Aug. 4, 1953 O. E. HILL 2,647,504

GRINDING WHEEL TRUING APPARATUS

Filed Sept. 8, 1950 4 Sheets-Sheet 1

Fig. 2

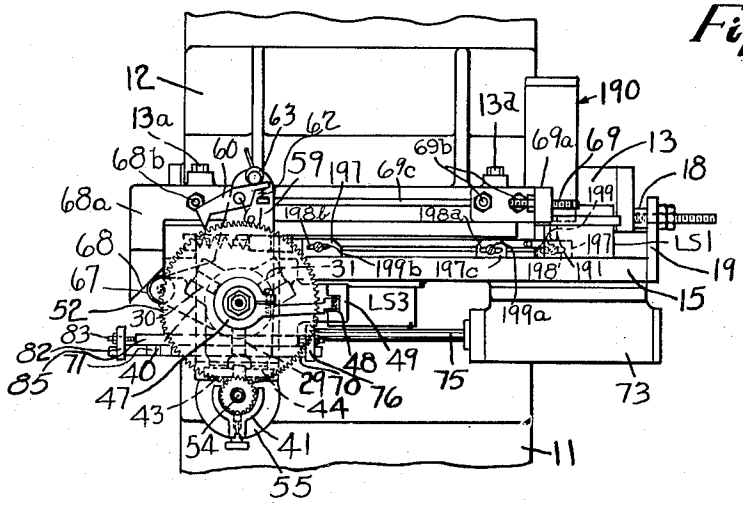
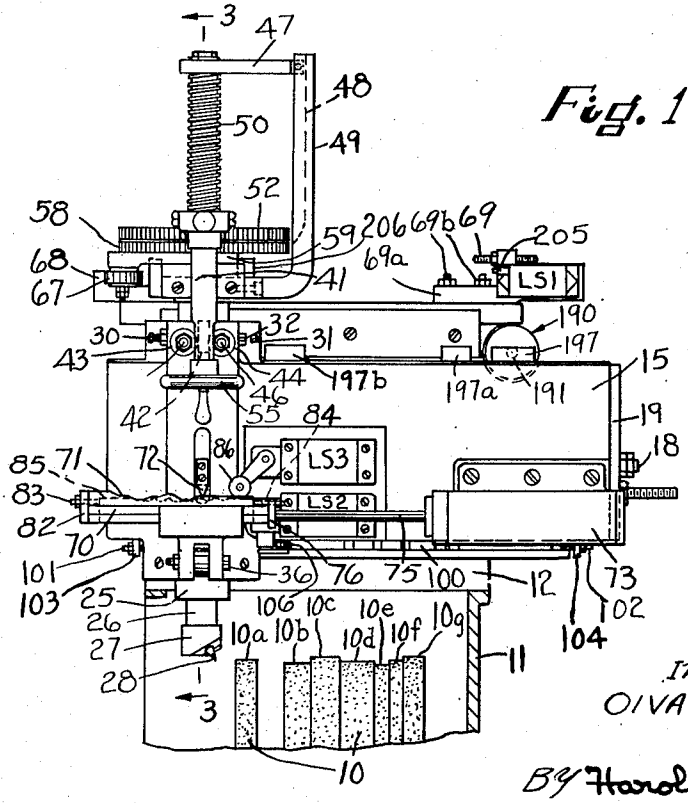


Fig. 1



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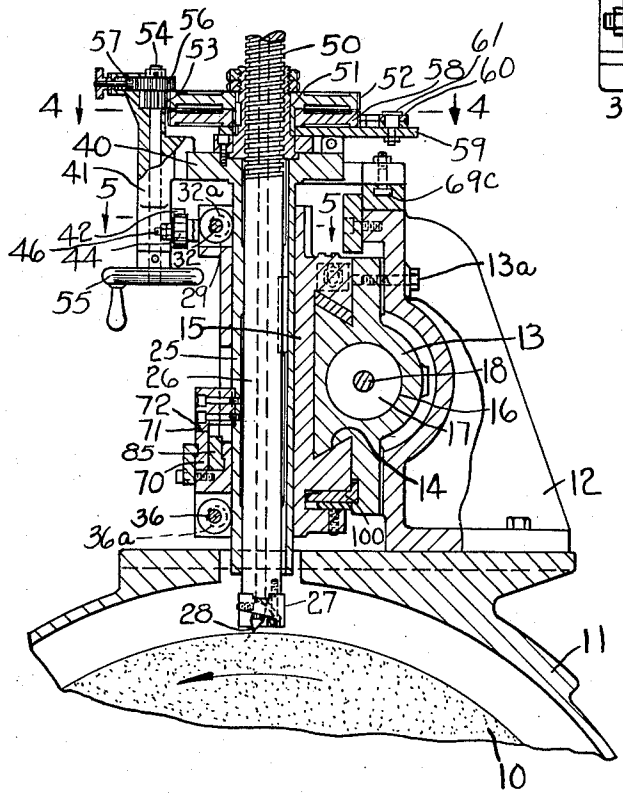
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Aug. 4, 1953 O. E. HILL 2,647,504

GRINDING WHEEL TRUING APPARATUS

Filed Sept. 8, 1950 4 Sheets-Sheet 2

Fig. 3



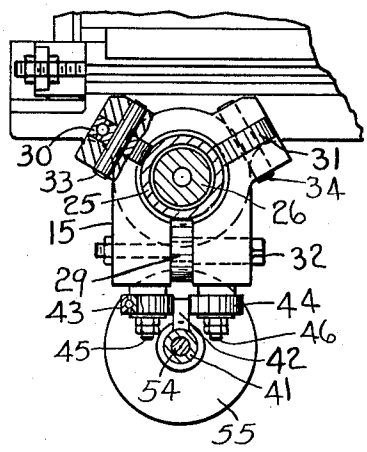


Fig. 5

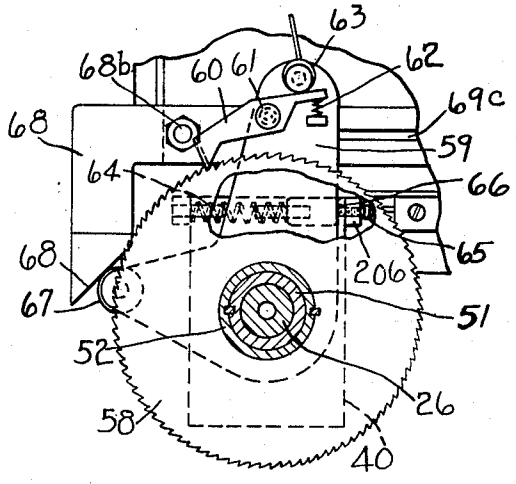


Fig. 4

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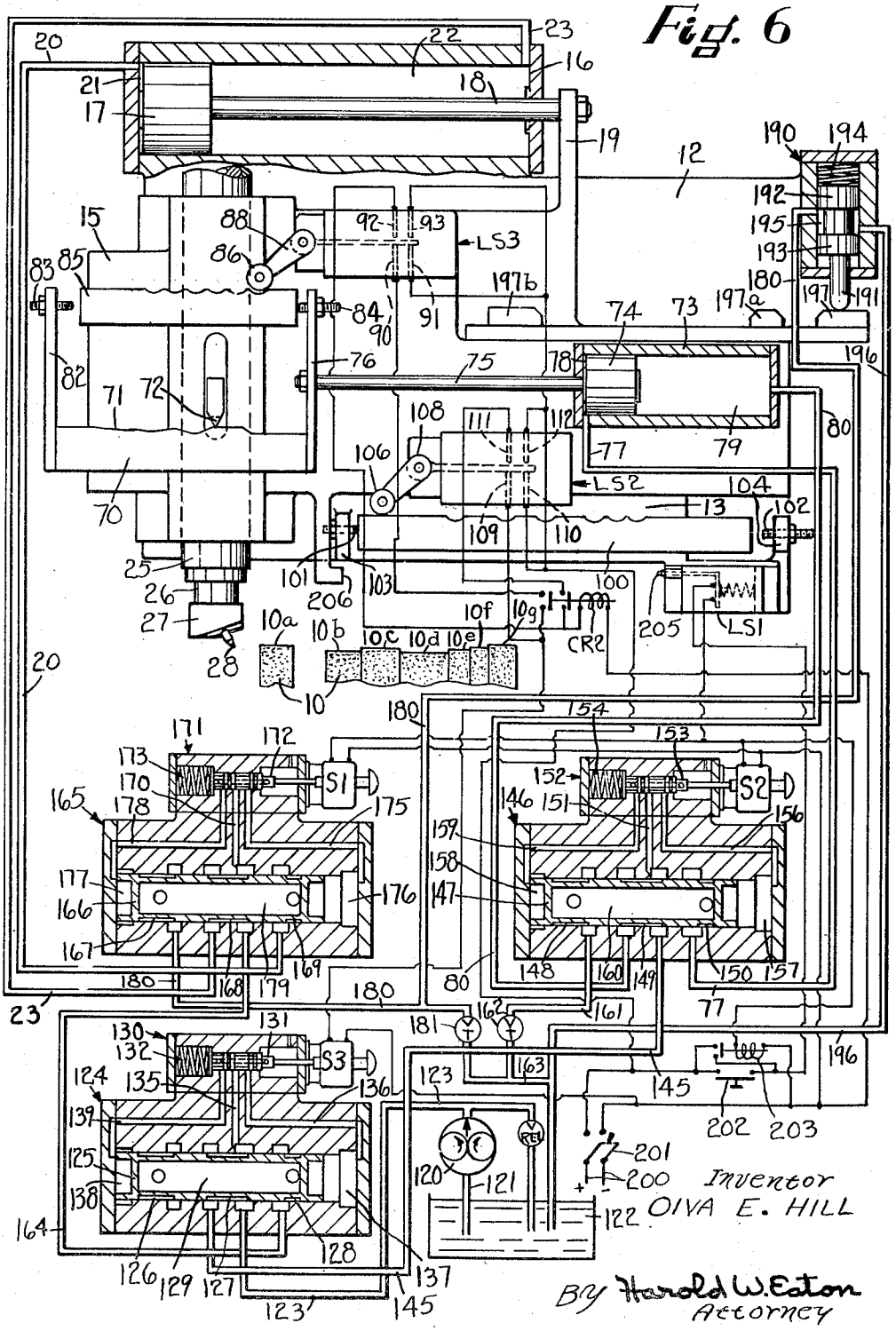
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GRINDING WHEEL TRUING APPARATUS

Filed Sept. 8, 1950 4 Sheets-Sheet 3

Fig. 6



Aug. 4, 1953 O. E. HILL 2,647,504

GRINDING WHEEL TRUING APPARATUS

Filed Sept. 8, 1950 4 Sheets-Sheet 4

Fig. 7

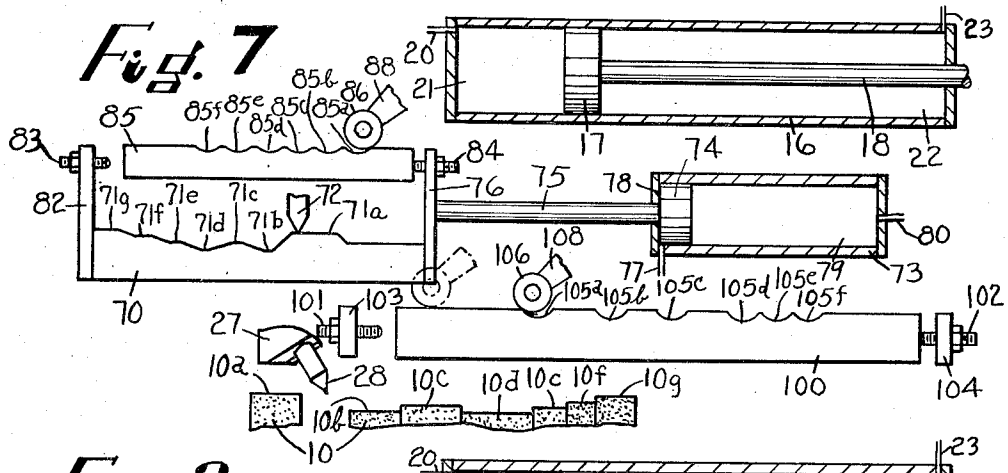


Fig. 8

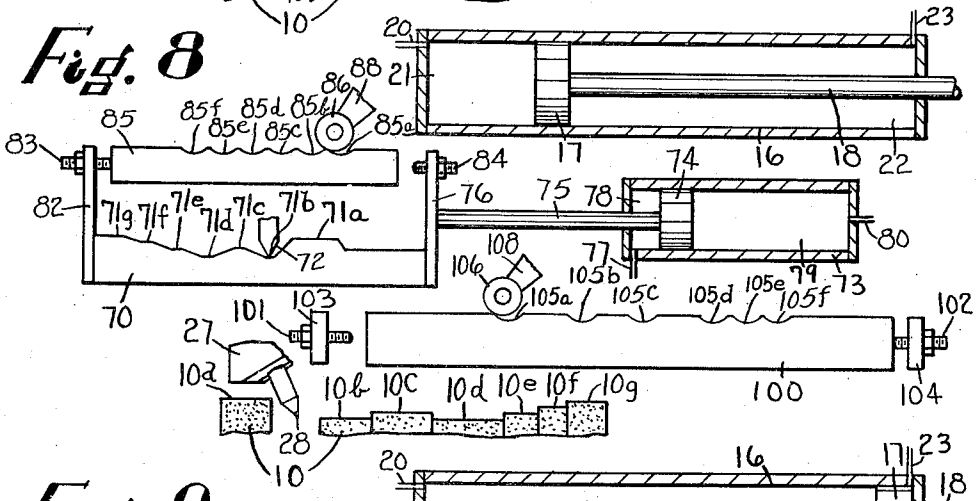
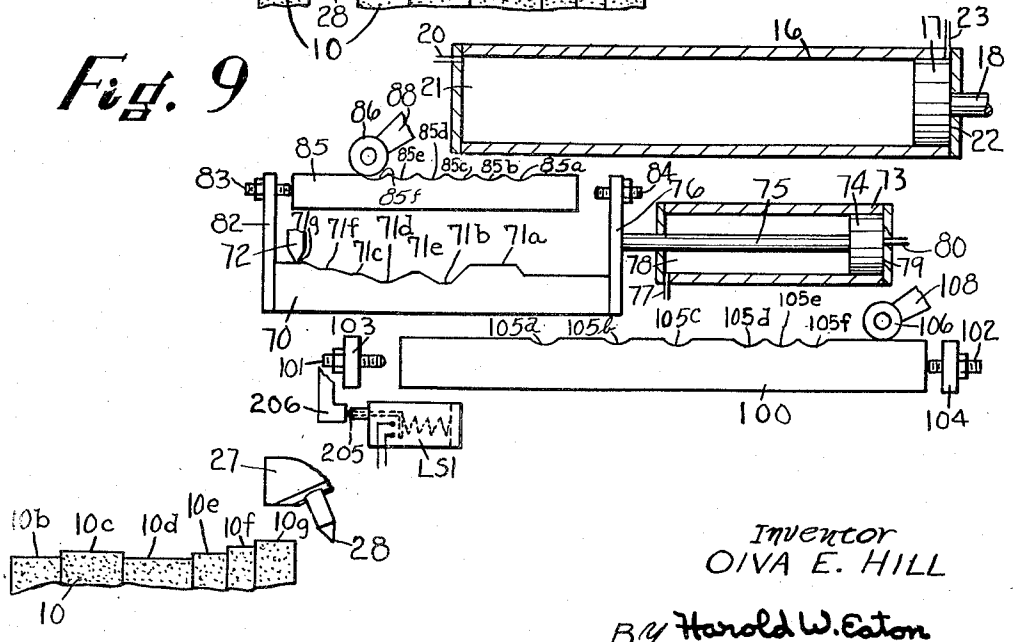


Fig. 9



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GRINDING WHEEL TRUING APPARATUS

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Application September 8, 1950, Serial No. 183,775

10 Claims. (Cl. 125—11)

1

The invention relates to a grinding wheel truing apparatus, and more particularly to a truing apparatus for truing different diameters on a single wheel or a plurality of adjacent wheels.

One object of the invention is to provide a simple and thoroughly practical truing apparatus for truing a multi-diameter grinding wheel. Another object is to provide a hydraulically-actuated electrically-controlled truing apparatus successively to true a plurality of different diameters on the periphery of a grinding wheel. Another object is to provide truing apparatus with a hydraulically-actuated cam mechanism automatically to position the truing tool successively to true multiple adjacent diameters on either a single grinding wheel or a plurality of adjacent grinding wheels. Another object is to provide a hydraulically operated traverse mechanism for a truing tool and a hydraulically operated cam mechanism actuated in timed relation therewith successively to position the truing tool for truing a plurality of varying diameters on a grinding wheel. 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 grinding wheel truing apparatus;

Fig. 2 is a plan view of the truing apparatus;

Fig. 3 is a fragmentary vertical sectional view, on an enlarged scale, taken approximately on the line 3—3 of Fig. 1;

Fig. 4 is a horizontal sectional view, on an enlarged scale, taken approximately on the line 4—4 of Fig. 3, showing the pawl and ratchet feed mechanism for the truing tool;

Fig. 5 is a fragmentary horizontal sectional view, on an enlarged scale, taken approximately on the line 5—5 of Fig. 3, showing the anti-friction support for the truing tool holder;

Fig. 6 is a combined hydraulic and electrical diagram of the control mechanism for the truing apparatus;

Fig. 7 is a diagrammatic view showing the relative position of the parts after the truing tool has traversed across the first portion of the grinding wheel to be trued;

Fig. 8 is a similar diagrammatic view showing

2

the relative position of the parts after the truing tool has been positioned to true the second portion of the grinding wheel; and

Fig. 9 is a similar diagrammatic view showing the relative position of the parts after the truing tool has completed a traversing movement across the entire face of the grinding wheel to be trued;

The truing apparatus has been illustrated in the drawings as applied to a grinding machine having a rotatable grinding wheel 10 which is partially surrounded by a wheel guard 11. The grinding wheel 10 may be a single grinding wheel, or as shown in Fig. 6 spaced grinding wheels having surfaces 10*a*, 10*b*, 10*c*, 10*d*, 10*e*, 10*f* and 10*g* of different diameters to be trued. The wheel guard 11 serves as a support for an upwardly extending bracket 12. The bracket 12 supports a slide base 13 which is fixedly mounted thereon by a plurality of screws 13*a* (only one of which has been illustrated in Fig. 3). The slide base 13 is provided with a dovetailed slideway 14. A longitudinally movable slide 15 is provided with dovetailed slideways which mate with the slideway 14 to facilitate a longitudinal movement of the slide 15 in a direction parallel to the axis of rotation of the grinding wheel 10.

A hydraulically operated mechanism is provided for traversing the slide 15 longitudinally comprising a hydraulic cylinder 16 which as shown is formed integral with the slide base 13. The cylinder 16 contains a slidably mounted piston 17 mounted on one end of a piston rod 18. The other end of the piston rod 18 is fastened to a bracket 19 formed integral with the slide 15. When fluid under pressure is passed through a pipe 20 into a cylinder chamber 21 (Fig. 6), the piston 17 together with the slide 15 will be moved longitudinally toward the right. During this movement of the piston 17, fluid within a cylinder chamber 22 may exhaust through a pipe 23.

The slide 15 serves as a support for a transversely movable vertically arranged sleeve 25. A spindle 26 is mounted within the sleeve 25 and supports a truing tool holder 27 at its lower end. The truing tool holder 27 is provided with a diamond or truing tool 28 which is arranged to true the periphery of the grinding wheel as will be hereinafter described.

The sleeve 25 is preferably supported by a plurality of anti-friction rollers to facilitate free movement thereof in generating the desired form or shape on the grinding wheel. The sleeve 25 is supported adjacent its upper end by a plurality of anti-friction rollers 29, 30 and 31. The rollers

29, 30 and 31 are supported by studs 32, 33 and 34 respectively. The stud 32 is preferably provided with an eccentric 32a to facilitate adjustment of the roller 29 toward and from the sleeve 25.

The lower end of the sleeve is similarly supported by a plurality of anti-friction rollers, only one of which has been illustrated in Fig. 3. The roller 35 is supported by an eccentric stud 36 having an eccentric 36a to facilitate adjustment of the roller 35. The other two rollers in this set are arranged in an identical manner with the arrangement shown in Fig. 5, consequently these rollers have not been illustrated in the drawings.

The upper end of the sleeve 25 is provided with an integral flange 40 which serves as a support for a bracket 41. The bracket 41 is provided with a lug 42 having parallel side faces which are engaged by a pair of spaced anti-friction rollers 43 and 44. The rollers 43 and 44 are supported by studs 45 and 46 which are in turn fixedly mounted on the slide 15. The rollers 43 and 44 serve as a guide for the sleeve 25 as it is moved vertically during operation.

The truing tool spindle 26 is slidably keyed within a central aperture within the sleeve 25. In order to facilitate adjustment of the truing tool 28 toward and from the periphery of the grinding wheel being trued, a nut and screw feeding mechanism is provided comprising a feed screw 50 formed on the upper end of the spindle 26. The screw 50 is surrounded by a nut 51 which is rotatably supported on the upper end of the flanged portion 40 of the sleeve 25. A gear 52 is keyed to the nut 51. The gear 52 meshes with a pinion 53 mounted on the upper end of a vertically arranged rotatable shaft 54. The shaft 54 is rotatably mounted within the bracket 41 and is provided at its lower end with a manually operable hand wheel 55. It will be readily apparent from the foregoing disclosure that rotation of the hand wheel 55 will be transmitted through the shaft 54, the pinion 53, the gear 52, to rotate the nut 51 and thereby to impart an axial adjustment of the truing tool spindle 26.

In order to hold the nut 51 in adjusted position, a serrated wheel 56 is fixedly mounted on the upper end of the shaft 54. A spring pressed pawl 57 mounted on the bracket 41 is arranged to engage the serrated wheel 56 and thereby to hold the feed nut 51 in adjusted position.

In order to steady the upwardly extending portion of the feed screw 50, an arm 47 is clamped around a cylindrical surface formed on the upper end of the screw 50 (Figs. 1 and 2). The right hand end of the arm 47 is provided with a pair of spring pressed balls which ride in a vertically arranged groove 48 formed in a vertically extending bracket 49. The bracket 49 is fixedly mounted on the flange 40 of the sleeve 25.

It is desirable to provide an automatically-actuated mechanism for imparting a feeding movement to the truing tool at the end of its longitudinal traversing movement. This is preferably accomplished by means of a pawl and ratchet mechanism comprising a ratchet wheel 58 which is keyed to the nut 51 (Fig. 3). A pawl carrier 59 (Figs. 3 and 4) is rotatably mounted on the nut 51 and is provided with a feed pawl 60. The feed pawl 60 is supported by a stud 61 fastened to the pawl carrier 59. A compression spring 62 serves normally to maintain the pawl 60 in operative engagement with the ratchet wheel 58. A

manually operable rotatable eccentric 63 is provided to facilitate rocking the pawl 60 to an inoperative position if desired so as to facilitate a manual adjustment of the truing tool spindle. A compression spring 64 normally urges the pawl carrier 59 in a clockwise direction (Fig. 4) with the stud 65 in operative engagement with a stop surface 66 which is fixedly mounted on the flanged portion 40 of the sleeve 25.

When the slide 15 approaches the right hand end of its stroke, the pawl carrier 59 engages an adjustable stop screw 69 which serves to rock the pawl carrier 59 in a counterclockwise direction so as to impart a predetermined down feeding movement to the truing tool 28. The stop screw 69 is carried by a bracket 69a which is adjustably clamped on the upper surface of the bracket 12 by clamping screws 69b. The clamping screws 69b ride in a T-slot 69c formed in the upper surface of the bracket 12. The pawl carrier 59 is provided with a laterally extending arm which supports a roller 67. The roller 67 is arranged in the path of a cam 68 so that when the slide 15 approaches the left hand end position, the pawl carrier 59 is actuated to impart a predetermined down feeding movement to the truing tool 28. The cam 68 is formed on a bracket 68a which is adjustably mounted on the bracket 12. A clamp bolt 68b carried by the bracket 68a rides in the T-slot 69c.

An automatically actuated mechanism is provided for positioning the truing tool 28 in a vertical direction to true the various diameters on the periphery of the grinding wheel 10. This mechanism may comprise a slidably mounted cam bar 70 which is slidably supported on the longitudinally movable slide 15. The cam bar 70 is provided with a cam face 71 having a plurality of horizontal portions 71a, 71b, 71c, 71d, 71e, 71f and 71g for positioning the truing tool 28 successively to true the faces 10a, 10b, 10c, 10d, 10e, 10f and 10g of the grinding wheel 10. A follower 72 is fixedly mounted on the vertically movable sleeve 25 so that when the cam bar 70 is moved longitudinally the follower will be moved in a vertical direction to impart a corresponding movement to the sleeve 25, the spindle 26, the truing tool holder 27 and the truing tool 28.

A hydraulically operated mechanism is provided for intermittently traversing the cam bar 70 comprising an hydraulic cylinder 73 which is fixedly mounted on the longitudinally movable slide 15. The cylinder 73 contains a slidably mounted piston 74. The piston 74 is connected by means of a piston rod 75 with a bracket 76 which is fixedly mounted on the right hand end of the cam bar 70. When fluid under pressure is passed through a pipe 77 into a cylinder chamber 78, at the left hand end of the cylinder 73, the piston 74 will be caused to move toward the right imparting a corresponding movement to the piston rod 75, the bracket 76, and the cam bar 70. During this movement fluid within a cylinder chamber 79 is exhausted through a pipe 80.

An automatic control mechanism is provided which is operated by and in timed relation with the movement of the cam bar 70 comprising a slide bar 85 which is also slidably mounted on the longitudinally movable slide 15. The left hand end of the cam bar 70 is provided with an upwardly extending bracket 82 having an adjustably mounted stop screw 83 mounted adjacent to the upper end thereof in alignment with the left hand end of the slide bar 81. The bracket 76 is also

provided with an adjustably mounted stop screw 84 which is aligned with the right hand end of the slide bar 81. The upper face of the slide bar 85 is provided with a plurality of scallops 85a, 85b, 85c, 85d, 85e and 85f which are arranged to engage and actuate the actuating roller 86 of a limit switch LS3. The roller 86 is mounted on the lower end of a pivotally mounted arm 88 which is arranged to actuate an actuating arm 88 of the limit switch LS3. The limit switch LS3 is provided with two pairs of contacts 90 and 91 which are normally open and 92 and 93 which are normally closed. When the slide bar 70 is indexed longitudinally by movement of the piston 74, the scalloped surface of the slide bar 85 will actuate the roller 86 to shift the contact arm of the limit switch LS3 so as to make and break the normally open and normally closed contacts therein. The operation of this limit switch LS3 will be more fully described hereinafter.

A slide bar 100 is also slidably supported on the rear face of the slide 15 (Fig. 3). The slide bar 100 is arranged to move with the longitudinally movable slide 15 through a limited stroke as governed by a pair of spaced aligned stop screws 101 and 102 which are mounted in lugs 103 and 104 respectively. The lugs 103 and 104 are fixedly mounted on the slide base 13. The slide bar 100 is provided with a plurality of spaced scallops 105a, 105b, 105c, 105d, 105e and 105f. An actuating roller 106 of a limit switch LS2 is arranged to operatively engage the upper surface of the slide bar 100 (Figs. 6, 7, 8 and 9). The limit switch LS2 is fixedly mounted on the longitudinally movable slide 15. The roller 106 is supported on the lower end of an actuating arm 108 of the limit switch LS2. The limit switch LS2 is provided with two pairs of contacts 109 and 110 which are normally opened and contacts 111 and 112 which are normally closed. During the initial longitudinal movement of the slide 15 toward the right, the roller 106 rides along the upper surface of the slide bar 100 until it starts to drop into the scallop 105a which serves to actuate the limit switch LS2 in a manner to be hereinafter described. When the roller 106 moves out of a scallop onto the top of the slide bar 100, due to longitudinal movement of the slide 15, the normally closed contacts 111—112 open so as to break the holding circuit and thereby to deenergize CR2. CR2 remains deenergized until the next movement of the cam bar 70 and slide bar 85 allow roller 86 to drop into a scallop to close the normally closed contacts 92—93 of the limit switch LS3 thereby energizing CR2 and again establishing a holding circuit.

A hydraulic system is provided for supplying fluid under pressure to the cylinders 16 and 73 comprising a motor driven fluid pump 120 which draws fluid through a pipe 121 from a reservoir 122 (Fig. 6). The pump 120 forces fluid under pressure through a pipe 123 to a control valve 124. The control valve 124 is a shuttle-type valve comprising a slidably mounted valve member 125 having a plurality of valve pistons formed thereon to provide a plurality of valve chambers 126, 127 and 128. The valve member 125 is also provided with a central passage 129 to facilitate exhaust of fluid through the valve 124. A pilot valve 130 is provided for shifting the valve member 125 axially by means of fluid under pressure. The pilot valve 130 comprises a slidably mounted valve member 131 which is normally held in a right hand end position by means of a compression spring 132. A solenoid S3 is provided to shift the valve member 131 toward the left. In the position of the control valve 124 and the pilot valve 130, fluid under pressure passing through the pipe 123 enters the valve chamber 127 and passes through a passage 135, through a chamber in the valve member 131 and through a passage 136 into an end chamber 137 to move the slidably mounted valve member 125 toward the left (Fig. 6) into the position illustrated. During this movement fluid within an end chamber 138 may exhaust through a passage 139, through the pilot valve 130 and into the reservoir 122. The control valve 124 serves to pass fluid under pressure either to a control valve 146 for controlling the admission to and exhaust of fluid from the cylinder 73 or to a control valve 165 for controlling the admission to and exhaust of fluid from the cylinder 16.

In the position of the valve 124 (Fig. 6), fluid under pressure entering the valve chamber 127 passes through a pipe 145 to the control valve 146. The control valve 146 comprises a slidably mounted shuttle-type valve member 147 having a plurality of valve pistons thereon which form a plurality of valve chambers 148, 149 and 150. In the position of the valve 146 (Fig. 6) fluid under pressure passing through the pipe 145 enters the valve chamber 149 and passes through a passage 151 to a pilot valve 152. The pilot valve 152 comprises a slidably mounted valve member 153 which is normally held in a right hand end position by means of a compression spring 154. A solenoid S2 is provided for shifting the valve member 152 toward the left.

In the position of the valve 146 (Fig. 6) fluid under pressure passing through the passage 151 passes through a chamber in the valve member 153, through a passage 156 into an end chamber 157 to move the valve member 147 toward the left into the position illustrated in Fig. 6. During this movement of the valve member 147, fluid within an end chamber 158 may exhaust through a passage 159. The valve member 147 is provided with a central passage 160 to facilitate passage of fluid exhausting from the cylinder 73. In the position of the valve 146 (Fig. 6) fluid under pressure entering the valve chamber 149 passes through the pipe 80 into the cylinder chamber 79 to move the piston 74 toward the left into the position illustrated in Fig. 6. During this movement fluid within the cylinder chamber 78 may exhaust through the pipe 77 through the valve chamber 150 in the valve member 147, through the central passage 160, through the valve chamber 148 and exhaust through a pipe 161, through a throttle valve 162 and through a pipe 163 into the reservoir 122. The throttle valve 162 serves to control the rate of exhaust of fluid from the cylinder 73 and thereby serves to control the speed of movement of the piston 74.

The control valve 165 is provided with a slidably mounted shuttle-type valve member 166 having a plurality of valve pistons formed thereon to provide a plurality of valve chambers 167, 168 and 169. Fluid under pressure passing through the pipe 164 enters the valve chamber 168 and passes through a passage 170 into a pilot valve 171. The pilot valve 171 is provided with a slidably mounted valve member 172 which is normally held in a right hand end position by means of a compression spring 173. A solenoid S1 is provided for shifting the valve member 172 into a reverse position. Fluid under pressure passing through the passage 170 passes through a cham-

ber formed in the valve member 172, through a passage 175 into an end chamber 176 to move the valve member 166 toward the left into the position illustrated in Fig. 6. During this movement fluid within an end chamber 177 may exhaust through a passage 178, through the pilot valve 172 and exhaust into the reservoir 122. The valve member 166 is provided with a central passage 179 to facilitate the exhaust of fluid from the cylinder 16.

When fluid under pressure is passed through the pipe 164 into the valve chamber 168, fluid may pass through the pipe 23 into the cylinder chamber 22 to move the piston 17 toward the left into the position illustrated in Fig. 5. During this movement of the piston 17 fluid within the cylinder chamber 21 may exhaust through the pipe 29 into the valve chamber 169, through the central passage 179, through the valve chamber 167 and exhaust through a pipe 180. The pipe 180 is provided with an adjustable throttle valve 181 through which fluid may exhaust into the exhaust pipe 183 and into the reservoir 122. It will be readily apparent from the foregoing disclosure that the throttle valve 181 controls the rate of exhaust of fluid from the cylinder 16 and thereby controls the speed of movement of the piston 17.

The throttle valve 181 serves as above described to control the rate of exhaust of fluid from both ends of the cylinder 16 depending upon the position of the valve 165 to provide a relatively slow uniform speed of the truing tool 28 during a truing operation. It is desirable to speed up the movement of the truing tool during its initial idle stroke until the diamond or truing tool 28 moves into operative engagement with the surface 10*a* to be trued and also to speed up the movement of the truing tool in gaps between wheel faces such as between faces 10*a* and 10*b*. This is preferably accomplished by providing a by-pass valve 190 which is connected to by-pass fluid around the throttle valve 181. The by-pass valve 190 has been illustrated on a somewhat enlarged scale in the diagrammatic illustration in Fig. 6. This valve is a piston type valve comprising a valve stem 191 having valve pistons 192 and 193 formed integrally therewith. A compression spring 194 serves normally to urge the valve stem 191 in a downward direction normally to maintain the by-pass valve 190 in a closed or inoperative position. The valve pistons 192 and 193 form a valve chamber 195 through which fluid may pass from the exhaust line 180 into a pipe 196 which connects with the exhaust pipe 183 thereby by-passing fluid around the throttle valve 181. The by-pass valve 190 is fixedly mounted on the bracket 12 and is arranged so that the valve stem 191 lies in the path of a plurality of adjustable dogs 197, 197*a*, and 197*b* which are adjustably mounted on the upper surface of the slide 15. The dogs 197, 197*a* and 197*b* are provided with elongated slots 198, 198*a* and 198*b* respectively. Clamping screws 199, 199*a* and 199*b* pass through the elongated slots 198, 198*a* and 198*b* formed in the dogs 197, 197*a* and 197*b* and are screw threaded into the slide 15. It will be readily apparent from the foregoing disclosure that the dogs 197, 197*a* and 197*b* may be adjusted longitudinally relative to the slide 15 to vary the operation of the by-pass valve 190 during the longitudinal movement of the slide 15. As illustrated in Fig. 6, the valve stem 191 is on top of the dog 197 thus holding the valve 190 in an open position so that unrestricted flow of fluid from the pipe 180, through the valve chamber 197 into the pipe 196 is obtained. When the slide 15 starts its longitudinal movement toward the right to move the truing tool 28 into operative engagement with the face 10*a* of the grinding wheel 10, the slide 15 moves at a rapid rate until the valve stem 191 rides down the sloping surface of the dog 197 thereby releasing the compression of the spring 194 which moves the valve piston 192 downwardly to close the port at the end of the pipe 180 thereby preventing further by-pass of fluid into the pipe 196. During the traverse of the diamond 28 across the wheel face 10*a*, the throttle valve 181 governs the speed to produce a slow uniform traverse of the truing tool during the truing operation. After the diamond 28 completes its pass across the face 10*a*, the valve stem 191 engages the sloping face on the right hand end of the dog 197*a* which again serves to open the by-pass valve to facilitate by-passing of fluid from the pipe 180 through valve chamber 197 into pipe 196. The slide 15 will then resume a rapid traverse across the gap between the wheel faces 10*a* and 10*b*. By the time the truing tool 28 moves into engagement with the face 10*b*, the slide 15 will have moved a sufficient distance so that the valve stem 191 rides down the sloping surface at the left hand end of the dog 197*a* to again cut off the by-pass of fluid between the pipes 180 and 196 to slow down the movement of the slide to the pre-set truing speed. The slow speed continues during the intermittent passage of the truing tool across the faces 10*b*, 10*c*, 10*d*, 10*e*, 10*f* and 10*g*. After the diamond or truing tool 28 completes its pass across the face 10*g*, the valve stem 191 engages the sloping surface at the right hand end of the dog 197*b* to again raise the valve stem 191 to by-pass fluid from the pipe 180 into the pipe 196 thereby speeding up the movement of the slide 15 toward the right until the slide reverses in a manner to be hereinafter described.

Electric power is supplied to the truing apparatus through a pair of power lines 209. A main switch 201 is provided to render the electrical controls of the truing apparatus operative or inoperative as desired. A cycle start push button switch 202 is provided having a holding coil 203 which serves in a manner to be hereinafter described to initiate a truing cycle. A normally closed limit switch LS1 is fixedly mounted on the slide base 13. The limit switch LS1 is provided with an actuating plunger 205 which is arranged in the path of a lug 206 which is fixedly mounted on the longitudinally movable slide 15. When the longitudinally movable slide 15 approaches the right hand end of its stroke, the lug 206 engages the actuating plunger 205 to open the normally closed limit switch LS1 to initiate a return stroke of the longitudinally movable slide 15 in a manner to be hereinafter described.

The parts as shown diagrammatically in Fig. 6 are at the starting position. When it is desired to start a truing cycle, the fluid pump is first started and then the main switch 201 is closed which serves to make a circuit to energize solenoid S3 which serves to shift the pilot valve member 131 toward the right so that fluid within the pipe 123 passes through the valve chamber 127, through the passage 135, through the passage 139 into the end chamber 136 to shift the valve member 125 toward the right so that fluid under pressure within the pipe 123 passes through the valve chamber 127 and through the pipe 164 to

the control valve 165. The push button cycle control switch 202 is then closed which serves to energize both of the solenoids S1 and S2. When the solenoid S1 is energized, fluid under pressure from the pipe 164 is passed through the passages previously described into the end chamber 177 to shift the valve member 166 into a right hand end position. In this position of the valve 165, fluid under pressure passing through the pipe 164 passes through the pipe 20 into the cylinder chamber 21 to move the piston 17 and the slide 15 toward the right at a rapid rate to move the diamond or truing tool 28 into operative engagement with the face 10*a* of the grinding wheel 10. As the truing tool 28 moves into engagement with the face 10*a*, the valve stem 191 rides off the dog 197 thereby cutting off the by-pass of fluid between the pipes 180 and 196 so that the speed of the piston 17 and the slide 15 is slowed down to a slow truing speed as governed by the throttle valve 181. The slow speed of the slide 15 continues while the diamond or truing tool 28 is passing across the face 10*a*. During the initial movement of the slide 15 toward the right, due to frictional connections therebetween, the slide 15 moves the slide bar 100 toward the right until the slide bar engages the adjustable stop screw 102. As the slide 15 continues its movement toward the right, the valve stem 191 rides up onto the dog 197*a* to speed up the movement of the slide 15 and truing tool 28. When the slide 15 moves a sufficient distance so that the roller 106 of the limit switch LS2 drops into the scallop 105*a*, the normally open contacts 109 and 110 are opened to break a circuit thereby deenergizing the solenoid S3 so that the valve member 125 returns to the position illustrated in Fig. 6. Deenergizing the solenoid S3 cuts off fluid pressure from the valve 165 thereby stopping the movement of the piston 17 and the slide 15. Fluid under pressure then passes through the pipe 145 to the control valve 146. The solenoid S2 being energized, fluid under pressure passes through the pipe 77 and into the cylinder chamber 78 to move the piston 74 toward the right thereby shifting the cam bar toward the right so that the follower 72 rides down a sloping surface into engagement with the surface 71*b* of the cam bar 70. This movement shifts the truing tool into the position illustrated in Fig. 8 in position for truing the face 10*b* of the grinding wheel 100. During this movement of the cam bar 70 toward the right, the slide bar 85 starts moving after the stop screw 83 moves into engagement with the left hand end thereof. When the slide bar 85 starts moving toward the right, the roller 86 drops further into the scallop 85*a* so that the normally closed contacts 92 and 93 are closed to energize the relay switch CR2. The normally closed contacts 111 and 112 of the limit switch LS2, being closed, serves as a holding circuit to maintain CR2 energized until the roller 86 starts to move upwardly as it moves into engagement with the left hand portion of the scallop 85*a* and opens contacts 90 and 91 of the limit switch LS3. As the roller 86 moves upwardly, the normally open contacts 90 and 91 are again closed to close a circuit through contactors of the switch CR2 to again energize the solenoid S3 thereby cutting off fluid from the valve 146 to stop the movement of the piston 74 toward the right at the same time admitting fluid under pressure to the valve 165. The solenoid S1 being energized, fluid under pressure will again be passed through the pipe 20 into the cylinder chamber 21 to start the next longitudinal movement of the piston 17 and slide 15 to carry the truing tool 28 across the face 10*b* of the grinding wheel 10.

Longitudinal movement of the piston 17 and slide 15 toward the right continues until the roller 106 starts to enter the scallop 105*b* in the slide bar 100 which again serves to open a circuit to deenergize the solenoid S3 so that fluid is cut off from the valve 165 to stop the movement of the piston 17 and slide 15 toward the right when the truing tool 28 reaches the end of the face 10*b* of the grinding wheel 10. When the solenoid S3 is deenergized, fluid under pressure is again passed through the pipe 145 to the control valve 146. The solenoid S2 being energized, fluid under pressure is passed through the pipe 77 into the cylinder chamber 78 to start a further movement of the piston 74 toward the right from the position illustrated in Fig. 8. When the piston 74 starts moving toward the right, the movement of the cam bar 70 toward the right causes the follower 72 to ride up an inclined surface onto the portion 71*c* of the cam bar 70 so as to position the truing tool 28 for truing the face 10*c* of the grinding wheel 10. During this movement of the cam bar 70, the slide bar 85 also moves toward the right. When the roller 86 moves into engagement with the next rise on the scallop 85*b*, the roller 86 is again raised to close the normally open contacts 90 and 91 thereby closing a circuit through relay switch CR2 to energize the solenoid S3 thereby cutting off the flow of fluid under pressure to the valve 146 to stop the movement of the piston 74. At the same time fluid is passed through the pipe 164 to the control valve 165 through the pipe 20 into the cylinder chamber 21 to again start movement of the piston 17 and slide 15 toward the right to traverse the truing tool across the face 10*c* of the grinding wheel 10.

During the entire right hand movement of the piston 17 and slide 15, solenoids S1 and S2 remain energized and the solenoid S3 is intermittently energized and deenergized to first pass fluid into the cylinder 16 to traverse the truing tool across a portion of the wheel, thereafter to cut fluid off from the cylinder 16 and admit fluid to the cylinder 73 to reposition the truing tool 28 for truing the next adjacent face on the grinding wheel. These movements are successively repeated while faces 10*d*, 10*e*, 10*f* and 10*g* are being trued. After the truing tool 28 has passed across the face 10*g* of the grinding wheel 10, the valve stem 191 rides into engagement with the dog 197*b* which again opens the by-pass valve 190 to by-pass fluid from the pipe 180 through the valve chamber 195 into the pipe 196 to start a rapid movement of the slide 15 which carries the actuating roller 106 of the limit switch LS2 into the position illustrated in Fig. 9 with the diamond 28 assuming the position illustrated therein. When the parts are in this position, the cam bar 70 is stopped with the follower 72 in engagement with the face 71*g* of the bar 70 and the roller 86 of the limit switch LS3 is in engagement with the left hand end of the scallop 85*f* on the slide bar 85. As the slide 15 approaches the right hand end position, a stop lug 206 on the slide 15 engages the actuating plunger 205 of the normally closed limit switch LS1 which serves to break a circuit thereby deenergizing both of the solenoids S1 and S2 and also deenergizing the holding coil 203 of the starter switch 202. The solenoids S1 and S2 both

remain deenergized during the return movement of the piston 17 and slide 15 toward the left.

The deenergizing of the solenoids S1 and S2 serves to reverse the flow of fluid to the cylinders 16 and 73 so that the slide 15 and truing tool 28 move toward the left when fluid under pressure is passed thereto by the control valve 165 and the piston 74 is similarly moved toward the left intermittently to traverse the cam bar 70 toward the left when fluid is admitted to the cylinder 73 by the control valve 146. During the initial movement of the slide 15 toward the left, the slide bar 100 is frictionally moved with the slide 15 until it moves into engagement with the stop screw 101. This shifting movement of the slide bar 100 serves to reposition the scallops 105*f*, 105*e*, 105*d*, 105*c*, 105*b* and 105*a* so that as the roller 106 rides down the face of the scallop, the limit switch LS2 will be actuated. It will thus be seen that on the movement of the slide toward the left, the left hand edges of the scallops control the actuation of the switch LS2 while on the return stroke of the slide toward the right, the right hand edges of the scallops control actuation of the roller 106 and limit switch LS2. Similarly, during the initial movement of the piston 74 and the cam bar 70 toward the left, the slide bar 85 remains stationary until the last motion is taken up and the stop screw 84 (Fig. 9) engages the right hand end thereof after which the bar 85 starts its movement toward the left.

As the slide 15 approaches its right hand end position, the pawl carrier 59 moves into engagement with an adjustable stop screw 69 to actuate the pawl carrier and thereby to feed the truing tool 28 downwardly for the return traverse across the face of the grinding wheel.

During the return traverse of the slide 15 and the truing tool 28 toward the left, the solenoids S1 and S2 remain deenergized during the entire stroke and the solenoid S3 is intermittently energized and deenergized as controlled by the limit switches LS2 and LS3 in the same manner as on the stroke of the slide 15 and truing tool 28 toward the right. During the return stroke of the slide, the holding coil 203 of the push button starter switch 202 is deenergized so that when the slide 15 and truing tool 28 reach the extreme left hand end position after a pass across the faces 10*g*, 10*f*, 10*e*, 10*d*, 10*c*, 10*b* and 10*a* into the position illustrated in Fig. 6, the truing cycle is stopped. In other words the mechanism is set up and arranged so that for each actuation of the push button starter switch 202, the truing tool 28 makes one complete reciprocation passing across the operative faces of the grinding wheel 10 toward the right and then returns toward the left into the starting position.

As the truing tool approaches the left hand end of its stroke, the roller 67 (Fig. 4) engages the cam face 69 to rock the pawl carrier 59 and the feed pawl 60 to impart a rotary feeding movement to the ratchet wheel 58 thereby feeding the diamond or truing tool 28 downwardly for the next truing operation. If more than one complete reciprocation of the truing tool across the wheel is desired, the push button starter switch 202 may be again actuated to start a second cycle of operation. This procedure may be followed as many times as desired to obtain the desired truing operation on the operative face of the grinding wheel 10.

The operation of this improved grinding wheel truing apparatus will be readily apparent from the foregoing disclosure. Assuming all of the parts to have been previously adjusted for a given truing operation, the fluid pressure pump 120 is started, the main switch 200 is closed after which the push button starter switch 202 is actuated to initiate a truing cycle. As above explained the truing tool is intermittently indexed longitudinally toward the right in a manner above described to pass the truing tool across the operative faces of the various portions of the grinding wheel after which the diamond is fed downwardly before the truing tool 28 starts its return stroke toward the left. After the return stroke toward the left has been completed the mechanism stops. As the truing tool approaches the stop position, the truing tool is again fed downward in a manner above described so that it is ready for the next truing cycle.

During a truing cycle, the truing tool 28 moves rapidly toward the right until it approaches the face 10*a* of the grinding wheel 10, at which time the valve 190 is closed by action of the spring 194 and the dog 197 to slow down the movement of the truing tool 28 to a slow truing speed as governed by the throttle valve 181. Truing tool 28 traverses across the face 10*a* of the grinding wheel 10 to true the same. When the truing tool 28 leaves face 10*a*, the dog 197*a* (Fig. 6) opens the valve 190 so that the slide 15 and truing tool 28 traverse rapidly across the gap between the wheel faces 10*a* and 10*b*. The cam bar 70 is then traversed toward the right so that the follower 72 rides down onto cam face 71*b*. The truing tool then traverses across the face 10*b* of the grinding wheel 10 after which the longitudinal movement of the slide 15 and the truing tool 28 stops and the longitudinal movement of the cam bar 70 starts further movement toward the right to raise the follower 72 into engagement with the cam face 71*c*. During this upward movement of the follower 72 the truing tool trues the shouldered face between wheel faces 10*b* and 10*c*. This movement cycle of operation continues during the traverse of the truing tool 28 and slide 15 toward the right. When the slide 15 approaches a right hand end position, the pawl carrier 59 engages a stop screw 69 to actuate the feed pawl 60 and causes a downward feeding movement of the truing tool 28 before the truing tool starts its traversing movement toward the left. After the slide reaches an extreme right hand end position, as illustrated diagrammatically in Fig. 9, the slide movement reverses and the slide 15 and the truing tool 28 are traversed intermittently toward the left to again pass across the faces 10*g*, 10*f*, 10*e*, 10*d*, 10*c*, 10*b* and 10*a* to produce a further truing operation thereon. When the slide 15 and truing tool 28 approach the extreme left-hand end position as shown in Fig. 6, the roller 67 on the pawl carrier 59 engages a cam face 68 to actuate the feed pawl 60 and cause a further downward feeding movement of the truing tool 28 ready for the next truing operation. As above explained for each actuation of the push button starter switch 202, the truing tool makes one complete reciprocation across the face of the wheel and then stops. If further truing is desired, it is necessary to again actuate the push button starter switch 202 to start another truing cycle.

It will thus be seen that there has been provided by this invention a grinding wheel truing apparatus in which the various objects hereinabove set forth together with many thoroughly

practical advantages are successfully achieved. As many 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 having a frame, a longitudinally movable slide on said frame, a transversely movable hollow sleeve on said slide, a truing tool holder therein, a truing tool mounted thereon, a feeding mechanism operatively connected between the holder and the sleeve to adjust said holder relative to said sleeve, means including a longitudinally movable cam on said slide and a follower on said sleeve which engages said cam successively to position the truing tool in a plurality of predetermined positions, means including a pair of independent fluid motors one of which is operatively connected to traverse said slide and the other is operatively connected to traverse said cam, an electrically controlled valve means operatively connected to control said motors so as to alternately and successively traverse said slide longitudinally and said cam longitudinally relative to said slide intermittently to true a plurality of different diameters on a grinding wheel.

2. In a grinding wheel truing apparatus having a longitudinally movable slide, a transversely movable hollow sleeve on said slide, a truing tool holder therein, a truing tool mounted on the end of said holder, a feeding mechanism operatively connected to said holder to adjust said holder relative to said sleeve, means including a longitudinally movable cam slidably mounted on said slide and a follower fixedly mounted on said sleeve in engagement with said cam, means including a fluid motor operatively connected to said slide intermittently to traverse said slide, and means including a fluid motor on said slide operatively connected to said cam intermittently to move said cam longitudinally relative to said slide when the slide is stationary successively to position the truing tool in predetermined positions on said slide for truing a plurality of different diameters on the periphery of a grinding wheel.

3. In a grinding wheel truing apparatus having a longitudinally movable slide, a piston and cylinder operatively connected to said slide intermittently to traverse said slide longitudinally, a transversely movable hollow sleeve on said slide, a truing tool slidably keyed therein, a truing tool on the end of said holder, a nut and screw mechanism operatively connected to said holder for adjusting said holder longitudinally relative to said sleeve, means including a longitudinally movable cam slidably mounted on said slide and a follower in engagement with said cam which is fixedly mounted on said sleeve, and means including a piston and cylinder on said slide operatively connected to said cam intermittently to move said cam longitudinally relative to said slide successively to position said holder and truing tool in predetermined positions for truing a plurality of varying diameters on a grinding wheel.

4. In a grinding wheel truing apparatus having a longitudinally movable slide, a piston and cylinder operatively connected thereto intermittently to traverse said slide, a transversely movable hollow sleeve on said slide, a truing tool holder slidably keyed therein, a truing tool mounted on said holder, a feeding mechanism on said sleeve which is operatively connected to said holder for adjusting it relative to said sleeve, means including a longitudinally movable cam slidably supported on said slide and a follower engaging said cam which is fixedly mounted on said sleeve successively to position the truing tool in a plurality of predetermined positions, means including a piston and cylinder on said slide which is operatively connected to said cam intermittently to traverse said cam longitudinally relative to the slide, and means including a hydraulic control valve mechanism operatively connected with said cylinders alternately and successively to admit fluid under pressure to the first cylinder to traverse said slide longitudinally and to the second cylinder to traverse said cam longitudinally relative to said slide successively to position the truing tool for truing a plurality of different diameters on a grinding wheel.

5. In a grinding wheel truing apparatus having a base, a longitudinally movable slide thereon, a piston and cylinder operatively connected to the slide intermittently to traverse said slide longitudinally, a solenoid-actuated control valve operatively connected to said cylinder to control the passage of fluid under pressure to and from said cylinder, a transversely movable hollow sleeve on said slide, a truing tool holder slidably keyed therein, a truing tool mounted on the end of said holder, a feeding mechanism operatively connected between the sleeve and the holder to adjust said holder longitudinally relative to said sleeve, means including a longitudinally movable cam slidably mounted on said slide and a follower engaging said cam which is fixedly mounted on said sleeve, means including a piston and cylinder on said slide operatively connected to said cam intermittently to move said cam longitudinally relative to said slide successively to position said holder and truing tool in predetermined positions for truing a plurality of varying diameters on the grinding wheel, a second solenoid-actuated control valve operatively connected to the second cylinder to control the admission to and exhaust of fluid from said second cylinder, and means including a third solenoid-actuated control valve operatively connected to said first and second control valves successively to admit fluid under pressure to the first and second control valves so as to intermittently traverse said slide to true a wheel face and to traverse said cam to position the truing tool for truing the next wheel face.

6. In a grinding wheel truing apparatus, as claimed in claim 5, in combination with the parts and features therein specified of a limit switch on said slide, a serrated bar on said base which is arranged to actuate said limit switch by and in timed relation with the longitudinal movement of the slide to actuate the third solenoid valve to stop the longitudinal movement of the slide after it has moved through a predetermined distance and to start the longitudinal movement of the cam to reposition the truing tool for truing another portion of the grinding wheel, a second limit switch on said slide, and means including a serrated slide bar slidably supported on said slide which is actuated by and in timed relation with the movement of said cam to actuate the third valve to stop movement of cam bar and to start longitudinal movement of the slide to true a portion of the grinding wheel.

7. In a grinding wheel truing apparatus, as claimed in claim 5, in combination with the parts and features therein specified of a limit switch on said slide, a serrated slide bar slidably supported on the base to actuate said first limit switch, adjustable stop screws on the base to limit the endwise movement of said slide bar relative to the base to facilitate positioning the bar so that the limit switch is actuated at the same position of the slide during its movement in opposite directions to actuate the third solenoid valve to stop the longitudinal movement of the slide after it has moved through a predetermined distance and to start the longitudinal movement of the cam to reposition the truing tool for truing another portion of the grinding wheel, a second limit switch on said slide, a longitudinally movable serrated slide bar slidably supported on said slide and movable with said cam to actuate said second limit switch, and adjustable stop screws carried by the cam to facilitate endwise movement of said latter slide bar relative to the cam so that the second limit switch is actuated at the same position of the cam bar during its movement in opposite directions.

8. In a grinding wheel truing apparatus, as claimed in claim 5, in combination with the parts and features therein specified of a truing cycle start switch operatively connected to energize the first and second solenoid-actuated control valves, a holding circuit arranged to maintain said first and second valves energized during movement of the slide in one direction so that when fluid under pressure is passed thereto the slide and cam move intermittently in the same direction, a limit switch on the slide actuated by and in timed relation with the longitudinal movement of the slide to actuate the third solenoid-actuated control valve to stop the longitudinal movement of the slide after it has moved through a predetermined distance and to start the longitudinal movement of the cam to reposition the truing tool for truing another portion of the grinding wheel, a second limit switch on said slide actuated by and in timed relation with the movement of said cam to actuate said third solenoid-actuated control valve to stop the movement of the cam and to start the next longitudinal movement of the slide, and a third limit switch actuated by said slide at the end of its movement in one direction to deenergize the first and second control valves during the return stroke of said slide so that the direction of movement of the slide and cam are reversed on the return stroke of the truing tool.

9. In a grinding wheel truing apparatus as claimed in claim 5, in combination with the parts and features therein specified of a pawl and ratchet mechanism carried by said sleeve which is operatively connected to actuate said feeding mechanism, an adjustable screw to actuate said pawl when the slide reaches the end of its movement in one direction to advance the truing tool before the return movement of the slide, and means including an adjustable cam on said base to actuate said pawl when the slide reaches the end of its traverse in the opposite direction so as to advance the truing tool for the next truing cycle.

10. In a grinding wheel truing apparatus as claimed in claim 5, in combination with the parts and features therein specified of a manually operable throttle valve operatively connected to the first cylinder to control fluid exhausting therefrom so as to control the speed of movement of the first piston and the slide so as to control traversing speed of the truing tool, and an independent manually operable throttle valve operatively connected to the second cylinder to control fluid exhausting therefrom so as to control the speed of movement of the cam.

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