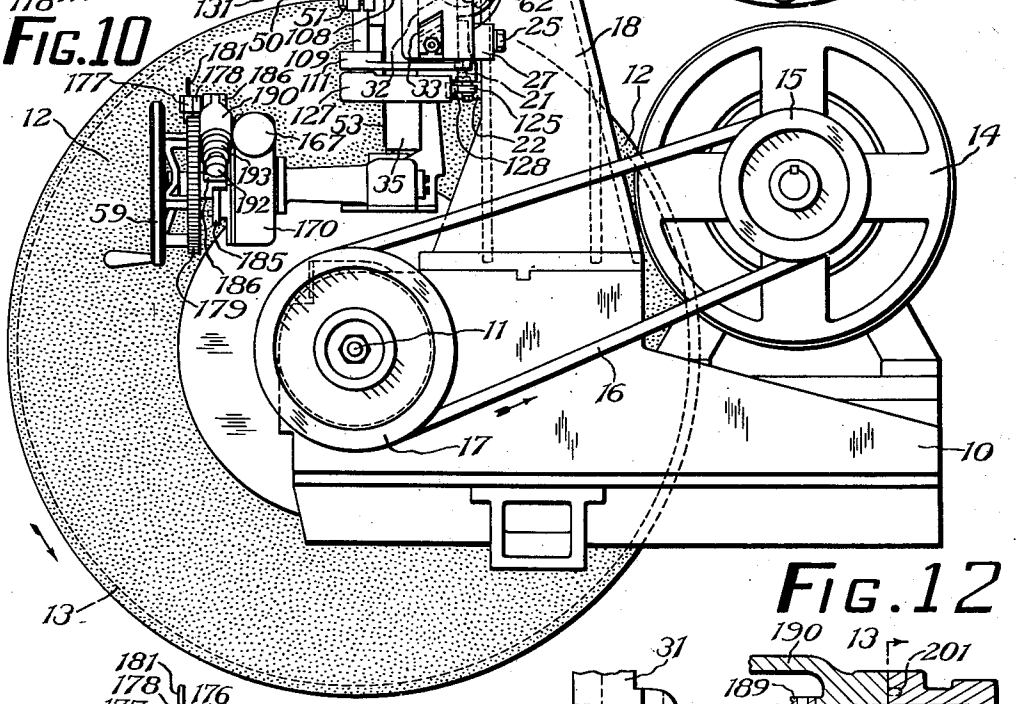


FIG. 12

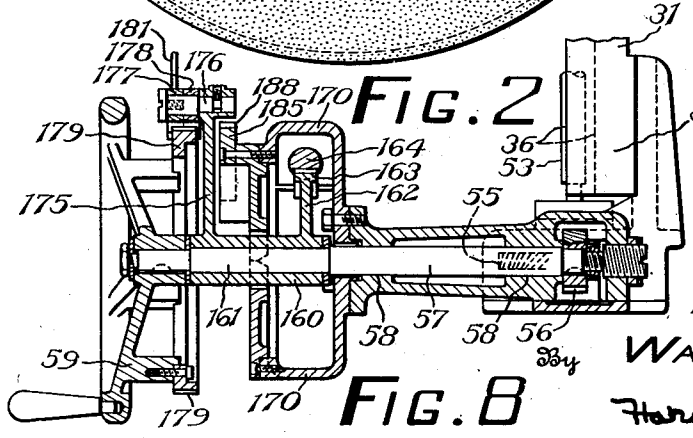


FIG. 8

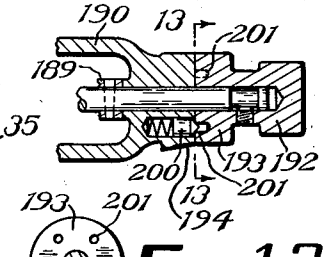


FIG. 13

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GRINDING WHEEL TRUING APPARATUS

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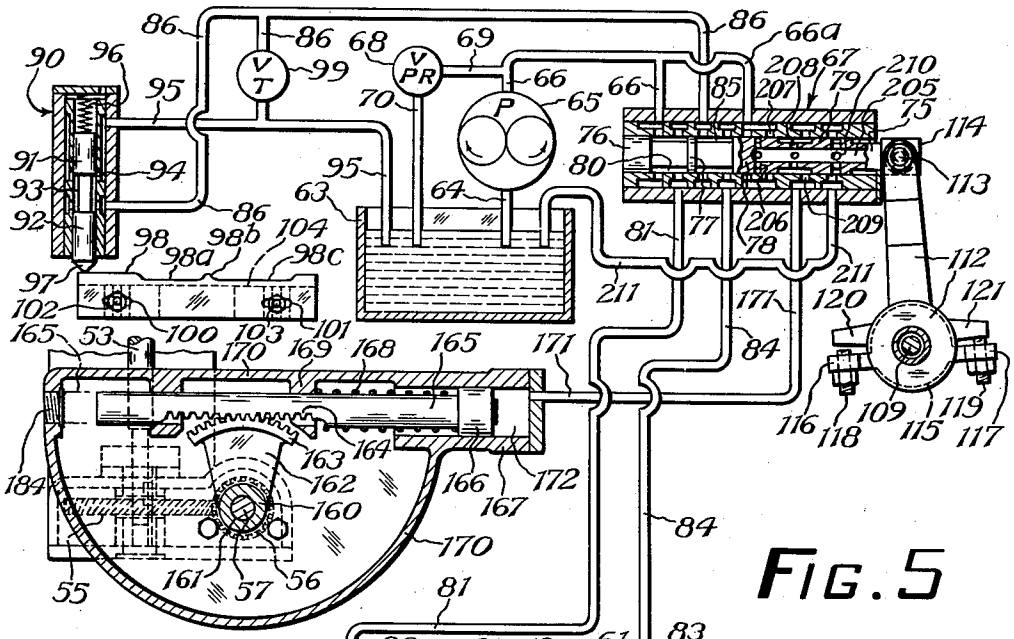


FIG. 5

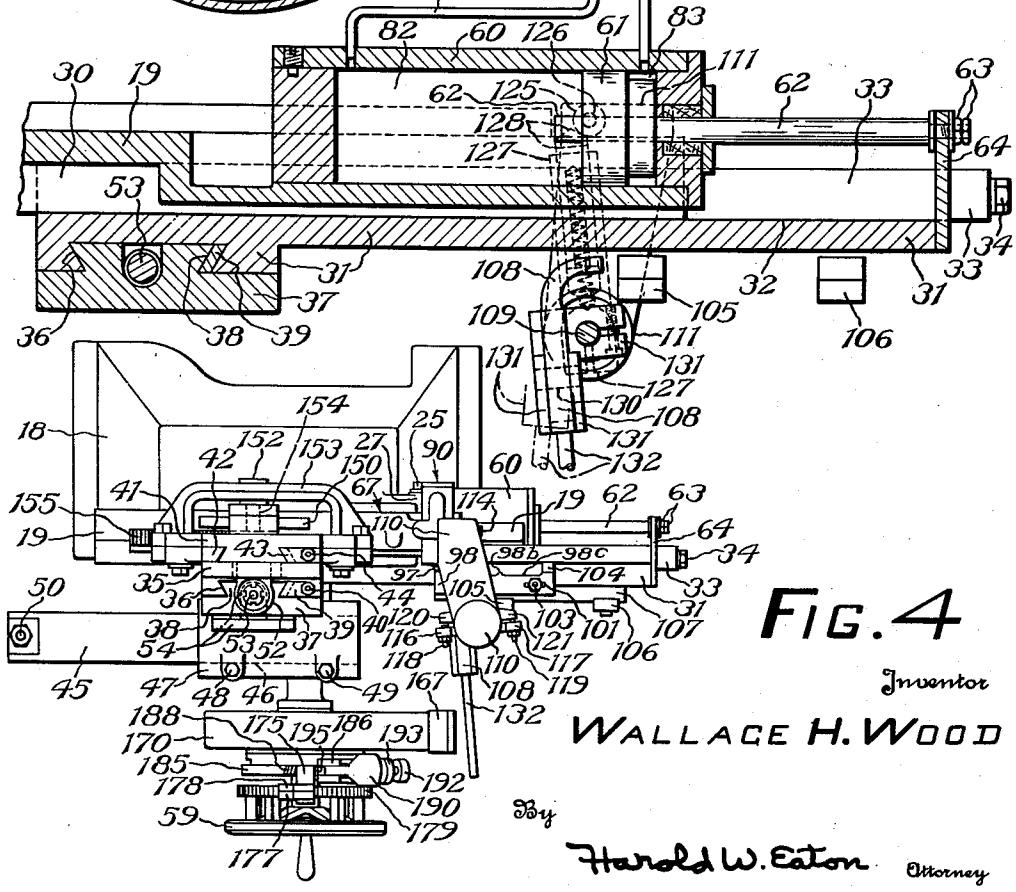


FIG. 4

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UNITED STATES PATENT OFFICE

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GRINDING WHEEL TRUING APPARATUS

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Application May 4, 1938, Serial No. 206,027

8 Claims. (Cl. 125—11)

The invention relates to grinding machines, and more particularly to a grinding wheel truing apparatus.

One object of the invention is to provide a simple and thoroughly practical truing apparatus for truing a predetermined form on a grinding wheel. Another object of the invention is to true a plurality of spaced cylindrical portions of disks of different diameters on a grinding element to a predetermined extent. Another object of the invention is to provide an improved truing apparatus whereby the truing tool is automatically reciprocated across the periphery of a grinding wheel or spaced grinding wheels and in which the wheel and tool are relatively fed toward each other at each end of the reciprocatory stroke. A further object of the invention is to provide an improved hydraulically operated wheel truing apparatus in which a hydraulically operated pawl and ratchet mechanism is arranged automatically to advance the truing tool at each end of its reciprocatory stroke. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of various possible embodiments of the mechanical features of this invention,

Fig. 1 is a front elevation of the improved truing apparatus mounted on a wheel slide having the wheel guard removed;

Fig. 2 is a right-hand end elevation of the improved truing apparatus, showing the wheel slide and the wheel driving motor;

Fig. 3 is a rear elevation of the improved truing apparatus;

Fig. 4 is a plan view of the truing apparatus;

Fig. 5 is a hydraulic piping diagram showing the truing tool traversing and feeding mechanism;

Fig. 6 is a cross sectional view, on an enlarged scale, taken approximately on the line 6—6 of Fig. 1, showing the cam for causing a vertical movement of the truing tool and also the hydraulic truing tool traverse cylinder and associated parts;

Fig. 7 is a fragmentary vertical sectional view, taken approximately on the line 7—7 of Fig. 1;

Fig. 8 is a cross sectional view, on an enlarged scale, taken approximately on the line 8—8 of Fig. 1;

Fig. 9 is a fragmentary front elevation, on an enlarged scale, of the truing tool feeding mechanism, having parts broken away more clearly to show the construction;

Fig. 10 is a fragmentary sectional view through the feed pawls;

Fig. 11 is a fragmentary plan view of the feed pawls as shown in Fig. 10;

Fig. 12 is a fragmentary sectional view, on an enlarged scale, taken approximately on the line 12—12 of Fig. 9;

Fig. 13 is a cross sectional view, taken approximately on the line 13—13 of Fig. 12; and

Fig. 14 is a fragmentary sectional view, taken approximately on the line 14—14 of Fig. 9.

The improved truing apparatus has been illustrated in the drawings as mounted fixedly on top of a wheel slide 10 which rotatably supports a wheel spindle 11 carrying a plurality of grinding wheels 12 and 13 of the same or different sizes or diameters. The grinding wheel spindle 11 may be driven in any suitable manner, such as a motor drive in which an electric motor 14 is mounted on the upper surface of the wheel slide 10. The motor is provided with a driving pulley 15 which is of the multiple V-groove type and transmits power by means of multiple V-belts 16 to a multi-grooved pulley 17 mounted on the outer end of the wheel spindle 11.

The wheel slide 10 supports a frame or base 18 of the truing apparatus. An adjustable horizontally arranged member 19 is pivotally connected by a stud 20 with the frame 18. An adjusting screw 21 threaded into a lug 22 projecting from the base 18 serves to adjust the member 19 about its stud or pivot 20 to facilitate adjustment of the position of the member 19 relative to the base 18. A lock nut serves to lock the screw 21 in adjusted position. The member 19 may be clamped in adjusted position on the frame 18 by means of clamping screws 25 which pass through elongated slots 26 in the lugs 27 on the frame 18 and are screw threaded into the member 19. A dovetailed slideway 30 is formed integral with the member 19 and is arranged to support a horizontally movable slide 31 having a dovetailed surface 32 which mates with the dovetailed slideway 30. An adjustable tapered gib 33, interposed between the dovetailed ways 30 and 32, serves to take up lost motion between the fixed and movable parts of the slide. A screw 34 is provided to facilitate endwise adjustment of the gib 33.

The horizontal slide 31 is provided with a vertically arranged member 28 which is formed integral therewith or fixedly mounted thereto. The vertically extending portion 35 on the horizontal slide 31 is provided with a dovetailed slideway 36 which supports a vertically movable slide 37 having a mating dovetailed way 38. An adjustable tapered gib 39 serves to take up lost motion between the dovetailed slideways 36 and 38, and a screw 40 serves to facilitate adjustment of the gib 39.

A second vertically arranged slide 41 is sup-

ported by a dovetailed slideway 42 formed integral with the vertically extending member 35. The dovetailed slideway 42 is provided with an adjustable tapered gib 43 having a screw adjustment 44. The slide 41 is preferably arranged so that it may be moved vertically during the horizontal movement of the slide 31.

The vertical slide 37 adjustably supports a truing tool holder which in the present case is formed as a cylindrical bar 45 which is slidably keyed within an aperture 46 formed in a projection 47 of the slide 37. The truing tool holder or bar 45 is arranged to be clamped in adjusted position within the aperture 46 in the projection 47 of the slide 37 by binding screws 48 and 49. The truing tool support 45 carries at its outer end a truing tool 50 having a diamond point 51 arranged for successively truing the peripheral surfaces of the grinding wheels 12 and 13.

The slide 41 is preferably adjustably connected to the slide 37 so that during the traversing movement of the horizontal slide 31, the vertical slides 37 and 41 are moved together in a vertical direction to control the path of movement of the diamond or truing tool 51. The slide 41 is provided with a forwardly projecting boss or lug 52. A vertically extending feed screw 53 is rotatably connected to the lug 52 and extends downwardly through a nut (not shown) which is carried by or formed integral with the slide 37. The lower end of the screw 53 is journalled in and slidably keyed within a spiral gear 55 which meshes with a spiral gear 56 formed on the inner end of a rotatable shaft 57. The shaft 57 is journalled in bearings 58 within the casing and is provided at its outer end with a manually operable hand wheel 59. By adjustment of the wheel 59, the feed screw 53 may be rotated to adjust the position of the slide 37 relative to the vertically movable slide 41.

A power operated traversing mechanism is provided for producing a longitudinal traversing or reciprocating movement of the horizontally movable slide 31 to traverse the truing tool 51 relative to the periphery of the grinding wheels 12 and 13. In the preferred form a fluid pressure traversing or reciprocating mechanism is provided comprising a cylinder 60 which is formed within the member 19. A piston 61 is slidably mounted within the cylinder 60 and is connected to one end of a piston rod 62, the other end of which is fastened by nuts 63 to an end cap 64 formed integral with or fixedly mounted on the end of the horizontally movable slide 31.

A fluid pressure system is provided to convey fluid under pressure to the cylinder 60. This system may comprise a reservoir 63 which is preferably located within the base of the machine. Fluid is pumped from the reservoir 63 through a pipe 64 by means of a pump 65 which is preferably a motor driven fluid pressure pump of a standard well known type. Fluid under pressure from the pump 65 passes through a pipe 66, a portion of which is flexible hose, to a control valve 67. A pressure relief valve 68 is connected with the pressure pipe 66 by a short pipe 69 and serves to relieve excess pressure in the system and return it to the reservoir 63 through a pipe 70.

The control valve 67 is preferably a piston type valve and is arranged to control the admission and exhaust of fluid to and from the truing tool traverse cylinder 60 and also to control the admission of fluid to a truing tool feed mechanism to be hereinafter described.

The control valve 67 is provided with a valve stem 75 having formed integrally therewith a plurality of valve pistons 76, 77, 78 and 79. Fluid under pressure passing through the pipe 66 enters a chamber 80 between the valve pistons 76 and 77 and passes out through a pipe or passage 81 into a cylinder chamber 82 at the left-hand end of the cylinder 60 (Fig. 5) to move the piston 61 toward the right, which serves also to move the horizontal slide 31 and the truing tool 51 toward the right to its extreme right-hand position, as indicated in Figs. 1 and 5. During the movement of the piston 61 toward the right, fluid within a cylinder chamber 83 exhausts through a pipe or passage 84 into a valve chamber 85 located between the valve pistons 77 and 78 and out through a pipe or passage 86 into the reservoir 63. Similarly, when the valve stem 75 is shifted toward the right (Fig. 5), fluid under pressure from the pipe 66 passes through pipe 66a into the valve chamber 85 between the valve pistons 77 and 78 and passes through the pipe or passage 84 into the cylinder chamber 83 to cause the piston 61 to move toward the left and also moving the slide 31 and the truing tool 50 toward the left. During this movement, fluid within the cylinder chamber 82 passes out through the pipe 81 into the cylinder chamber 80 between the valve pistons 76 and 77 and out through the pipe or passage 86 to the exhaust.

A speed control mechanism is provided to control the speed of movement of the truing tool both during its idle stroke and during the traverse of the diamond 51 across the peripheries of the grinding wheels 12 and 13. It is desirable to provide a control valve mechanism in the exhaust pipe line or passage 86 so that the truing tool will traverse at a rapid rate during the idle stroke of the diamond 51 and will be automatically slowed down to a proper truing speed when the diamond 51 moves into operative truing engagement with the peripheries of the wheels 12 and 13. A speed control valve 90 of the piston type is connected at one end of the pipe line 86. The valve 90 is a piston type valve having a pair of valve pistons 91 and 92. Fluid exhausting through the pipe 86 enters a valve chamber 93 between the valve pistons 91 and 92 and in the position shown in Fig. 5 passes out through a port 94 and a pipe 95, a portion of which is flexible hose, to the reservoir 63. In the position of the valve 90 (Fig. 5), unrestricted exhaust of fluid from the pipe 86 passes out through the pipe 95 so that the piston 61 and slide 31 together with the diamond 51 will traverse at a maximum speed.

The valve pistons 91 and 92 are normally urged in a downward direction by means of a spring 96. The lower end of the valve piston 92 is provided with a conical end portion 97 which rides upon an adjustable cam 98. The cam 98 is held in a relatively fixed position and is supported on the horizontally movable slide 31. The control valve 67 and the speed control valve 90 are supported by the fixed member 19. When the slide 31 traverses toward the left (Figs. 1 and 5), the slide will travel at a rapid rate until the conical end 97 rides into a low portion 98a on the cam 98. The forward movement of the valve pistons 91 and 92 (Fig. 5) serves to close the port 94, after which fluid within the pipe 86 exhausts through a needle valve 99 and into the pipe 95 into the reservoir 63. By manipulating the needle valve 99, the speed of movement of the truing tool 51 during its truing traverse across the face of the grinding wheels 12 and 13 may be regulated as desired. It will be readily apparent from the

foregoing disclosure that when the valve pistons 91 and 92 are in a rearward position (Fig. 5), the port 94 is wide open, allowing unrestricted exhaust of fluid to allow the truing tool slide 31 to traverse at a maximum speed, and upon closing of the port 94 fluid must thereafter exhaust through the needle valve 99 to allow the traverse to continue at a slow truing speed. In truing a pair of spaced wheels 12 and 13, such as shown in Fig. 1, the cam 98 is arranged so that the grinding tool 50 will travel at a rapid rate until the diamond 51 is about to engage the periphery of the wheel 12, after which the truing tool 50 travels at a slow truing speed. When the truing tool 50 leaves the wheel 12, due to a raised portion 98b on the cam 98, the traverse will resume a rapid idle traverse until the diamond 51 is about to engage the periphery of the wheel 13, at which time the control valve 90 again moves forwardly as the cone shaped follower 97 rides onto the portion 98c of the cam 98 to slow down the traverse of the truing tool 50 to a truing speed to true the periphery of the wheel 13, after which the follower 97 rides again upon a high portion of the cam to finish the stroke of the slide 31 at a rapid rate. This mechanism operates in a similar manner on the reverse stroke. By varying the shape of the cam 98, the speed of the truing tool 50 may be readily controlled for truing either a pair of wheels, as shown in the drawings, or any other arrangement, such as a single wide faced wheel or a multiplicity of wheels arranged in spaced relationship on the end of the spindle 11. The cam 98 is provided with elongated slots 100 and 101 through which clamping T-bolts 102 and 103 pass adjustably to secure the cam 98 onto an upwardly extending projection 104 of the horizontal slide 31.

In truing a grinding wheel or a plurality of grinding wheels arranged in spaced relationship with each other, it is desirable to reciprocate the truing tool across the peripheral surface of the wheel either one or more reciprocations for each truing operation. In the disclosure in the drawings, a mechanism has been illustrated for controlling the valve 67 so that the truing tool 50 may reciprocate continuously as many times as the operator desires.

A reversing mechanism is provided for automatically actuating the reversing or control valve 67 to control the continuous reciprocation of the truing tool 50. A pair of adjustable dogs 105 and 106 are adjustably supported by a T-slot 107 formed in a projection of the slide 31. A reversing lever 108 is supported on a vertically arranged rock shaft 109 which is journalled in bearings 110 and 111 which are supported on the fixed member 19. The rod 109 is rotatably supported in the bearings 110 and 111. A lost motion connection is provided between the rod 109 and the valve stem 75. A lever 112 is rotatably supported by the upper end of the rod 109 and carries a pin 113 at its upper end which rides in a groove in the spool shaped member 114 which is formed integral with or fixedly mounted on the outer end of the stem 75. The lever 112 is free to rotate relative to the shaft 109. A member 115 is keyed to rotate with the shaft 109 and is provided with two oppositely extending arms 116 and 117 each of which is provided with an adjustable stop screw 118 and 119, respectively. The lever 112 is provided with two projecting arms 120 and 121 which are arranged in the path of the stop screws 118 and 119. When the shaft 109 is rocked to reverse the valve 67, the member 115 rocks until the lost motion is taken up before the lever 112 starts to move to shift the reversing valve 67. By manipulation of the screws 118 and 119, the extent of lost motion between the member 115 and the lever 112 may be varied as desired.

A suitable load and fire mechanism is provided for controlling the shifting movement of the control valve 67. A roller 125 is supported by a stud 126 fixedly mounted on the bracket 111 on the fixed member 19. An arm 127 is fixedly keyed to the lower end of the shaft 109 and serves as a support for a spring-pressed arrow pointed plunger 128 which cooperates with the roller 125 and serves as a load and fire mechanism to control the reversal of the valve 67.

The reversing lever 108 is preferably pivotally supported by a stud 130. The stud 130 is supported by a member 131 which is rigidly clamped onto the vertical shaft 109. The reversing lever 108 is provided with a forwardly projecting, manually operable lever 132 by means of which the mechanism may be manually controlled. By raising the control lever 132 to the dotted position 132a (Fig. 6), the reversing lever 108 may be dropped out of the path of the reversing dogs 105 and 106 to allow the slide 31 to move to its extreme right-hand position, as illustrated in Fig. 1, with the piston 61 bearing against the end of the cylinder 60.

When it is desired to start the truing operation, the operator manually rocks the lever 132 in a clockwise direction (Fig. 4) which serves to shift the valve stem 75 of the control valve 67 toward the right (Fig. 5) to start the movement of the piston 61 toward the left to cause a corresponding movement of the truing tool 50. Due to the angled-off surface on the under side of the dog 105, the lever 132 will swing into position 132a and then drop into an operating position so that the reverse lever 108 lies in the path of the reversing dogs 105 and 106. The reciprocation of the truing tool 50 and its supporting slide 31 continues until the wheels 12 and 13 have been trued to the desired extent, at which time the operator raises the control lever 132 into position 132a to allow the slide 31 to traverse to an inoperative position toward the right, as shown in Fig. 1.

In order that the truing tool 50 may true a plurality of spaced grinding wheels of different diameters, such as a pair of spaced grinding wheels 12 and 13, respectively, it is desirable to provide a control mechanism to move the slides 37 and 41 in timed relation with the traversing or reciprocating movement of the horizontal slide 31 so that a single truing tool 50 may be utilized to true both wheels, that is so that the diamond 51 may pass across the periphery of the wheel 12 and then the slides 37 and 41 may be moved into a second predetermined position to true the periphery of the grinding wheel 13. Due to the short space between the two grinding wheels and due to the difference in their diameters, it is not feasible to utilize a fixed cam bar for this purpose. To overcome this difficulty, a rotatable cam 150 is provided to transmit a vertical motion to the slides 37 and 41, which movement is controlled by the longitudinal traversing movement of the truing tool 50 and the horizontal slide 31. The rotatable cam 150 is supported on a shaft 151 which is supported on the vertical member 35 which is integral with the horizontal slide 31. The outer end of the shaft 151 is clamped and supported in a bearing 152 formed integral with a bracket 153 which straddles the slide 41 and is fixedly mounted on the vertical member 35. A follower

154 is fixedly mounted on the vertically movable slide 41 and is arranged to engage the periphery of the rotatable cam 150.

In order to transmit the desired vertical movement to the truing tool 50 and its supporting slide 37 in timed relation with the traversing movement of the horizontal slide 31, a rack bar 155 is fixedly mounted on the member 19. A gear 156, either formed integral with or connected to rotate with the cam 150, meshes with the rack 155 and transmits a rotary motion to the cam 150 as the shaft supporting the cam is moved longitudinally during the traversing movement of the slide 31 and the truing tool 50. The cam 150 is preferably designed to give the desired vertical movement to the truing tool 50 and, as illustrated, comprises two concentric portions for holding the truing tool 50 against vertical movement during the interval in which it traverses across the periphery of the wheel, and the connecting portions between the two concentric surfaces are shaped to give a predetermined lift or drop to the truing tool 50 and its supporting slides 37 and 41 so that the diamond 51 may be readily moved after truing the larger diameter wheel 12 down to a position to true the smaller diameter wheel 13 and vice versa when the slide 31 is traversed in the reverse direction.

In order to attain one object of the invention, an automatic feeding mechanism is provided for feeding the diamond 51 and truing tool 50 and its supporting slide 37 downwardly at each end of the reciprocatory stroke of the slide 31, so that the truing tool 50 will cut a fresh path across the wheel periphery. In the preferred construction, an hydraulically actuated pawl and ratchet mechanism is provided incrementally to rotate the feed screw 53 at each end of the longitudinal traversing stroke of the slide 31 to re-position the truing tool 50 for the next traversing movement. A sleeve 160 is rotatably supported on a reduced portion 161 of the shaft 57. The sleeve 160 has formed integrally therewith an outwardly extending arm 162 having a gear segment 163 formed at its outer end. The gear segment 163 meshes with a slidably mounted rack 164 formed adjacent to one end of a piston rod 165 having an integral piston 166 fixed at its right-hand end (Fig. 5). The piston 166 is slidably mounted within a fluid pressure cylinder 167. A spring 168 surrounding the piston rod 165 and interposed between the piston 166 and a shoulder 169 within a casing 170 serves normally to urge the piston 166 in a direction toward the right (Fig. 5). When fluid under pressure is admitted through a pipe 171 into a cylinder chamber 172, the piston 166 is moved toward the left (Fig. 5) against the compression of the spring 168 to move the rack bar 164 toward the left and to swing the gear segment 163 and associated parts in a counterclockwise direction (Fig. 5).

The sleeve 160 is also provided with a radially extending arm 175 which supports a stud 176 at its outer end. The stud 176 supports a pair of pawls 177 and 178 which are arranged to engage a ratchet wheel 179 which is in turn rigidly fixed to rotate with the hand wheel 59. The hand wheel 59 is keyed to a reduced end portion of the shaft. The pawls 177 and 178 vary in length by an amount substantially equal to one-half of a ratchet tooth. The pawls 177 and 178 are normally held in an operating position by means of a spring-pressed plunger 180 which engages notches in the stud 176 and may be moved into an inoperative position by means of a manually operable lever 181. The lever 181 is fastened to the pawl 177. The pawl 177 is provided with a clearance hole 182. A pin 183 is fixed to the pawl 178 and passes through the clearance hole 182 so that when the pawl 177 is swung to and from an operating position by means of the lever 181, the pawl 178 will also be moved by means of the pin 183. It will be readily apparent from the foregoing disclosure that when the pawl carrying stud 176 and pawls 177 and 178 are oscillated in either direction by the spring 168 or by the admission of fluid under pressure into the cylinder chamber 172, the pawls 177 and 178 will be caused to oscillate, either riding idly over the ratchet wheel 179 when moved in a clockwise direction (Figs. 1 and 9) or will rotate the ratchet wheel 179 when moved in a counterclockwise direction.

In order that the extent of feed of the diamond 51 or truing tool 50 may be regulated and controlled so as to feed the desired amount at each end of the tool reciprocation, a stop mechanism is provided to limit the oscillating movement of the pawls 177 and 178. When fluid under pressure is admitted through the pipe 171 into the cylinder chamber 172, it serves to move the piston 166 and piston rod 165 toward the left (Fig. 5) which serves to swing the gear segment 163 in a counterclockwise direction (Fig. 5) which in turn oscillates the pawls 177 and 178 and the ratchet wheel 179 and feed wheel 59 also in a counterclockwise direction (Figs. 1 and 9) to turn the feed screw 53 and thereby advance the diamond 51 toward the wheel axis so that upon its next traversing stroke across the wheels, it will true a predetermined amount off the wheels. The engagement of the end of the piston rod 165 with a stop screw 184 serves to limit the movement of the pawls 177 and 178 in a counterclockwise direction.

The spring 168 serves to return the piston rod 165 toward the right (Fig. 5) to return the feeding mechanism parts, namely the pawls 177 and 178, to their initial position ready for the next feeding movement. In order to adjust the extent of infeeding movement, a stop device is provided for limiting the movement of the pawls 177 and 178 in their idle movements in a clockwise direction (Figs. 1 and 9). An arcuate slideway 185 is fixedly secured to the casing 170 and serves as a support for an arcuate slide 186 which is provided with a stop abutment 187. By adjusting the position of the arcuate slide 186, the position of the abutment 187 may be varied as desired to regulate the extent of movement of the pawls 177 and 178 in their idle stroke over the teeth of the ratchet wheel 179. To facilitate adjustment of the abutment 187, the periphery of the arcuate slideway 185 is formed as a worm segment 188. A worm 189 is rotatably supported in a housing 190 which is pivotally supported by a stud 191 carried by the slide 186. The worm 189 is arranged to mesh with the worm segments 188. In case it is desired to make a quick adjustment of the abutment 187, the casing 190 may be swung in a counterclockwise direction about the stud 191 as a pivot to throw the worm 189 out of mesh with the worm segment 188 and the slide 186 may then be adjusted on its arcuate slideway 185 and the worm 189 again thrown into mesh with the worm segment 188. The worm 189 is rotatably supported in the casing 190 in bearings and is supported so that it may be rotated manually precisely to adjust the position of the abutment 187 by means of a knob 192 which is mounted on the outer end of the shaft for the worm 189.

To facilitate adjustment of the abutment 187, a graduated scale is provided on a collar 193 carried by the knob 192 and a fixed index point 194 is provided on the casing 190 so that the abutment 187 may be precisely adjusted to reposition the arm 175 as desired. It will be readily apparent from the foregoing disclosure that when the pawls 177 and 178 are moved idly over the ratchet wheel 179 in a clockwise direction (Figs. 1 and 9) by means of the released compression of the spring 168, the movement will continue until an abutment 195 carried by the arm 175 engages the adjustably fixed abutment 187 which stops the movement of the piston 166 toward the right (Fig. 5) under the influence of the spring 168. The pawls 177 and 178 are then in position for the next infeeding movement. To facilitate holding the knob 192 in its adjusted position, a spring-pressed plunger 200 is carried by the frame 190 and is arranged to engage one of a plurality of holes or depressions 201 within the portion 193 of the knob 192.

The fluid pressure system is preferably arranged so that fluid under pressure may be admitted through the pipe 171 into the cylinder chamber 172 to actuate the feeding mechanism to advance the truing tool 50 at each end of its reciprocatory stroke. This is preferably accomplished by providing a valve mechanism which is controlled in timed relationship with the traverse control valve. In the preferred construction, as illustrated in the drawings, the right-hand end of the valve 67 is arranged so as to control the admission of fluid to the feed cylinder 167 at each end of the tool stroke so as to advance the diamond 51 toward the wheel axis before the tool starts its traversing movement in the reverse direction. The right-hand end of the valve stem 75 is provided with a central aperture 205. When the valve stem 75 is moved toward the right to reverse the direction of fluid under pressure to the traverse cylinder 60, the ports 206 within the piston 78 pass a port 207 in the valve sleeve and fluid under pressure from the pipe or passage 66*a* passes through the port 207, the port 206, into the central aperture 205 within the valve stem 75, and out through apertures 208 and a port 209, into the pipe 171, into the feed cylinder chamber 172 to move the piston 166 toward the left (Fig. 5) against the compression of the spring 168 to move the feed mechanism part in a counterclockwise direction (Figs. 1, 5 and 9).

The valve stem 75 in reversing moves so that the port 206 in the valve piston passes by the port 207. After the port 206 passes the ports 207 in the valve sleeves, the piston 78 cuts off fluid under pressure from the feed mechanism and when the valve reaches its extreme right-hand position, fluid under pressure from pipe or passage 66*a* enters the valve chamber 85 to admit fluid under pressure to the pipe or passage 84 to start the tool traverse toward the left. In the position of the valve as illustrated in Fig. 5, the released compression of the spring 168 exhausts fluid from the cylinder chamber 172, through the pipe 171, which passes through the port 209 and ports 208 in the valve stem 75 into the central aperture 205 and exhausts out through ports 210 in the valve stem, into a pipe or passage 211 which conveys it to the reservoir 63.

It will be readily apparent that each time the valve stem 75 is moved either toward the right or toward the left, the ports 206 within the valve piston 78 will coincide with the port 207 in the valve sleeve so that fluid under pressure from the pipe or passage 66*a* will be admitted to the feed cylinder chamber 172 to actuate the feed pawls 177 and 178 which in turn serve to turn the ratchet wheel 179 and the feed wheel 59 to advance the truing tool 50 a predetermined distance toward the wheel axis at each end of the reciprocatory stroke of the truing tool 50.

The operation of this improved truing apparatus will be readily apparent from the foregoing disclosure. Assuming all of the parts have been previously adjusted, that is, the dogs 105 and 106 for length of stroke and the stop 187 for the amount of feed, the operation of the mechanism is initiated by the operator swinging the control lever 132 in a clockwise direction (Fig. 5) to shift the control valve 67 into its reverse position. During this movement, fluid passes through to the feed cylinder 60 to advance the truing tool 50 a predetermined amount before fluid is admitted through the pipe 84 to start the traverse of the slide 31 and diamond 51 toward the left (Figs. 1 and 5). The diamond 51 traverses first at a rapid rate with fluid exhausting through the valve 90 which is controlled by the cam 98. As the truing tool 50 approaches the side of the wheel 12, the released compression of the spring 96 cooperating with the cam 98 serves to close the valve 90 and thereafter fluid exhausts through the adjustable needle valve 99 into the reservoir 63 to traverse the truing tool 50 at a truing speed. During this movement the gear 156 rolling on the stationary rack 155 rotates the cam 150 so that when the truing tool 50 engages the periphery of the wheel 12, the follower 154 will be in engagement with a concentric portion on the cam 150 so that there is no vertical movement of the truing tool 50 as it passes across the periphery of the wheel 12.

When the tool 50 has traversed across the face of the wheel 12, the continued longitudinal movement of the slide 31 rotates the cam 150 through a further extent to drop the truing tool 50 to position it for truing the wheel 13 to a second predetermined diameter and the follower 154 engages a second concentric portion on the cam 150 during the time the truing tool 50 is traversing across the periphery thereof. During this pass of the truing tool across the periphery of the two spaced grinding wheels 12 and 13, the speed of movement of the slide 31 is governed by the contour of the cam 98 which is arranged so that when the truing tool is out of engagement with the wheel peripheries, the slide 31 will travel at a rapid rate and when the tool is in truing engagement with either of the grinding wheels, the truing tool will be traversed at a predetermined slow truing speed.

The movement of the slide 31 toward the left continues until the dog 106 engages the reversing lever 108 which rocks the shaft 109, first taking up lost motion between the shaft 109 and the lever 112 and then causing the arrow pointed spring pressed plunger 128 to ride over the roller 125. After the high point of the arrow 128 rides by the periphery of the roller 129, the released compression of the spring quickly snaps the reverse valve 75 into its reverse position. During the shift-over of the reverse valve, fluid under pressure from the pipe or passage 66*a* passes through the valve port 207 above described into the pipe or passage 171 to actuate the tool feeding mechanism to advance the truing tool 50 ready for the next traversing movement. The diamond 51 will continue to traverse automati-

cally until the lever 132 is raised to the dotted position 132a when the slide 31 is moving in a direction toward the right which serves to throw the reversing lever 108 out of the path of the dog 105 to allow the truing tool 50 to move to its extreme right-hand or inoperative position (Fig. 1). In this position of the parts, the piston 61 abuts against the cylinder head and the truing tool 50 and associated parts remain in this position so that the truing tool is out of engagement with the grinding wheels 12 and 13 during the grinding operation.

It will thus be seen that there has been provided by this invention a wheel spindle positioning mechanism in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As various possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a grinding wheel truing apparatus, a truing tool, means to reciprocate said tool longitudinally, means including a rotatable cam and a follower to control the transverse movement of said tool, means actuated by the longitudinal movement of said tool to rotate said cam, and an automatically actuated pawl and ratchet mechanism to feed said tool transversely at each end of its longitudinal stroke.

2. In a grinding wheel truing apparatus, a truing tool, means including a fluid pressure operated piston and cylinder longitudinally to reciprocate said tool, means including a rotatable cam and a follower to control the transverse movement of said tool, and a fluid pressure operated pawl and ratchet mechanism automatically to feed said tool transversely at each end of its longitudinal stroke.

3. In a grinding wheel truing apparatus, a truing tool, means including a fluid pressure operated piston and cylinder to reciprocate said truing tool longitudinally, means including a rotatable cam and a follower to control the transverse movement of said tool, means actuated by said longitudinal movement to rotate said cam, and a fluid pressure operated pawl and ratchet mechanism automatically to feed said tool transversely at each end of its longitudinal stroke.

4. In a grinding wheel truing apparatus, a truing tool, means including a fluid operated piston and cylinder longitudinally to reciprocate said tool, means including a rotatable cam which is rotated in timed relation with said longitudinal reciprocation to move said tool transversely so as to control the position of the truing tool during a truing operation, means including a nut and screw mechanism to feed said tool transversely, a pawl and ratchet mechanism to actuate said nut and screw mechanism, and means including a fluid pressure operated piston and cylinder operatively connected to actuate said pawl and ratchet at each end of the longitudinal reciprocatory stroke of said tool.

5. In a grinding wheel truing apparatus, a truing tool, means including a fluid pressure operated piston and cylinder to reciprocate said tool longitudinally, a control valve therefor, means including a rotatable cam and a follower, means including a rack and gear mechanism to rotate said cam in timed relation with said longitudinal movement to control the transverse movement and positioning of said truing tool, and a fluid pressure operated pawl and ratchet mechanism automatically to feed said tool transversely at each end of its longitudinal stroke, said control valve being arranged to control the operation of said fluid pressure operated pawl and ratchet mechanism.

6. In a grinding wheel truing apparatus, a truing tool, means including a fluid operated piston and cylinder longitudinally to reciprocate said tool, means including a rotatable cam and a follower to move the truing tool transversely to control the position of the tool during a truing operation, said cam being provided with one or more concentric portions to true cylindrical portions on one or more spaced grinding wheels, means including a rack and gear mechanism which is actuated in timed relation with the longitudinal reciprocation of said tool to rotate said cam, means including a nut and screw feeding mechanism to feed said tool transversely, a pawl and ratchet mechanism to actuate said nut and screw mechanism, and means including a fluid pressure operated piston and cylinder operatively connected to actuate said pawl and ratchet at each end of its reciprocatory stroke.

7. In a grinding wheel truing apparatus, a truing tool, a vertically movable slide to support said tool, a horizontally reciprocable slide to support said vertical slide, means including a rotatable cam and a follower transversely to control the position of the tool during the longitudinal movement of the horizontal slide and truing tool, a fluid pressure piston and cylinder to reciprocate said horizontal slide, a control valve therefor, a reversing mechanism including adjustable dogs on said horizontal slide, a reversing lever for actuating said control valve, means including a fluid pressure piston and cylinder operatively connected to adjust said vertical slide relative to said horizontal slide so as to produce a feeding movement of the truing tool, said control valve being so constructed and arranged as to admit fluid under pressure to said second cylinder when the valve is shifted in either direction into a reverse position so as to actuate the infeeding of the truing tool at each end of the tool reciprocation.

8. In a grinding wheel truing apparatus, a truing tool, a vertically movable slide therefor, a horizontally reciprocable slide to support said vertical slide, a fluid pressure piston and cylinder to reciprocate said horizontal slide, means including a rotatable cam and a follower transversely to control the position of the truing tool during the longitudinal movement of said horizontal slide and truing tool, said cam being provided with one or more concentric portions to position the vertical slide and truing tool to true cylindrical portions on one or more spaced grinding wheels of different diameters, a nut and screw to feed said vertical slide relative to said horizontal slide, a pawl and ratchet mechanism to actuate said nut and screw, a second fluid pressure piston and cylinder to actuate said pawl and ratchet, and a single control valve automatically to control the admission to and exhaust of fluid to reciprocate said horizontal slide and traverse the truing tool and which during reversal of the valve serves to admit fluid under pressure to said second cylinder automatically to feed said truing tool at each end of the tool stroke.

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