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O. E. HILL

2,659,358

GRINDING WHEEL TRUING APPARATUS

Filed May 8, 1951

4 Sheets-Sheet 1

Fig. 2

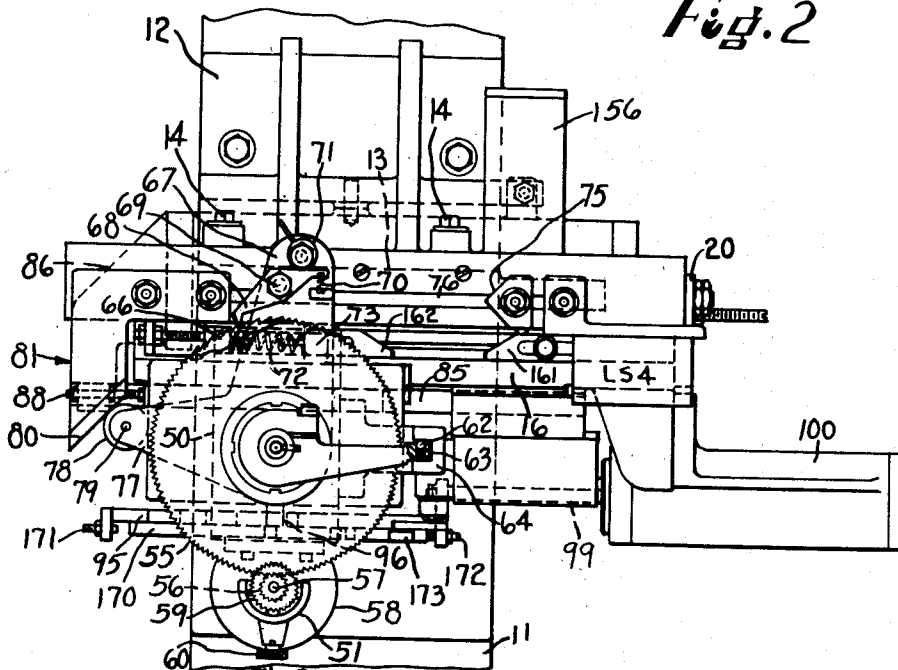
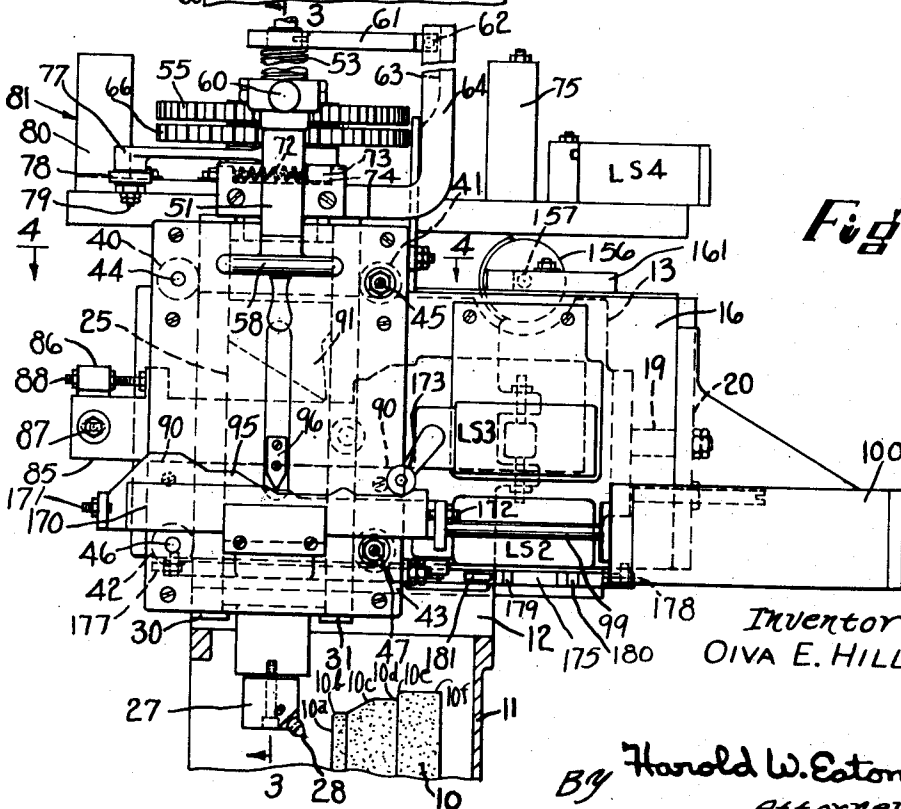


Fig. 1



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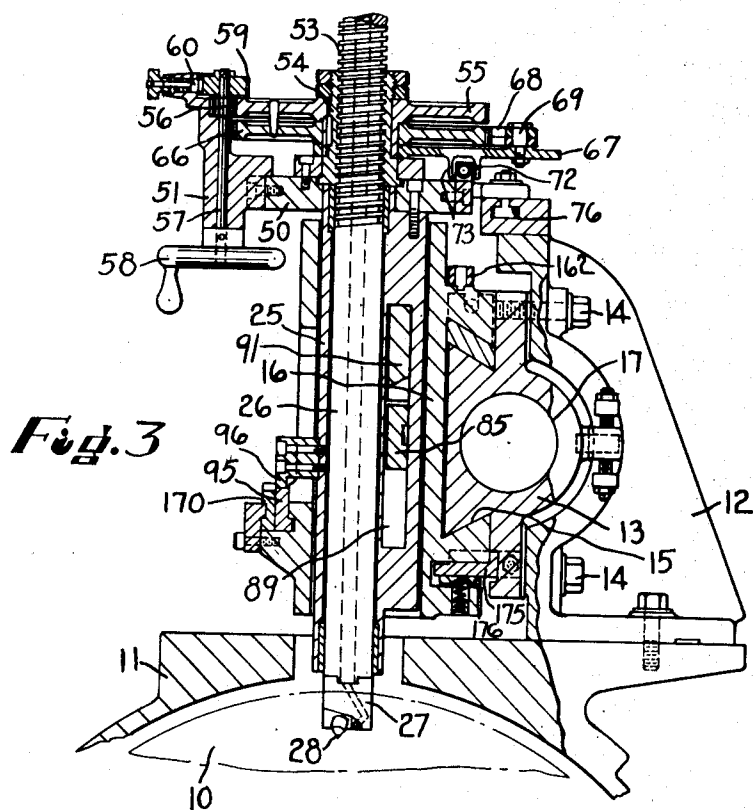
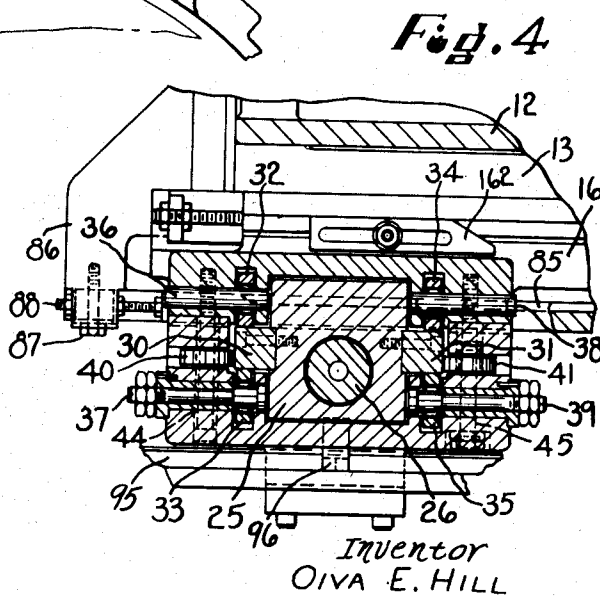
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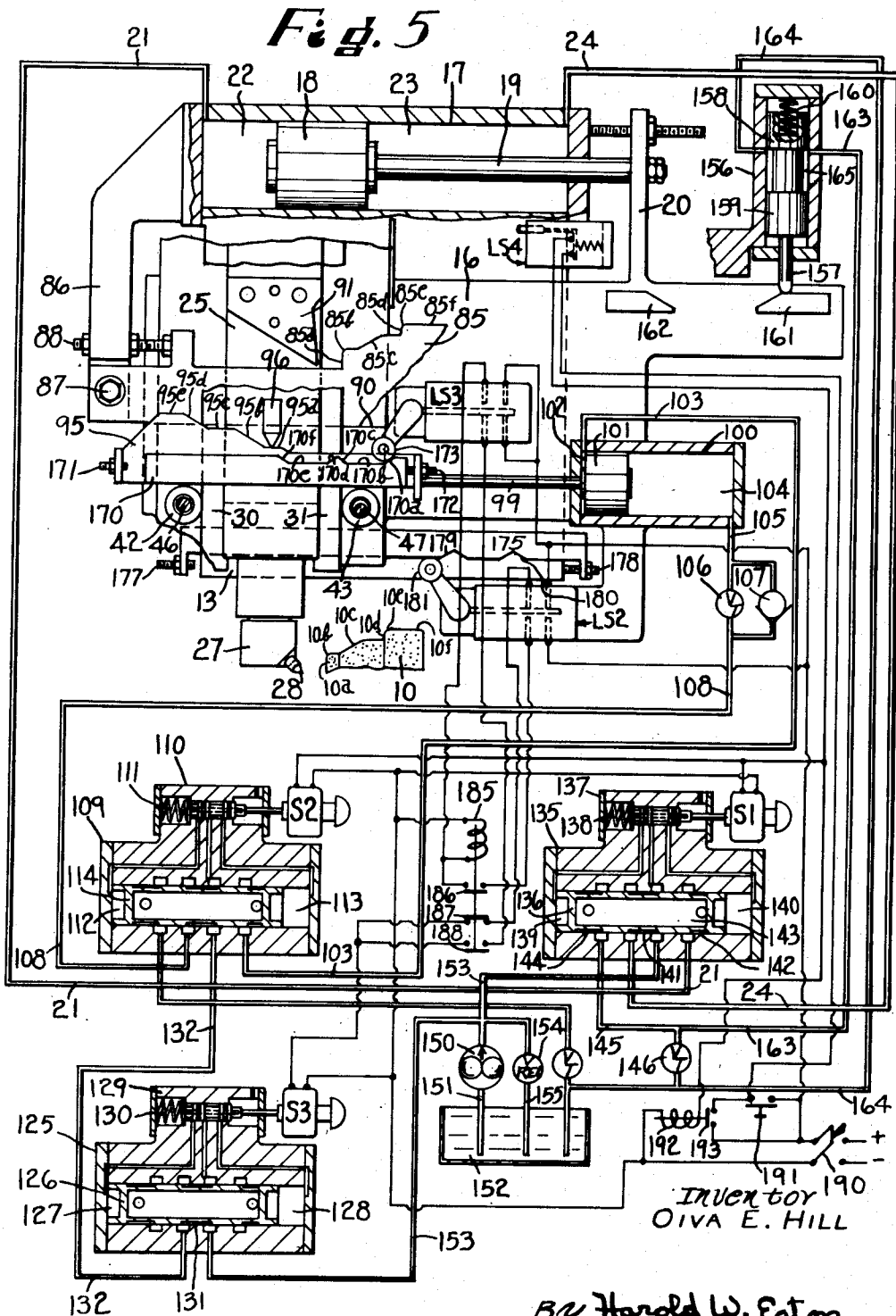
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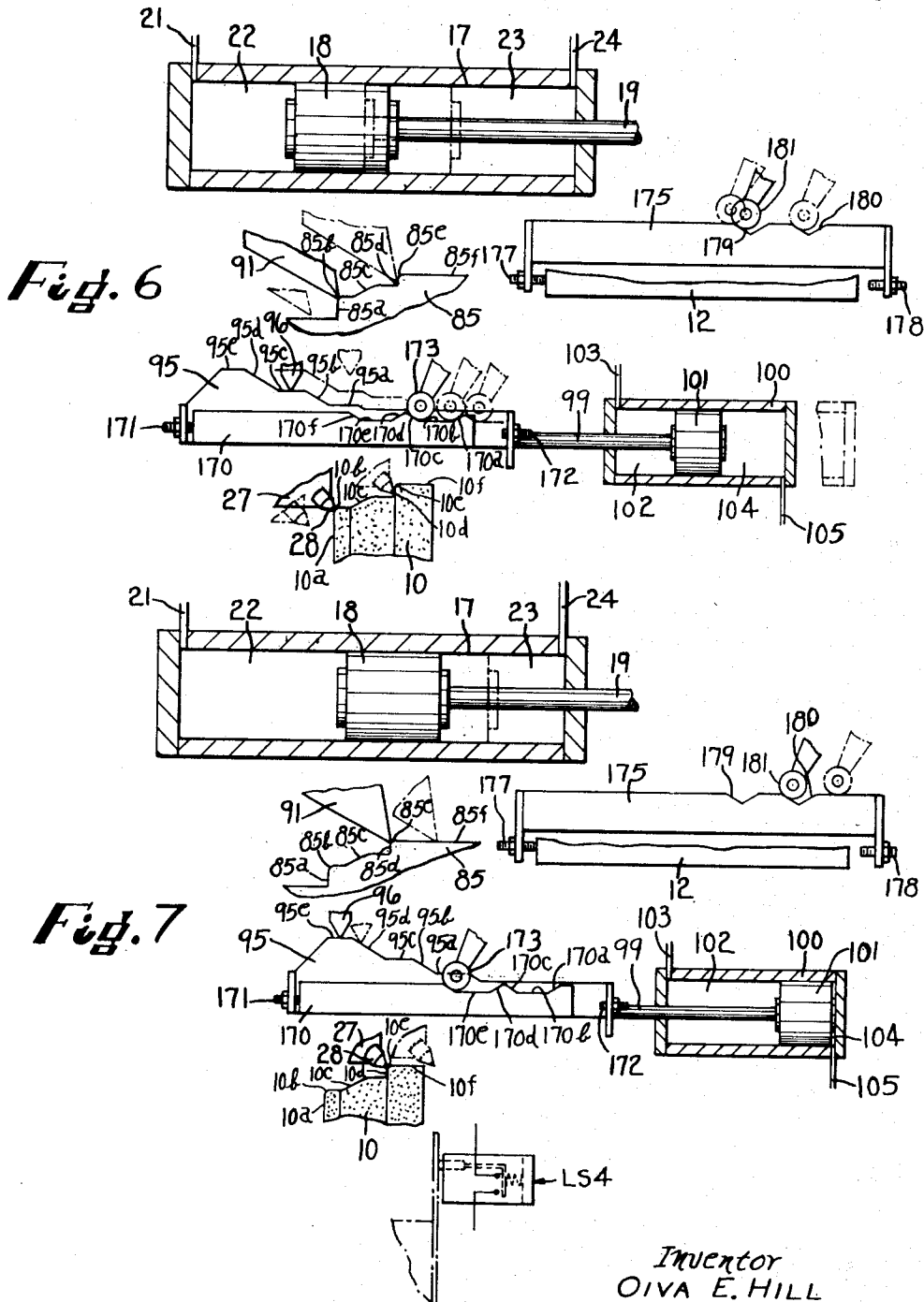
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GRINDING WHEEL TRUING APPARATUS

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UNITED STATES PATENT OFFICE

2,659,358

GRINDING WHEEL TRUING APPARATUS

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Application May 8, 1951, Serial No. 225,199

5 Claims. (Cl. 125—11)

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The invention relates to a grinding wheel truing apparatus, and more particularly to a truing apparatus for truing a formed face on the periphery of a grinding wheel. The present invention relates to a modified form of the truing apparatus disclosed in my copending application, Serial No. 183,775, filed September 8, 1950.

One object of the invention is to provide a simple and thoroughly practical truing apparatus for truing an irregular shape on the periphery of the grinding wheel having for example spaced portions of different diameters and an irregular surface therebetween. Another object is to provide an hydraulically-actuated electrically-controlled truing apparatus successively to true the periphery of a grinding wheel having spaced portions of different diameters and an irregular surface therebetween. Another object of the invention is to provide a truing apparatus with an hydraulically-actuated cam mechanism automatically to position the truing tool successively to true multiple diameters on a single grinding wheel and a formed face therebetween. Another object is to provide an hydraulically operated traverse mechanism for a truing tool and an hydraulically operated cam mechanism actuated in timed relation therewith successively to position the truing tool for truing portions of the periphery of the wheel to be trued. Another object is to provide an hydraulically operated cam control mechanism in timed relation with the traversing movement of the truing tool to position the truing tool to true spaced portions of varying diameters combined with a master cam and a follower for generating an irregular formed face therebetween. 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 formed wheel truing apparatus;

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

Fig. 3 is a vertical sectional view, taken approximately on the line 3—3 of Fig. 1, through the truing apparatus;

Fig. 4 is a horizontal sectional view, taken approximately on the line 4—4 of Fig. 1;

Fig. 5 is a combined hydraulic and electrical

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diagram of the control and actuating mechanism for the truing apparatus;

Fig. 6 is a fragmentary diagrammatic view showing the positions of the parts as the truing tool traverses toward the right; and

Fig. 7 is a similar fragmentary diagrammatic view showing the positions of the parts as a further traversing movement of the truing tool toward the right.

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 as shown in Fig. 1, or if desired may be a plurality of adjacent grinding wheels having a peripheral formed face thereon 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 14. The slide base 13 is provided with a dovetailed slideway 15 which mates with a correspondingly shaped dovetailed slideway on a longitudinally movable slide 16. The slide 16 is arranged to traverse longitudinally in a direction parallel to the axis of rotation of the grinding wheel 10. An hydraulically operated mechanism is provided for traversing the slide 16 longitudinally comprising an hydraulic cylinder 17 which is formed integral with the slide base 13. The cylinder 17 contains a slidably mounted piston 18 mounted on one end of a piston rod 19. The other end of the piston rod 19 is fastened to a bracket 20 formed integral with the longitudinally movable slide 16. When fluid under pressure is passed through a pipe 21 into a cylinder chamber 22 (Fig. 5), the piston 18 together with the slide 16 will be moved longitudinally toward the right. During this movement of the piston 18, fluid within a cylinder chamber 23 may exhaust through a pipe 24. A suitable fluid pressure system and a control mechanism therefor for supplying fluid under pressure to the cylinder 17 will be hereinafter described.

The longitudinally movable slide 16 serves as a support for a transversely movable vertically arranged sleeve 25. The sleeve 25 is preferably square in cross section as indicated in Fig. 4. The sleeve 25 is provided with a central aperture for supporting a vertically movable spindle 26. The spindle 26 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 10 as will be hereinafter described.

The sleeve 25 is provided with a pair of vertically extending ribs or slides 30 and 31 which serve as guides for controlling the vertical movement of the sleeve 25. A plurality of rollers 32, 33, 34 and 35 (Fig. 4) are mounted on studs 36, 37, 38 and 39 respectively. The rollers 32, 33, 34 and 35 are arranged to engage the opposite faces of the slides 30 and 31 to support the sleeve 25 having free vertical sliding movement. The studs 37 and 39 are preferably provided with eccentric portions for supporting the rollers 33 and 35 to facilitate a transverse adjustment of the rollers so as to take up lost motion between the sliding parts. A similar set of rollers (not shown) are provided for supporting the lower end of the slides 30 and 31.

Similarly a plurality of rollers 40, 41, 42 and 43 are provided for engaging the opposed side faces of the slides 30 and 31. These rollers are rotatably supported on studs 44, 45, 46 and 47 respectively. The studs 45 and 47 are preferably provided with eccentric portions for supporting the rollers 41 and 43 to facilitate a transverse adjustment of the rollers to take up backlash between the sliding parts. It will thus be seen that an anti-friction sliding support has been provided for the sleeve 25 so that it may be freely moved in a vertical direction to carry the truing tool 28 in the desired and predetermined path to true a predetermined shape on the periphery of the grinding wheel 10.

A suitable adjusting mechanism is provided for adjusting the spindle 26 relative to the sleeve 25 to facilitate either a manual adjustment of the truing tool or diamond 28 or an automatic feeding movement thereof during a truing operation. The upper end of the sleeve 25 is provided with an integral flange 50 which serves as a support for a bracket 51. The upper end of the spindle 26 is provided with a screw thread 53 which meshes with a surrounding nut 54. The nut 54 is rotatably supported on the flanged portion 50 of the sleeve 25. A gear 55 is keyed to the nut 54. The gear 55 meshes with a pinion 56 mounted on the upper end of a vertically arranged rotatable shaft 57. The shaft 57 is rotatably mounted within the bracket 51 and is provided at its lower end with a manually operable hand wheel 58. It will be readily apparent from the foregoing disclosure that rotation of the hand wheel 58 will be transmitted through the shaft 57, the pinion 56, the gear 55, to rotate the nut 54 and thereby to impart an axial adjustment of the truing tool spindle 26.

In order to hold the nut 54 in adjusted position, a serrated wheel 59 is fixedly mounted on the upper end of the shaft 57. A spring pressed pawl 60 mounted on the bracket 51 is arranged to engage the serrated wheel 59 and thereby to hold the feed nut 54 in adjusted position.

In order to steady the upwardly extending portion of the feed screw 53, an arm 61 is clamped around a cylindrical surface formed on the upper end of the screw 53 (Figs. 1 and 2). The right-hand end of the arm 61 is provided with a spring pressed ball 62 which rides in a vertically arranged groove 63 formed in a vertically extending bracket 64. The bracket 64 is fixedly mounted on the flange 50 of the sleeve 25. It will be readily apparent from the foregoing disclosure that the arm 61 serves to hold the screw 53 and the spindle 26 against rotary motion but allows a free axial movement thereof.

It is desirable to provide an automatically actuated mechanism for imparting a feeding movement to the truing tool at the ends of its longitudinal traversing movement. This is preferably accomplished by a pawl and ratchet mechanism comprising a ratchet wheel 66 which is keyed to the nut 54 (Fig. 3). A pawl carrier 67 (Figs. 1, 2 and 3) is rotatably mounted on the nut 54 and is provided with a pivotally mounted feed pawl 68. The feed pawl 68 is supported by a stud 69 fastened to the pawl carrier 67. A compression spring 70 serves normally to maintain the pawl 68 in operative engagement with the ratchet wheel 66. A manually operable rotatable eccentric 71 (Fig. 2) is provided to facilitate rocking the pawl 68 to an inoperative position if desired so as to facilitate a manual adjustment of the truing tool spindle 26. A compression spring 72 normally urges the pawl carrier 67 in a clockwise direction (Fig. 2) with a stud 73 in operative engagement with a stop surface 74 which is fixedly mounted on the flange 50 of the sleeve 25.

An automatically operated mechanism is provided for actuating the pawl carrier 67 at the ends of the traversing movement of the truing tool to facilitate an automatic downward feed of the truing tool 28 before each pass of the tool across the peripheral face of the grinding wheel 10. When the slide 16 approaches the right-hand end of its stroke, the pawl carrier 67 engages an adjustable dog 75 which serves to rock the pawl carrier 67 in a counterclockwise direction so as to impart a predetermined downward feeding movement to the truing tool 28. The adjustable dog 75 is adjustably supported by a T-slot 76 formed in the upper surface of the bracket 12. The height of the dog 75 is sufficient to allow maximum vertical movement of the spindle 26 relative to the sleeve 25.

The pawl carrier 67 is provided with a laterally extending arm 77 which supports a roller 78 on a stud 79. The roller 78 is arranged in the path of a cam face 80 formed on an adjustable dog 81 so that when the slide 16 approaches the left-hand end of its stroke, the pawl carrier 67 is rocked in a counter-clockwise direction so as to impart a predetermined down feeding movement to the truing tool 28. The height of the cam face 80 is sufficient to allow maximum vertical movement of the spindle 26 relative to the sleeve 25. The dog 81 is adjustably supported by the T-slot 76. It will be readily apparent from the foregoing disclosure that when the slide 16 traverses toward the right, the pawl carrier 67 will move into engagement with the dog 75 as the slide approaches the right-hand end of its stroke thereby imparting a down feeding movement to the truing tool 28 before the return stroke of the slide 16. Similarly when the slide 16 travels toward the left, the roller 78 will engage the cam face 80 on the dog 81 as the slide 16 approaches the left-hand end of its stroke to impart a down feeding movement of the truing tool 28.

A suitable forming mechanism is provided for generating a predetermined shape on the periphery of the grinding wheel 10. This mechanism may comprise a forming bar 85 which is anchored to a bracket 86 by means of a clamping bolt 87. An adjusting screw 88 serves to precisely adjust the forming bar 85 in a longitudinal direction. The bracket 86 is fixedly supported on the fixed bracket 12. The forming bar 85 extends through an elongated slot 89 (Fig. 3)

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formed in the sleeve 25 and is arranged to slide upon a slide surface 90 formed on the longitudinally movable slide 16. A follower 91 is fixedly mounted on the sleeve 25 and is arranged to follow a portion of the form on the bar 85 during the longitudinal movement of the slide 16 in a manner to be hereinafter described.

A hydraulically operated lifting mechanism is provided for causing a vertical motion of the sleeve 25 to true a shouldered portion on the grinding wheel. This mechanism may comprise a slide bar 95 which is slidably supported on the longitudinally movable slide 16. A follower 96 is fixedly mounted on the sleeve 25 and is arranged to be actuated by the bar 95 when it is moved longitudinally relative to the slide 16.

The bar 95 is arranged to be traversed longitudinally relative to the slide 16 by an hydraulically operated mechanism comprising a cylinder 100 which is fixedly mounted on the slide 16. The cylinder 100 contains a slidably mounted piston 101 which is connected to one end of a piston rod 99. The other end of the piston rod 99 is connected to the slide bar 95. When fluid under pressure is admitted through a pipe 103 into a cylinder chamber 102, the piston 101 together with the piston rod 99 and the slide bar 95 are moved toward the right. During this movement of the piston 101, fluid within a cylinder chamber 104 exhausts through a pipe 105, a throttle valve 106 is provided in the pipe line 105 to regulate the rate of exhaust of fluid from the chamber 104 thereby determining the rate of longitudinal movement of the slide bar 95. A ball check valve 107 is provided so that when fluid under pressure is passed through a pipe 108, it may bypass the throttle valve 106, through the ball check valve 107 into the cylinder chamber 104 so that the piston 101 may be moved toward the left at a relatively fast rate of speed.

A fluid operated control valve 109 is provided to control the admission to and exhaust of fluid from the cylinder 100. This control valve 109 comprises a pilot valve 110 which is normally held in a right-hand end position by a compression spring 111. A solenoid S2 is provided which when energized serves to shift the pilot valve 110 toward the left to reverse the flow of fluid so as to shift the control valve 109 into a reverse position. The pilot valve 110 serves to control the admission to and exhaust of fluid from a pair of opposed end chambers 112 and 113 to control the longitudinal shifting movement of a slidably mounted valve member 114.

An hydraulic system is provided for supplying fluid under pressure for actuating the various parts of the truing apparatus comprising a motor driven fluid pump 150 which draws fluid through a pipe 151 from a fluid reservoir 152 and forces fluid under pressure through a pipe 153 to the control valves as will be hereinafter described. An adjustable pressure relief valve 154 is connected in the pipe line 153 to facilitate exhausting excess fluid under pressure through a pipe 155 into the reservoir 152.

A fluid operated control valve 125 is provided for controlling the admission of fluid to the control valve 109. This valve is a piston type valve comprising a slidably mounted valve member 126 which is moved endwise by the admission to an exhaust of fluid from end chambers 127 and 128 formed at the opposite ends thereof. The valve 125 includes a pilot valve 129 which is normally held in a right-hand end position by a compression spring 130. A solenoid S3 is provided

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for shifting the pilot valve 129 toward the left to facilitate reversing the position of the slidably mounted valve member 126. In the position of the valve 125 (Fig. 5) fluid under pressure passing through the pipe 153 may pass through a chamber 131 in the slidably mounted valve member 126 and pass out through a pipe 132 to the control valve 109. When the solenoid S3 is energized, the slidably mounted valve member 126 is moved toward the right into a right-hand end position which serves to cut off the flow of fluid to the control valve 109 and thereby to cut off the passage of fluid under pressure to the cylinder 100.

An hydraulically operated control valve 135 is provided for controlling the admission to and exhaust of fluid from the cylinder 17. This valve comprises a slidably mounted valve member 136. A pilot valve 137 is normally held in a right-hand end position by a compression spring 138. A solenoid S1 is provided which when energized serves to shift the pilot valve toward the left thereby shifting the valve member 136 toward the right. The pilot valve 137 serves to control the admission to and exhaust of fluid from a pair of end chambers 139 and 140 formed in opposite ends of the control valve 135. In the position of the valve 135 (Fig. 5), fluid under pressure in the pipe 153 passes through a valve chamber 141 and through the pipe 24 into the cylinder chamber 23 to cause the piston 18 to move toward the left. During the movement of the piston 18 toward the left, fluid within the cylinder chamber 22 may exhaust through the pipe 21 into a valve chamber 142, through a central passage 143 in the valve member 136, through a valve chamber 144 and exhaust through a pipe 145 and a throttle valve 146 into the reservoir 152. The throttle valve 145 serves to control the rate of exhaust of fluid and thereby determines the rate of traversing movement of the piston 18.

It is desirable to provide means for bypassing fluid around the throttle valve 146 so that the slide 16 may move rapidly during idle portions of its stroke. This mechanism may comprise a bypass valve 156 which is preferably a piston type valve comprising a valve stem 157 having a pair of spaced valve pistons 158 and 159 formed integrally therewith. A compression spring 160 normally serves to urge the valve stem 157 downwardly into the path of a pair of spaced adjustable dogs 161 and 162 which are carried by the slide 16. A pair of fluid pipes 163 and 164 are connected to opposite sides of the valve 156 and in the position as shown in Fig. 5 allow fluid to bypass through a valve chamber 165 formed between the valve pistons 158 and 159 so that unrestricted flow of fluid may bypass the throttle valve 146 thereby facilitating a rapid movement of the slide 16. It will be readily apparent from the foregoing disclosure that when the valve stem 157 rides down the slope of the dog 161, the compression spring 160 will cause a downward movement of the valve stem 157 so that the valve piston 158 cuts off the passage of fluid between the pipes 163 and 164 thus rendering the bypass valve 156 inoperative so that the throttle valve 146 thereafter controls the rate of movement of the slide 16.

A suitable electrical control apparatus is provided for controlling the energization of solenoids S1, S2 and S3 so as to control the admission to and exhaust of fluid from the cylinders 17 and 100. As illustrated in Figs. 3 and 5, a slide bar 170 is slidably supported on the lon-

gitudinally movable slide 16 in sliding contact with the slide bar 95. The slide bar 170 is held in frictional engagement with the slide 16 so that the bar 95 may be moved longitudinally by the piston 101 without moving the bar 170 until the lost motion between the adjustable stop screws 171 and 172 is taken up. The upper surface of the slide bar 170 is provided with a plurality of surfaces 170a, 170b, 170c, 170d, 170e and 170f which are arranged in the path of an actuating roller 173 of the limit switch LS3.

Another slide bar 175 (Figs. 3 and 5) is slidably supported by the slide 16 and is held in frictional engagement therewith by a friction plate 176 (Fig. 3). The slide bar 175 is arranged so that it moves longitudinally with the slide 16 until the lost motion is taken up between adjustable stop screws 177 and 178, carried by the bar 175 and end surfaces of the slide base 13. The slide bar 175 is provided with a pair of spaced notches 179 and 180 into which an actuating roller 181 of the limit switch LS2 may drop as the slide 16 and bar 175 move longitudinally so as to actuate the limit switch LS2 and thereby to control the energization and de-energization of the solenoid S3. The energization of the solenoid S3 is in part controlled by a magnetic switch 165 having a pair of normally open contactors 186 and 188 and a normally closed contactor 187.

A main control switch 190 is provided for connecting a source of electrical energy to the circuit. A manually operable starter switch 191 is provided for starting the truing cycle. Closing of the starter switch 191 serves to energize a magnetic switch 192 and thereby close a normally open contactor 193.

The operation of the improved formed wheel truing apparatus will be readily apparent from the foregoing disclosure. The main switch 190 is closed to render the electrical circuits operative. Closing of the main switch 190 serves to energize the solenoid S3 so that the valve member 126 is shifted toward the right thereby cutting off fluid under pressure from the pipe 132. The truing cycle may then be started by closing the push-button starter switch 191 which serves to energize the magnetic switch 192 which sets up a holding circuit. The closing of the starter switch 191 serves to energize the solenoids S1 and S2 which remain energized during the traversing movement of the slide 16 to the right. Fluid under pressure from the pump 150 passes through the control valve 135, through the pipe 21 into the cylinder chamber 22 to start movement of the piston 18 and the slide 16 toward the right. Due to the fact that the bypass valve 156 is opened, the slide 16 and truing tool 23 travel first at a relatively fast rate until the follower 91 is about to engage the surface 85a of the template 85 and the truing tool 28 is about to contact the side face 10a of the grinding wheel 10. At this time the valve stem 157 rides down the sloping surface of the dog 161 thereby cutting off the bypassing of fluid between the pipes 163 and 164 so that thereafter the fluid exhausting from the cylinder 17 is controlled by the throttle valve 146. Fluid under pressure remains within the cylinder chamber 22 during the entire traversing movement of the piston 18 toward the right. Engagement of the follower 91 with the side face 85a of the template 85 serves to stop the movement of the slide 16 toward the right with the truing tool 28 in engagement with the side face 10a of the grinding wheel 10.

When the follower 91 moves into engagement with the surface 85a of the template 85, the slide bar 175 has shifted longitudinally relative to the slide base 13 so that the stop screw 177 is in engagement therewith. The roller 181 of the limit switch LS2 rides into the groove 179 thereby shifting the limit switch LS2 to open the upper contacts thereof so as to break a circuit through contactor 187 of switch 185 to de-energize the solenoid S3 so that fluid under pressure may pass through the pipe 132, through the control valve 109, through the pipe 168 into the cylinder chamber 102 to cause the piston 101 to move toward the right at a speed governed by the throttle valve 106. Movement of the piston 101 toward the right causes a corresponding movement to be imparted to the slide bar 95. During the initial movement of the slide bar 95, the slide bar 170 remains stationary until the stop screw 171 moves into engagement with the left-hand end thereof. As the slide bar 95 moves toward the right, the follower 95 moving up the inclined surface 95b of the slide bar 95 imparts a vertical movement to the sleeve 25 so that the follower 91 rides up the side face 85a of the template 85 and the truing tool 28 moves upwardly along the side face 10a of the grinding wheel 10 to true the same. When the slide bar 170 moves toward the right, the roller 173 swings in a counterclockwise direction to actuate the limit switch LS3 thereby energizing the magnetic switch 185. As the follower 91 reaches the radius 10b of the grinding wheel 10, the pressure within the cylinder chamber 22 moves the piston 18 toward the right and the shape of the template 85 controls the vertical movement of the follower 91 to generate the radius 10b on the grinding wheel 10 and also the formed surface 10c is generated by the follower 91 riding up the surface 85c of the template 85.

During the movement of the slide bar 95 toward the right to move the surface 95c into the position illustrated in Fig. 6, the roller 173 rides along the notch 170b maintaining the limit switch LS3 with the upper contacts closed to maintain the magnetic switch 165 energized until the roller 173 engages the inclined surface 170c which serves to shift the limit switch LS3 into the position illustrated in Fig. 5 thereby opening the circuit to the coil of the magnetic switch 165. The roller 181 is in engagement with the notch 179 of the slide bar 175 so that the lower contacts of the limit switch LS2 are closed thereby setting up a holding circuit to maintain the magnetic switch 185 energized and the solenoid S3 deenergized. The solenoid S3 remains deenergized until the piston 101 again moves and actuates the limit switch LS3 to energize magnetic switch 185. During the latter longitudinal movement of the piston 18 and the slide 16 toward the right, the roller 181 rides out of the notch 179 to shift the limit switch LS2 into the position illustrated in Fig. 5 so as to energize the solenoid S3 after the generation of the surface 10c on the wheel 10.

When the follower 91 approaches the shoulder 85d on the template 85 and the truing tool 28 approaches the shouldered face 10d on the grinding wheel 10, the roller 181 drops into notch 180 on the slide bar 175 thereby shifting the limit switch LS2 to deenergize the solenoid S3 so that the control valve 125 may again pass fluid under pressure through the pipe 132 to the control valve 109. Fluid under pressure passes from the control valve 109 through the pipe 103 to again

move the piston 101 toward the right. This movement causes a corresponding movement to the right of the slide bar 95 so that the follower 96 slides upwardly due to the sloping surface 95d on the slide bar 95 to raise the sleeve 25 and the truing tool 28 in a vertical direction to true the shouldered face 10d on the grinding wheel 10 as the follower 91 rides up the shouldered face 85d on the template 85. The upward movement of the follower 96 and truing tool 28 continues until the follower 96 is raised onto the portion 95e and the follower 91 has passed partially around the radius 85e on the template 85 so that the truing tool 28 is partially around the radius 10e of the grinding wheel 10. At this point fluid under pressure within the cylinder chamber 22 continues the piston 18 moving toward the right. The follower 91 following the radius 85e trues a corresponding radius 10e and thereafter a cylindrical portion on the grinding wheel 10.

As the truing tool 28 approaches the right-hand side face of the grinding wheel 10, the valve stem 157 rides up an inclined surface on the dog 162 to open the bypass valve 156 thereby speeding up the movement of the piston 18 and the slide 16 toward the right. Movement of the piston 18 and slide 16 toward the right continues until the slide 16 engages and opens the normally closed limit switch LS4 which serves to break the holding circuit thereby deenergizing the magnetic switch 192. Breaking the circuit and deenergizing switch 192 also serves to deenergize the solenoids S1 and S2 thereby shifting the control valves 135 and 109 respectively into the positions illustrated in Fig. 5 where they remain during the return traversing stroke of the piston 18 and slide 16 toward the left. The operation of the follower relative to the template 85 together with the controls above described operate in a similar manner on the traversing movement toward the left to again pass the truing tool across the face of the grinding wheel. Prior to the return stroke of the truing tool, the dog 75 engages the pawl carrier 67 and rocks it in counterclockwise direction. This movement serves through the pawl 68 and the ratchet wheel 66 to impart a down feeding movement to the truing tool 28 before the truing tool starts its return traverse toward the left. Similarly as the piston 18 and slide 16 approach the left-hand end of the traversing stroke, the roller 78 rides up the cam face 80 of the dog 81 to again impart a down feeding movement to the truing tool 28 so that it is positioned for the next truing operation.

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 slide base, a longitudinally reciprocable slide thereon, a transversely movable truing tool carrier on said slide, a truing tool thereon, means including a piston and cylinder on said base to traverse said slide longitudinally, means including a follower on said carrier which operatively en-

gages a forming bar on said slide to impart a controlled transverse movement to the truing tool carrier during longitudinal movement of the slide, means including a longitudinally movable cam on said slide, a follower on said carrier which engages said cam to impart a transverse movement to the carrier for truing a shouldered face on a grinding wheel being trued, means including a cylinder on said slide, a slidable piston therein which is operatively connected to said cam to move said cam longitudinally relative to said slide, said first follower and forming bar serving to hold said slide stationary during movement of said cam, and control means including a control valve mechanism operatively connected to both of said cylinders alternately and successively to traverse said slide longitudinally and to traverse said cam longitudinally relative to the slide to generate a predetermined contour on the operative face of a grinding wheel.

2. In a grinding wheel truing apparatus having a base, a longitudinally reciprocable slide, a transversely movable truing tool carrier on said slide, a truing tool adjustably mounted on said carrier, means including a follower on said carrier which operatively engages a forming bar on said slide to impart a controlled transverse movement to the truing tool carrier during longitudinal movement of the slide, a cylinder on said base, a piston slidably mounted therein which is operatively connected to said slide to traverse the slide longitudinally, means including a longitudinally movable cam on said slide which engages a follower on said carrier to impart a transverse movement to the truing tool carrier when the slide is stationary to true a shouldered face on a grinding wheel being trued, a cylinder on said slide, a piston slidable therein which is operatively connected to said cam to actuate said cam, and control means including a control valve mechanism operatively connected to both of said cylinders alternately and successively to traverse said slide longitudinally and to traverse said cam longitudinally relative to the slide so as to generate a predetermined contour on the operative face of a grinding wheel.

3. In a grinding wheel truing apparatus having a base, a longitudinally reciprocable slide thereon, a transversely movable truing tool carrier on said slide, a truing tool adjustably mounted on said carrier, a forming bar fixedly mounted relative to the base, a follower on said carrier which engages said forming bar to facilitate generating a predetermined shape on a peripheral portion of a grinding wheel being trued, means including a cylinder on said base, a piston slidable therein which is operatively connected to said slide to traverse said slide longitudinally, a longitudinally movable cam on said slide, a second follower on said carrier in operative engagement with said cam, means including a cylinder on said slide, a piston slidable therein which is operatively connected to said cam to move said cam longitudinally relative to said slide to cause a transverse movement of the carrier relative to the slide to facilitate truing a side face or a shouldered face on a grinding wheel being trued, said first follower and forming bar serving to hold the slide stationary during a transverse movement of the carrier for shoulder or side truing, and control means including a control valve mechanism operatively connected to both of said cylinders in-

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termittently to traverse said slide longitudinally and to traverse said cam longitudinally relative to said slide to generate a predetermined contour on the operative face of a grinding wheel.

4. In a grinding wheel truing apparatus having a base, a longitudinally reciprocable slide thereon, a transversely movable truing tool carrier on said slide, a truing tool adjustably mounted on said carrier, a follower on said carrier and a forming bar which is engaged by said follower and is fixedly mounted relative to the base to facilitate generating a predetermined shape on a portion of the operative face of a grinding wheel, a cylinder on said base, a piston slidable therein which is operatively connected to said slide to reciprocate said slide, means including a follower on said carrier and a longitudinally movable cam on said slide to facilitate a transverse movement of the carrier for side or shoulder truing, a cylinder on said slide, a piston slidable therein which is operatively connected to said cam to traverse said cam longitudinally relative to said slide, and electrically-controlled hydraulically-actuated mechanism operatively connected to both of said cylinders intermittently to traverse said slide longitudinally and to traverse said cam relative to said slide to generate a predetermined contour on the operative face of a grinding wheel.

5. In a grinding wheel truing apparatus, as claimed in claim 4, in combination with the parts and features therein specified of a solenoid-actuated control valve operatively connected to said

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slide cylinder to control the admission to and exhaust of fluid from the slide cylinder, a second solenoid-actuated control valve operatively connected to said cam actuating cylinder to control the admission to and exhaust of fluid from the cam actuating cylinder, a third solenoid-actuated control valve operatively connected to said second valve to control the admission of fluid to said second valve, a magnetic switch operatively connected to said third valve to actuate said third valve, means including a cycle start switch operatively connected to the first and second valves to energize the first and second valves to initiate a truing cycle, means including a switch on said slide which is actuated by and in timed relation with the longitudinal movement of said cam to energize said magnetic switch and the third valve to cause a transverse movement of the carrier for a side face or shoulder grinding operation.

OIVA E. HILL.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,171,516	Alvord	Sept. 5, 1939
2,248,463	Ott	July 8, 1941
2,302,854	Granberg	Nov. 24, 1942
2,433,027	Casella	Dec. 23, 1947
2,576,570	Castelli	Nov. 27, 1951

FOREIGN PATENTS

Number	Country	Date
536,300	Great Britain	May 9, 1941