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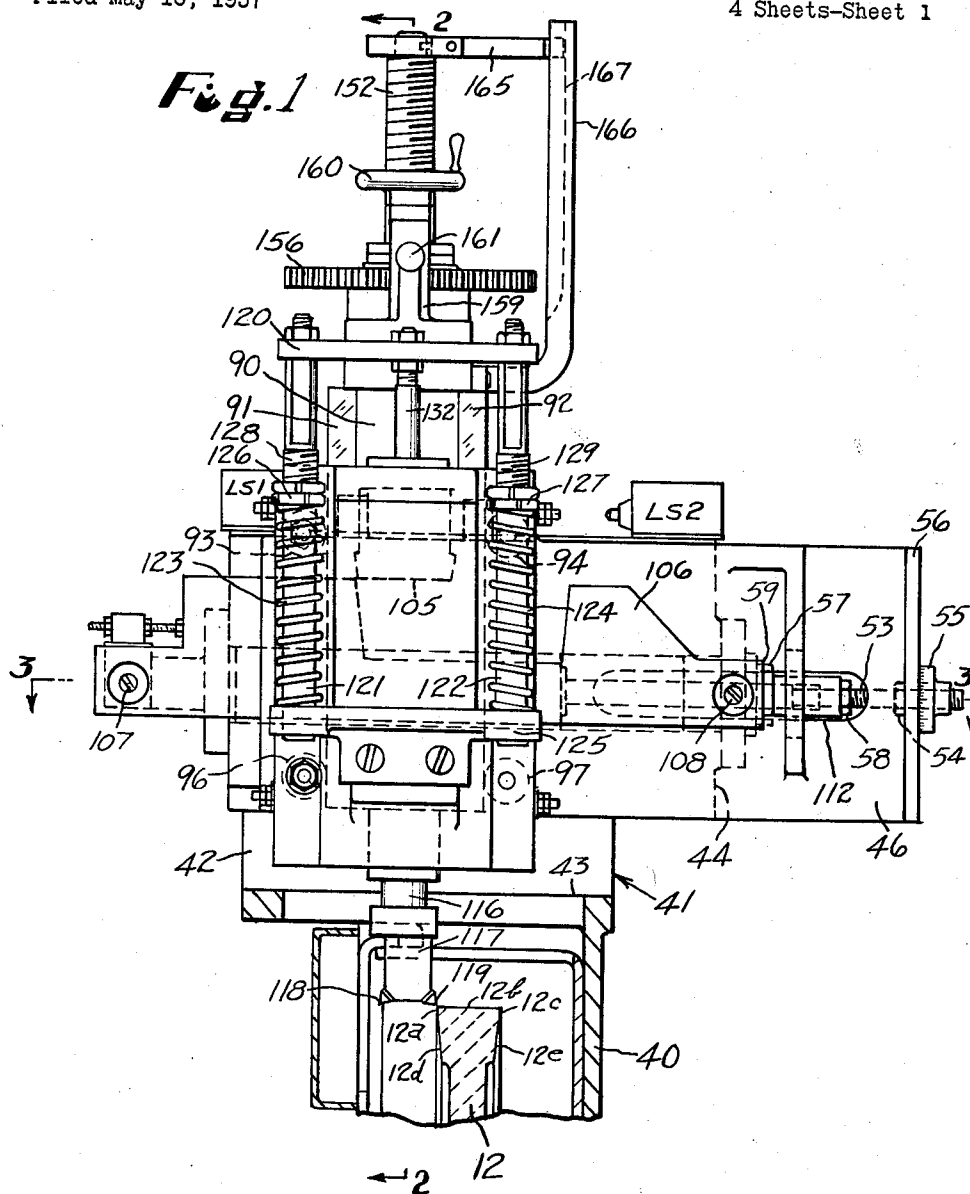
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2,861,561

GRINDING MACHINE-TRUING APPARATUS

Filed May 16, 1957

4 Sheets-Sheet 1



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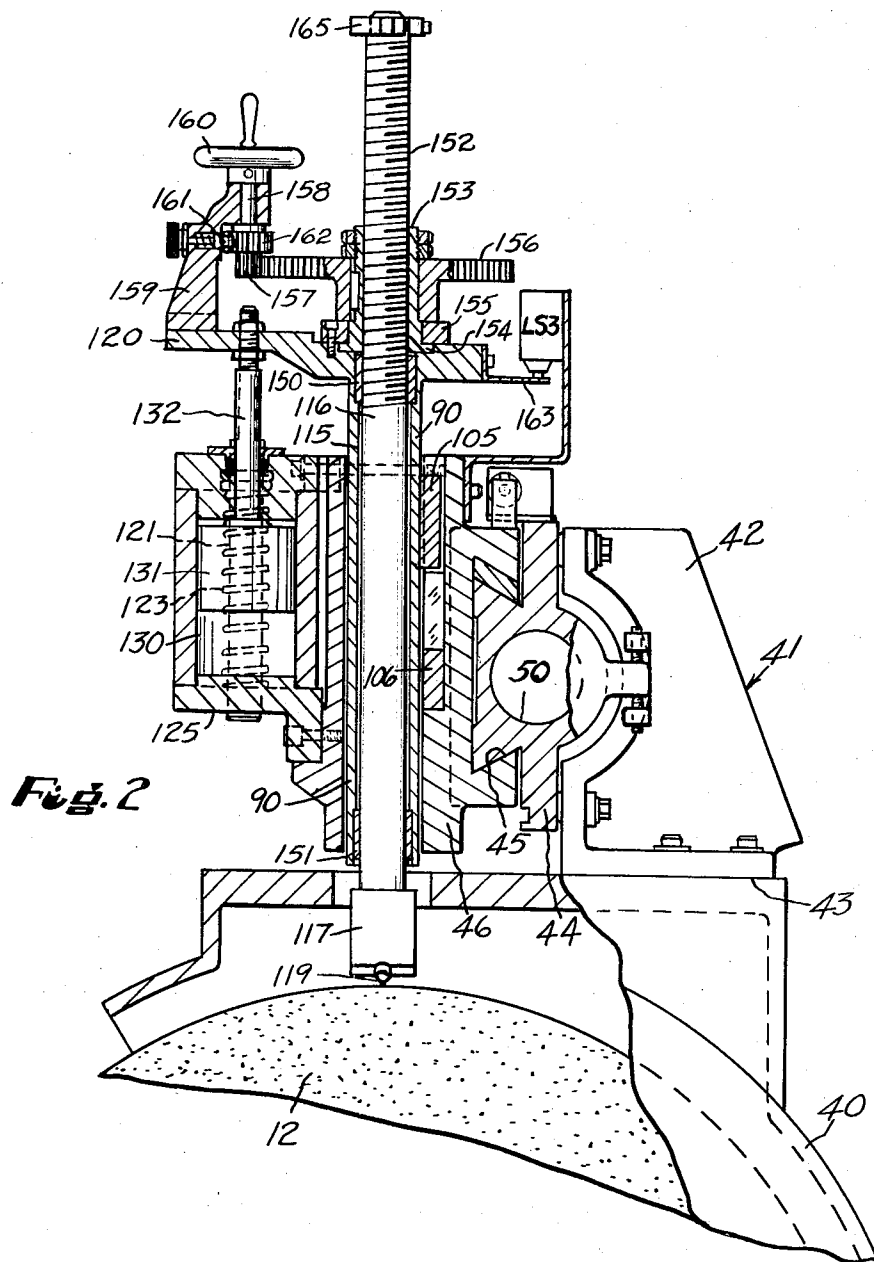
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Fig. 3

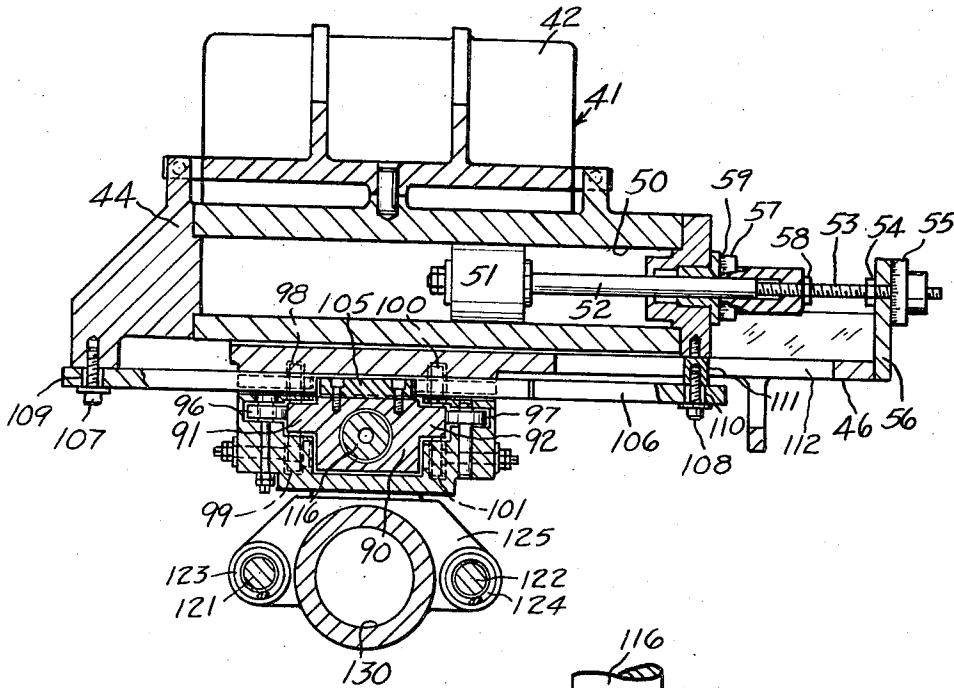
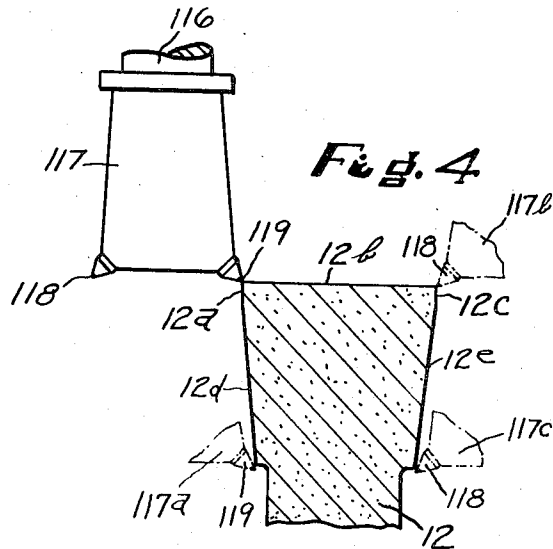


Fig. 4



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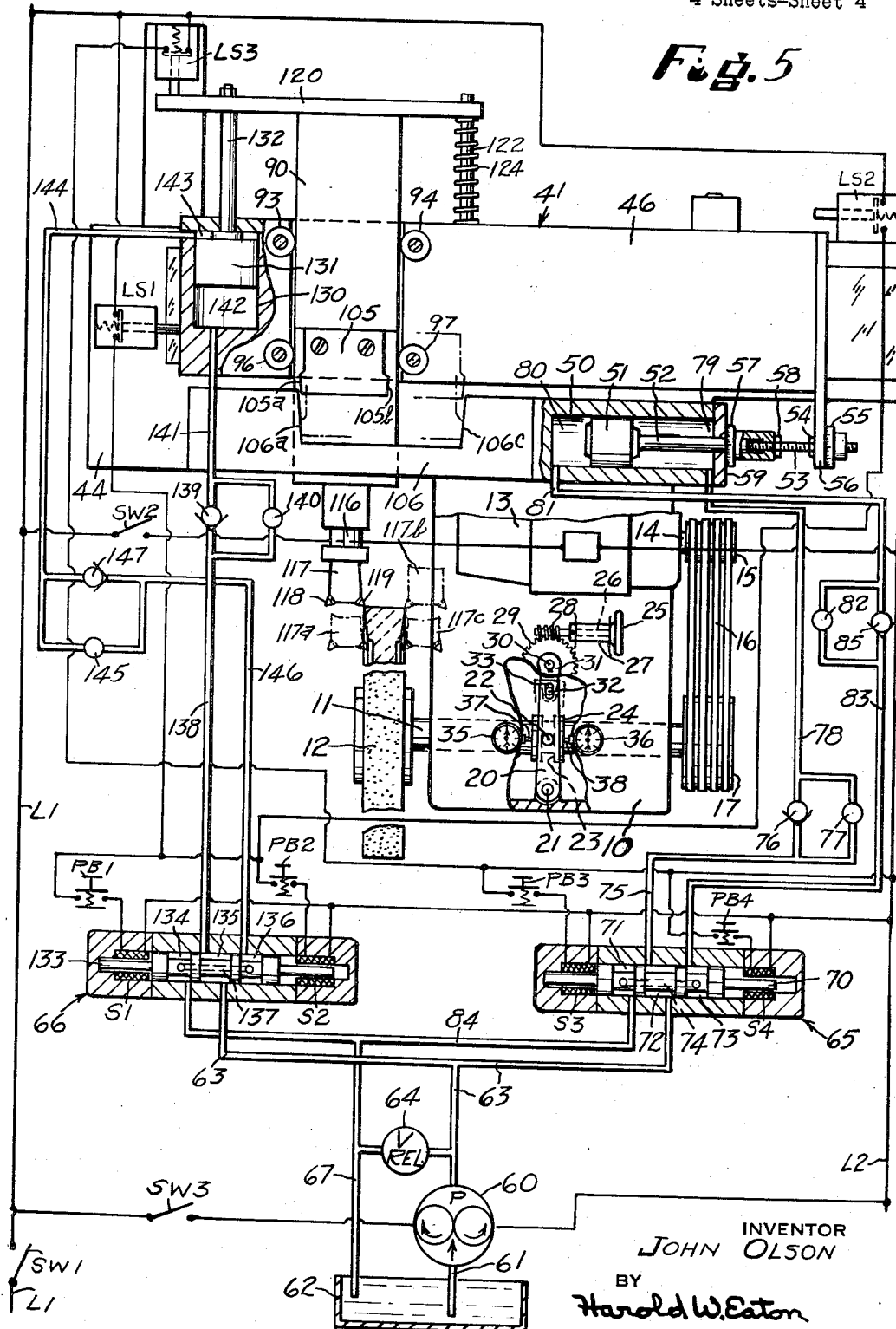
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Fig. 5



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GRINDING MACHINE-TRUING APPARATUS

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9 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 the periphery and opposed side faces of a grinding wheel. Another object is to provide a truing apparatus for truing opposed side faces of a grinding wheel with a plane face and an adjacent back tapered face. Another object is to provide a truing apparatus including a longitudinally movable slide and a transversely movable truing tool carrier both of which are actuated by fluid motors and a forming bar and follower arranged to facilitate truing a plane face and adjacent back tapered face on opposite sides of the grinding wheel.

A further object is to provide means for adjusting the end positions of the longitudinally movable slide to facilitate varying the extent of plane faces generated on opposite side faces of the grinding wheel. Another object is to provide a feeding mechanism for feeding the grinding wheel in an axial direction to facilitate truing a predetermined portion from each side face of the grinding wheel. Other objects will be in part obvious or in part pointed out hereinafter.

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, having parts broken away and shown in section.

Fig. 2 is a vertical sectional view, taken approximately on the line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view, taken approximately on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary diagrammatic view, on an enlarged scale, of a portion of the grinding wheel and the truing tools; and

Fig. 5 is a combined hydraulic and electric diagram showing the actuating mechanisms and the controls therefor.

A grinding wheel truing apparatus has been shown in the drawings for a grinding machine having a transversely movable wheel slide 10 which supports a rotatable wheel spindle 11. A grinding wheel 12 is mounted on the left hand end of the wheel spindle 11 (Fig. 4). A driving mechanism is provided for the wheel spindle 11 and the grinding wheel 12 comprising a motor 13 mounted on the upper surface of the wheel slide 10. The motor 13 is provided with a motor shaft 14 carrying a multiple V-groove pulley 15 which is connected by multiple V-belts 16 with a multiple V-groove pulley 17 which is mounted on the right hand end of the wheel spindle 11.

A wheel spindle positioning mechanism is provided for precisely positioning the grinding wheel 12 in an axial direction to facilitate a grinding wheel truing operation. This mechanism comprises a pivotally mounted yoke-shaped member 20 which is pivotally supported by a stud 21 within the wheel slide 10. The yoked member 20 is provided with diametrically opposed studs 22 (only one of which is illustrated in Fig. 5) which rides in an annular

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groove 23 formed in a spool shaped member 24 which is fastened to the wheel spindle 11.

An adjusting mechanism is provided for adjusting the position of the member 20 comprising a manually operable wheel 25 which is mounted on a rotatable shaft 26 journaled in a boss 27 formed integral with the wheel slide 10. The shaft 26 is provided with a worm 28 which meshes with a worm gear 29. The worm gear 29 is keyed onto a vertically arranged rotatable shaft 30. An arm 31 is keyed to the upper end of the shaft 30 and is provided with a stud 32 which engages an elongated slot 33 formed in the yoke-shaped member 20. It will be readily apparent from the foregoing disclosure that a rotary motion of the wheel 25 will be imparted through the mechanism above described to rock the yoke-shaped member 20 about the pivot stud 21 so as to impart a longitudinal axial movement to the wheel spindle 11. The direction of rotation of the wheel 25 serves to determine the direction of the axial movement of the wheel spindle 11.

To facilitate a precise axial positioning of the grinding wheel 12 during a truing operation, a pair of dial indicators 35 and 36 are mounted on the wheel slide 11. The dial indicators 35 and 36 are provided with actuating plungers 37 and 38 which bear against opposite end faces 25 of the spool shaped member 24.

The grinding wheel 12 is partially surrounded by a wheel guard 40, a fragment of which has been illustrated in Figures 1 and 2. The wheel guard 40 serves as a support for a grinding wheel truing apparatus 41 which is arranged in a manner to be hereinafter described to true the side faces 12a and 12c and the peripheral face 12b as indicated in Figure 1.

The truing apparatus 41 is supported by a bracket 42 which is fastened to an upper plane face 43 on the wheel guard 40. The bracket 42 serves as a support for a slide carrying member 44 having a dovetailed slideway 45 formed integral therewith. A longitudinally movable slide 46 having a mating dovetailed slideway is arranged to slide longitudinally on the way 45 in a substantially horizontal direction.

A hydraulically operated mechanism is provided for traversing the slide 46 longitudinally. This mechanism comprises a cylinder 50 which contains a slidably mounted piston 51. The piston 51 is connected to the left hand end of a piston rod 52 (Figs. 2 and 5). The right hand end of the piston rod 52 is provided with a screw threaded portion 53 which is connected to an end cap 56 mounted on the right hand end of the slide 46. A nut 54 on the threaded portion 53 engages the left hand end face of the end cap 56. A graduated nut or collar 55 on the threaded portion 53 engages the right hand end face of the end cap 56. By manipulation of the nuts 54 and 55, the effective length of the piston rod 52 may be varied. A graduated nut 57 mounted on the threaded portion 53 may be locked in an adjusted position by a lock nut 58. When the piston 51 moves toward the left, the nut 57 engaging a stop surface 59 serves to limit the movement of the piston 51 together with the longitudinally movable slide 56 toward the left.

A fluid pressure system is provided for supplying fluid under pressure to the mechanisms of the truing device comprising a motor driven fluid pump 60 which may be started and stopped by a manually operable switch SW3. The pump 60 draws fluid through a pipe 61 from a reservoir 62 and passes fluid under pressure through a pipe 63. A relief valve 64 connected to the pipe 63 serves to bypass excess fluid under pressure directly through a pipe 67 into the reservoir 62 and facilitate maintaining a substantially constant fluid pressure within the system. The pipe 63 conveys fluid under pressure to a pair of control valves 65 and 66. The control valve 65 serves to control the admission to and exhaust of fluid from the

cylinder 50. The valve 65 is a piston type valve comprising a slidably mounted valve member 70 having a plurality of spaced integral valve pistons to form a plurality of spaced valve chambers 71, 72 and 73. A central passage 74 in the valve member 70 serves to interconnect the valve chamber 71 with the valve chamber 73.

The valve 65 is actuated by a pair of solenoids S3 and S4. When the solenoid S3 is energized, the valve member 70 is moved into a right hand end position where it remains until the solenoid S4 is energized to shift the valve member 70 into a left hand end position. As shown in Figure 4 fluid under pressure from the pipe 63 enters the valve chamber 72 and passes through a pipe 75, through both a ball-check valve 76 and a throttle valve 77, through a pipe 78 into a cylinder chamber 79 to move the piston 51 together with the slide 46 toward the left into the position illustrated in Fig. 5 with the nut 57 engaging the stop surface 59. During this movement, fluid within a cylinder chamber 80 exhausts through a pipe 81, through a throttle valve 82, through a pipe 83 into the valve chamber 73, through the central passage 74 into the valve chamber 71 and exhausts through a pipe 84 and the pipe 67 into the reservoir 62. A ball-check valve 85 is provided between the pipes 81 and 83 so that when fluid under pressure is passed through the pipe 83 it may pass through both ball-check valve 85 and the throttle valve 82 into the cylinder chamber 80 to move the piston 51 toward the right at a rate controlled by the throttle valve 77. It will be readily apparent from the foregoing disclosure that by manipulation of the throttle valve 77 and 82, the speed of movement of the piston 51 and the slide 46 may be varied as desired.

The longitudinally movable slide 46 serves as a support for a vertically movable slide 90. The slide 90 is provided with a pair of diametrically opposite guide ribs 91 and 92 (Fig. 3). A plurality of pairs of anti-friction rollers 93-94 and 96-97 are arranged to engage the end faces of the ribs 91 and 92 to form an anti-friction support therefor. A plurality of pairs of anti-friction rollers 98-99 and 100-101 are provided for engaging the front and back faces of the ribs 91 and 92 to guide the slide 90 as it moves vertically. The vertical slide 90 is provided with a follower 105 which is arranged to engage a forming bar 106 which is adjustably mounted on the slide 46. The forming bar 106 is adjustably clamped to the slide 46 by a pair of spaced clamping screws 107 and 108 which pass through elongated slots 109 and 110 formed in the opposite ends of the forming bar 106 respectively and are screw threaded into portions of the slide supporting member 44. The screw 108 is preferably screw threaded into a block 111 which is in turn fastened to the member 44. The member 111 passes through an elongated slot 112 formed in the longitudinally movable slide 46. The vertically movable slide 90 is provided with a cylindrically shaped clearance hole 115 through which extends a shaft 116. The lower end of the shaft 116 supports a truing tool holder 117 having a pair of truing tools or diamonds 118 and 119.

A hydraulically operated mechanism is provided for moving the slide 90 vertically relative to the longitudinally movable slide 46. This mechanism comprises a cylinder 130 which is fixedly supported by the longitudinally movable slide 46. The cylinder 130 contains a vertically movable piston 131 which is connected to the lower end of a piston rod 132. The upper end of the piston rod 132 is connected to a plate or cross head 120 which is mounted on the upper end of the vertical slide 90. The piston and cylinder mechanism above described serves to impart a vertical movement to the vertical slide 90 to traverse the truing tools 118 and 119 respectively across the side faces of the grinding wheel 12 in a manner to be hereinafter described.

A safety mechanism is provided for moving the slide 90 into an uppermost position in a case of a failure of the fluid pressure mechanism. This mechanism com-

prises a pair of spaced parallel slide rods 121 and 122, the upper end of which are fixedly supported by the cross head 120. The lower ends of the rods 121 and 122 pass through a clearance hole formed within a plate 125 which is fixedly mounted on the slide 46. A pair of compression springs 123 and 124 surround the rods 121 and 122 respectively and are interposed between the plate 125 and nuts 126 and 127 which are adjustably supported by screw threaded portions 128 and 129 formed on the guide rods 121 and 122. By manipulation of the collars 126 and 127, the compression of the springs 123 and 124 may be varied as desired to exert a sufficient force on the vertical slide 90 to move it vertically into an uppermost position and to hold it in this position in case of failure of the fluid pressure system.

The control valve 66 is provided for controlling the admission to an exhaust of fluid from the cylinder 130. The valve 66 is a piston type valve having a slidably mounted valve member 133 which is provided with a plurality of integral valve pistons forming spaced valve chambers 134, 135, and 136. The valve member 133 is also provided with a central passage 137 which interconnects the valve chamber 134 with the valve chamber 136. In the position of the valve 66 (Fig. 5) fluid under pressure from the pipe 63 enters the valve chamber 135 and passes through a pipe 138, through both a ball-check valve 139 and a throttle valve 140, through a pipe 141 into a cylinder chamber 142 to move the piston 131 together with the slide 90 into an uppermost position as shown in Fig. 5. During the upward movement of the piston 131 and the slide 90, fluid within the cylinder chamber 143 exhausts through a pipe 144, through a throttle valve 145, through a pipe 146 into the valve chamber 136, through the central passage 137 into the valve chamber 134 and exhausts through the pipe 84 and the pipe 67 into the reservoir 62. A ball check valve 147 is provided between the pipes 144 and 146 so that when fluid under pressure passes through the valve 66 and the pipe 146, it may pass through both the ball-check valve 147 and the throttle valve 145, through the pipe 144 into the cylinder chamber 143 to cause a downward movement of the piston 131 and the slide 90 against the compression of the springs 123 and 124.

A suitable mechanism is provided for adjusting the shaft 116 relative to the vertical slide 90. The shaft 116 is supported in spaced bearings 150 and 151 carried by the vertical slide 90. The upper end of the shaft 116 is formed as a feed screw 152 which meshes with or engages a rotatable nut 153. The nut 153 is provided with an integral flange 154 which is supported within a recess formed in the cross head 120. A thrust collar 155 surrounding the nut 153 is fixedly mounted on the cross head 120 to take up the end thrust of the feed nut 153.

A gear 156 (Fig. 2) is keyed onto the nut 153 and meshes with a small gear 157. The gear 157 is mounted on the lower end of a rotatable shaft 158 which is rotatably journaled in a bracket 159. The bracket 159 is fixedly mounted on the cross head 120. A hand wheel 160 is pinned to the upper end of the shaft 158. It will be readily apparent from the foregoing disclosure that a rotary motion of the hand wheel 160 will be imparted through the mechanism above described to rotate the nut 153 and thereby impart a vertical adjustment to the feed screw 152 and the shaft 116. A spring pressed detent 161 carried by the bracket 159 is arranged to engage a serrated wheel or gear 162 to hold the shaft 158 in adjusted position. The cross head 120 is provided with a bracket 163 which is arranged to actuate a limit switch LS3 when the slide 90 is in its uppermost position.

An arm 165 is fastened to the upper end of the feed screw 152. The arm 165 is arranged to slide within a groove 167 formed in a bracket 166 so as to hold the shaft 116 and the feed screw 152 against rotary motion.

As illustrated, the truing apparatus is set up and arranged for truing the opposite side faces and the periph-

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ery of the grinding wheel 12. The opposite side faces adjacent to the periphery of the grinding wheel are formed as plane faces 12a and 12c which merge into back tapered faces 12d and 12e respectively to provide clearance on the side faces. The truing operation is performed by moving the truing tool holder 117 downwardly so that the truing tool 119 trues the plane face 12a with the follower 105 out of engagement with the forming bar 106. When the face 105a of the follower 105 moves downwardly into engagement with the face 106a of the forming bar 106, continued downward movement of the holder 117 causes the follower face 105a to slide down the face 106a of the forming bar thereby causing a longitudinal movement of the slide 46 toward the right against fluid under pressure in the cylinder chamber 79 so that the truing tool 119 trues the back tapered side face 12d on the grinding wheel 12. The holder 117 is then moved upwardly to again pass the truing tool 119 across the side faces 12d and 12a to true the same. The slide may then be traversed toward the right to pass the truing tools 119 and 118 across the peripheral face 12b to true the same.

When the piston 51 moves into engagement with the right hand end of the cylinder 50, the holder 117 is in position 117b. The holder 117 may then be moved downwardly from position 117b into position 117c (Fig. 5). During this movement of the holder 117, the truing tool 118 first trues the plane face 12c after which the face 105b of the follower 105 rides down the face 106c of the forming bar 106 to true the back tapered surface 12e on the grinding wheel 12. The holder 117 is then moved upwardly to again pass the truing tool across the faces 12e and 12c of the grinding wheel 12. The holder 117 may then traverse toward the left to again pass the truing tools 118 and 119 across the peripheral face 12b to true the same. The holder 117 may be fed downwardly by actuation of the hand wheel 160 before each pass across the peripheral face of the grinding wheel 12 to true the same to the desired and predetermined extent. The wheel spindle 11 may be adjusted axially by actuation of the hand wheel 25 before each pass of the truing tools across the side faces 12a—12d and 12c—12e to true the same to the desired and predetermined extent.

The extent of the plane faces 12a and 12c formed on the side faces of the grinding wheel 12 may be varied as desired. The graduated nut 55 may be adjusted relative to the screw 53 to vary the effective length of the piston rod 52 so as to vary the end position of the slide 46 as it moves toward the right thereby varying the gap between the face 105b of the follower 105 and the face 106c of the forming bar 106. Similarly the graduated nut 57 may be adjusted relative to the threaded portion 53 on the piston rod 52 to facilitate varying the left hand end position of the piston 51 and the slide 46 so as to vary the gap between the face 105a on the follower 105 and the face 106a on the forming bar 106.

If it is desired to increase the extent of the plane faces 12a and 12c the gap between the faces 105a and 105b of the follower 105 and the faces 106a and 106c respectively of the forming bar 106 may be increased so that the truing tools 118—119 travel a greater distance toward the axis of the wheel spindle 11 in a plane normal to the axis thereof before an endwise or axial motion is imparted to the grinding wheel 12 to generate the back tapered faces 12d and 12e. Similarly if it is desired to decrease the extent of the plane faces 12a and 12c, the gap between the follower 105 and the forming bar is decreased.

The hand wheel 25 is utilized to impart an axial feeding movement to the wheel spindle 11 and the grinding wheel 12 in either direction to facilitate truing the desired and predetermined amount from the side faces of the grinding wheel 12. By use of the dial indicators 35—36 the endwise positioning movement of the spindle

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11 may be precisely controlled. After a truing operation has been completed, the hand wheel 25 may be actuated to return the wheel spindle 11 and the grinding wheel 12 to a central position as indicated by the dial indicators 35—36 to position the grinding wheel 12 for a grinding operation.

As illustrated and described the follower 105 and the forming bar 106 are shaped and arranged to true a peripheral face and opposed back tapered frusto-conical side faces on a grinding wheel 12. If desired, shaped faces on both the periphery and sides of the grinding wheel may be trued by providing a follower and a forming bar which are shaped so as to produce the desired shape on the grinding wheel.

The operation of the truing apparatus will be readily apparent from the foregoing disclosure assuming all adjustments to have been previously made, the main switch SW1 is closed to supply power to the operating circuits. The switches SW2 and SW3 are closed to start the grinding wheel driving motor 13 and the motor for driving the fluid pump 60, respectively. Assuming the parts to be positioned as shown in Figure 5, the hand wheel 160 may be actuated to impart a down feeding movement to the truing tool holder 117, and the hand wheel 25 is actuated to move the wheel spindle 11 in an axial direction toward the left to position the grinding wheel 12 relative to the truing tool 119 for a side truing operation. The push button switch PB1 is then closed to shift the valve 133 toward the right to cause a downward movement of the piston 131 and the truing tool 119 to true the plane face 12a and the back-tapered face 12d on the grinding wheel 12. If it is desired to true an additional amount from the side face on the return upward movement of the truing tool 119, the hand wheel 25 may be again adjusted to cause a further axial movement toward the left of the wheel spindle 11 and the grinding wheel 12.

The push button switch PB2 may then be actuated to shift the valve member 133 toward the left into the position illustrated in Figure 5 so as to cause an upward movement of the piston 131 and the truing tool 119 to again true the back tapered side face 12d and the plane face 12a. The push button switch PB3 may then be closed to shift the valve member 70 toward the right to pass fluid under pressure into the cylinder chamber 80 to move the piston 51 together with the slide 46 toward the right thereby traversing the truing tools 119 and 118 across the peripheral face 12b. This movement toward the right continues until the truing tool holder reaches the position 117b (Fig. 5).

The hand wheel 25 may then be manipulated to adjust the wheel spindle 11 and the grinding wheel 12 axially toward the right to position the right hand side face of the grinding wheel for a side truing operation. The push button switch PB1 may be then actuated to shift the valve member 133 toward the right to start a downward movement of the piston 131 so that the truing tool holder 117 moves from position 17b into position 17c (Fig. 5). During this downward movement of the holder 117, the truing tool 118 first trues the plane face 12c and then the back tapered face 12b. When the truing tool holder 117 reaches the position 17c, the hand wheel 25 may again be actuated if it is desired to true an additional amount from the side faces 12e and 12c. The push button switch PB2 may then be actuated to shift the valve member 133 toward the left so as to cause an upward movement of the piston 131 and the truing tool holder 117 to shift it from position 17c into position 117b. During this movement of the holder 117, the truing tool 118 first trues the back tapered face 12e and thereafter the plane face 12c.

When the truing tool holder 117 reaches position 117b, the hand wheel 160 may be actuated to impart a downward feeding adjustment to the truing tool holder 117 to reposition the truing tool 118 and 119 for the next

pass across the peripheral face 12d of the grinding wheel 12. The push button switch PB4 may be then actuated to shift the valve member 70 into a left hand end position to traverse the piston 51 together with the slide 46 toward the right so as to traverse the truing tool holder 117 from position 117b into the full line position 117, as shown in Figure 5. During this movement of the truing tool holder 117 toward the left, the truing tools 118 and 119 pass across and true the peripheral face 12b of the grinding wheel 12. The traversing speed of the longitudinally movable slide 46 may be regulated by manipulation of the throttle valves 77 and 82. The return of the down feeding movement of the truing tool holder 117 and the upward movement thereof may be regulated by manipulation of the throttle valves 140 and 145.

It will thus be seen that there has been provided by this invention a grinding wheel truing apparatus in which the various objects hereinafter 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 are shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a grinding machine having a rotatable wheel spindle and a grinding wheel thereon; a grinding wheel truing apparatus including a frame, a longitudinally movable slide, a transversely movable truing tool carrier on said slide, a truing tool holder on said carrier having a truing tool for truing the peripheral and side face of a grinding wheel, means to move said slide longitudinally in either direction to facilitate traversing the truing tool across the peripheral face of the grinding wheel, means to control the end position of said slide to facilitate positioning the truing tool for a side truing operation means to move said carrier transversely in either direction relative to said slide to facilitate truing a plane face on the side face of the grinding wheel adjacent to the periphery, a forming bar on said frame, and a follower on said carrier which is shaped so as to impart a longitudinal movement to said slide during a portion of the transverse movement of said carrier to true a predetermined shape on the remainder of the side face of the grinding wheel.

2. In a grinding machine having a rotatable wheel spindle and a grinding wheel on said spindle; a grinding wheel truing apparatus including a frame, a longitudinally movable slide on said frame, a transversely movable truing tool carrier on said slide, a truing tool holder on said carrier having a pair of spaced truing tools for truing the periphery and opposite side faces of a grinding wheel, means to move said slide longitudinally in either direction, means to move said carrier transversely in either direction relative to said slide to facilitate truing a plane face on the side of the grinding wheel adjacent to the periphery thereof, means to control the end positions of said slide to facilitate positioning the truing tools for side truing operations, a forming bar on said frame, and a follower on said carrier which is shaped so as to impart a longitudinal movement to said slide after a predetermined transverse movement of the carrier so as to true a combined plane and a back-tapered side face adjacent to said plane face on the grinding wheel.

3. In a grinding machine as claimed in claim 2 in combination with the parts and features therein specified of means precisely adjust the wheel spindle axially to impart a positioning movement to the grinding wheel in either direction for a side truing operation, and means precisely to adjust the end positions of said slide to facilitate truing a predetermined plane side face on a grinding wheel before the follower engages the forming bar.

4. In a grinding machine, as claimed in claim 2, in combination with the parts and features therein specified

of means to precisely adjust the end positions of said slide to facilitate varying the initial spacing of the follower from the forming bar to facilitate truing predetermined plane faces on the opposite side faces of the grinding wheel adjacent to the periphery thereof, said follower being shaped and arranged to thereafter engage said forming bar so as to impart a longitudinal movement to said slide during the remainder of the transverse movement of the carrier so as to true a combined plane and a back-tapered face on the sides of the grinding wheel adjacent to said plane face.

5. In a grinding machine having a rotatable wheel spindle and a grinding wheel on said spindle; a grinding wheel truing apparatus including a frame, a longitudinally movable slide thereon, a transversely movable truing tool carrier on said slide, a truing tool holder on said carrier having a pair of spaced truing tools for truing the periphery and opposite side faces of a grinding wheel, a fluid motor to move said slide longitudinally in either direction, a control valve therefor, a fluid motor to move said carrier transversely in either direction relative to said slide to facilitate truing a plane face on the side of the grinding wheel adjacent to the periphery thereof, a control valve therefor, means to adjustably control the end positions of said slide to facilitate positioning the truing tool for truing a predetermined plane face on opposite sides of the grinding wheel, a forming bar on said frame, and a follower on said carrier which is shaped and arranged so as to impart a longitudinal movement to said slide during a portion of the traverse movement of the carrier so as to true a combined plane and a back-tapered side face on the grinding wheel.

6. In a grinding machine, as claimed in claim 5, in combination with the parts and features therein specified of yieldable means to move said carrier transversely to an inoperative position in case of fluid pressure failure.

7. In a grinding machine having a rotatable spindle and a grinding wheel thereon; a grinding wheel truing apparatus including a frame, a longitudinally movable slide, a transversely movable truing tool carrier on said slide, a truing tool holder on said carrier having a pair of spaced truing tools for truing the periphery and opposite side faces of the grinding wheel, a fluid motor to traverse said slide longitudinally in either direction to traverse the truing tools across the peripheral face of the grinding wheel, a control valve therefor, a fluid motor to move said carrier transversely in either direction relative to said slide to true a plane face on the opposite sides of the grinding wheel adjacent to the periphery thereof, a control valve therefor, a pair of adjustable stops precisely to control the end positions of said slide to position the truing tools for a side truing operation, a forming bar on said frame, and a follower on said carrier which is shaped and arranged to engage said forming bar after a predetermined transverse movement of the carrier so as to impart a longitudinal movement to said slide during the remainder of the transverse movement of the carrier to true a combined plane and a back-tapered side face on the grinding wheel.

8. In a grinding machine having a rotatable spindle and a grinding wheel thereon; a grinding wheel truing apparatus including a frame, a longitudinally movable slide thereon, a transversely movable truing tool carrier on said slide, a truing tool holder on said carrier having a pair of spaced truing tools for truing the periphery and opposite side faces of the grinding wheel, a piston and cylinder to move said slide longitudinally in either direction to facilitate traversing the truing tools across the peripheral face of the grinding wheel, a control valve therefor, a piston and cylinder to move said carrier transversely in either direction relative to said slide to facilitate truing a plane face on the opposite sides of the grinding wheel adjacent to the periphery thereof, a control valve therefor, a pair of adjustable stop devices precisely to control the end positions of said first piston

and said longitudinally movable slide to position the truing tools for a side truing operation, a forming bar on said frame, and a follower on said carrier which is shaped and arranged to engage said forming bar after a predetermined transverse movement of the carrier to impart a longitudinal movement to said slide during the remainder of the transverse movement of the carrier so as to true a combined plane and a back-tapered side face on the grinding wheel.

9. In a grinding machine, as claimed in claim 8, 10 in combination with the parts and features therein specified in which a piston rod connects the first piston with said slide, a screw threaded portion on said rod,

a graduated collar threaded on said portion to connect said rod with the slide to vary the effective length of the piston rod so as to precisely control one end position of said slide, and a second graduated collar threaded onto said portion to precisely control the other end position of said slide to facilitate precise positioning of the truing tool for side truing operations.

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