Dec. 25, 1956 W. F. JESSUP 2,775,235

BOOSTER FOR TEMPLATE CONTROLLED TRUING MECHANISM

Filed Aug. 22, 1955 4 Sheets-Sheet 1

Fig. 1

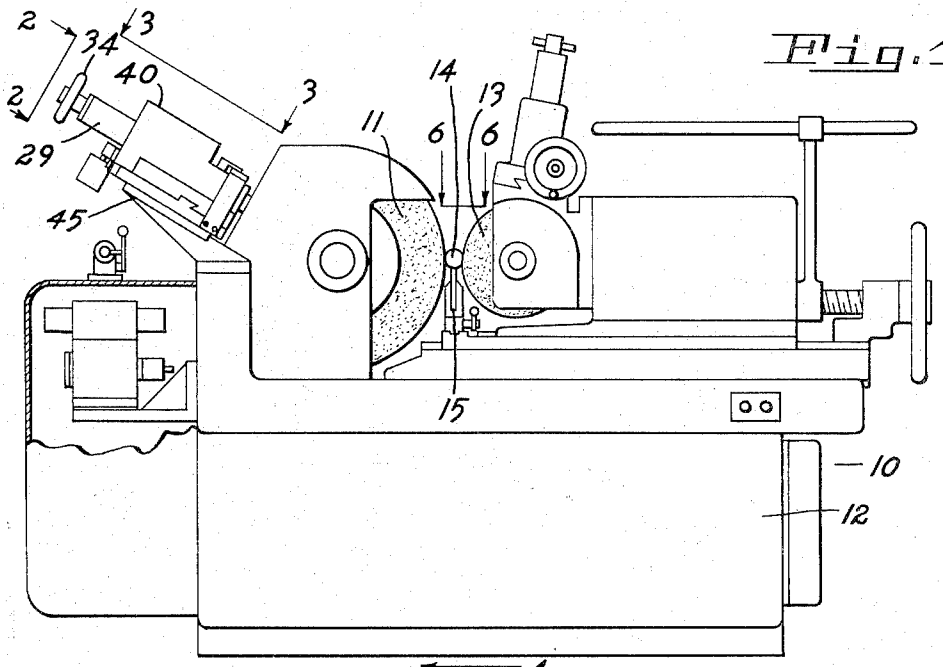
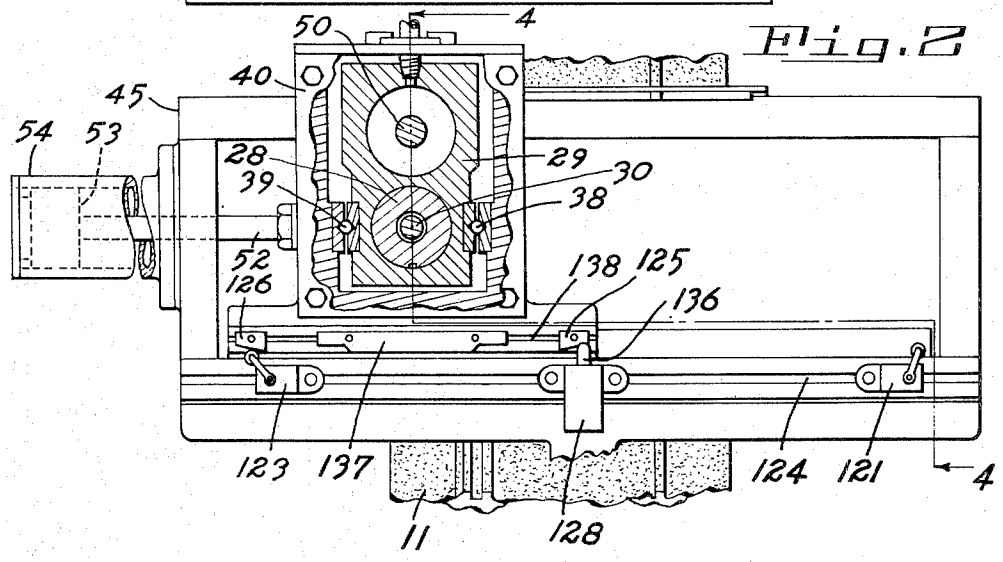


Fig. 2



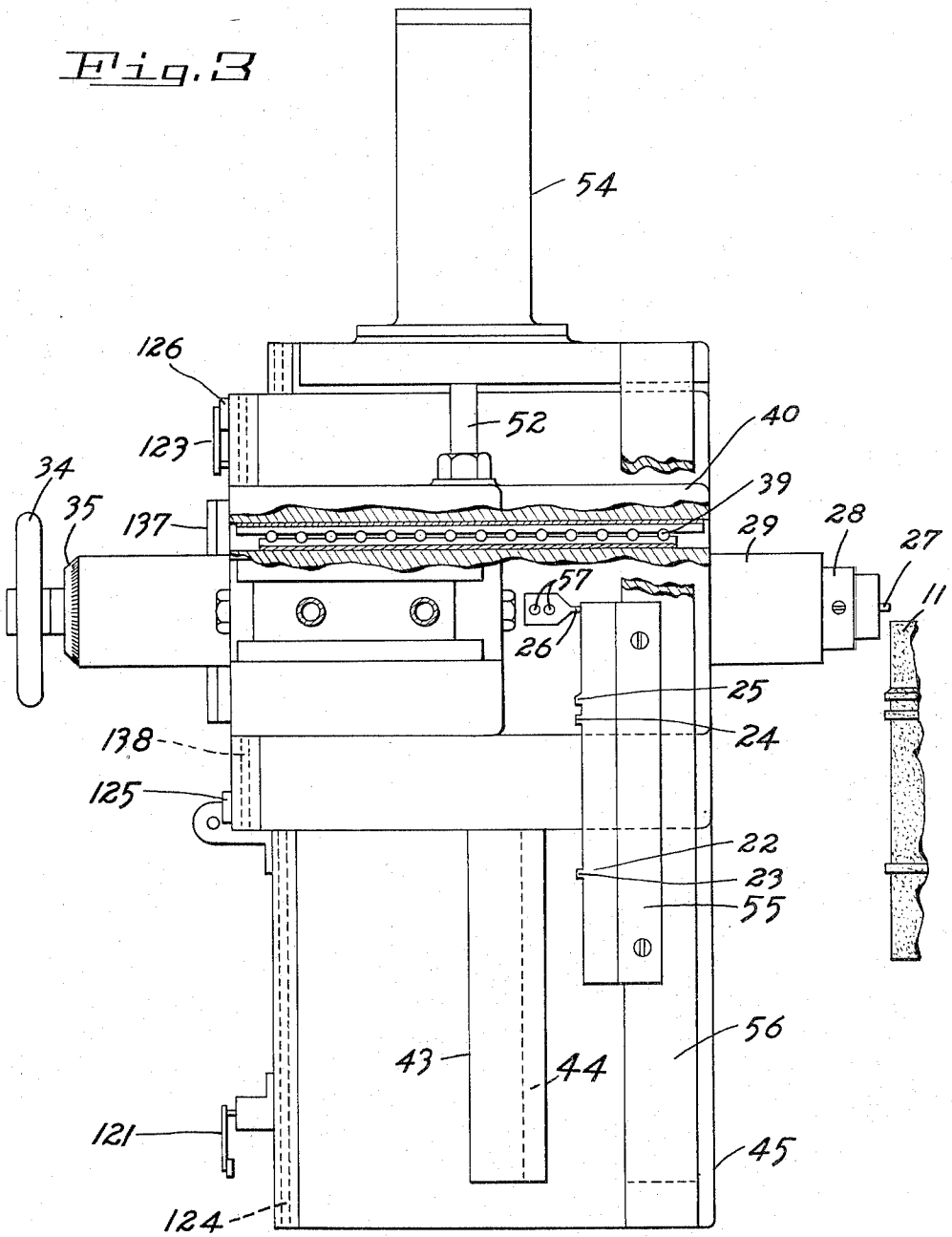
INVENTOR.
WILBUR F. JESSUP
BY
H. H. Parsons & L. W. Wright
ATTORNEYS.

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Fig. 3



INVENTOR.
WILBUR F. JESSUP
BY
H. K. Parsons & L. W. Wright
ATTORNEYS.

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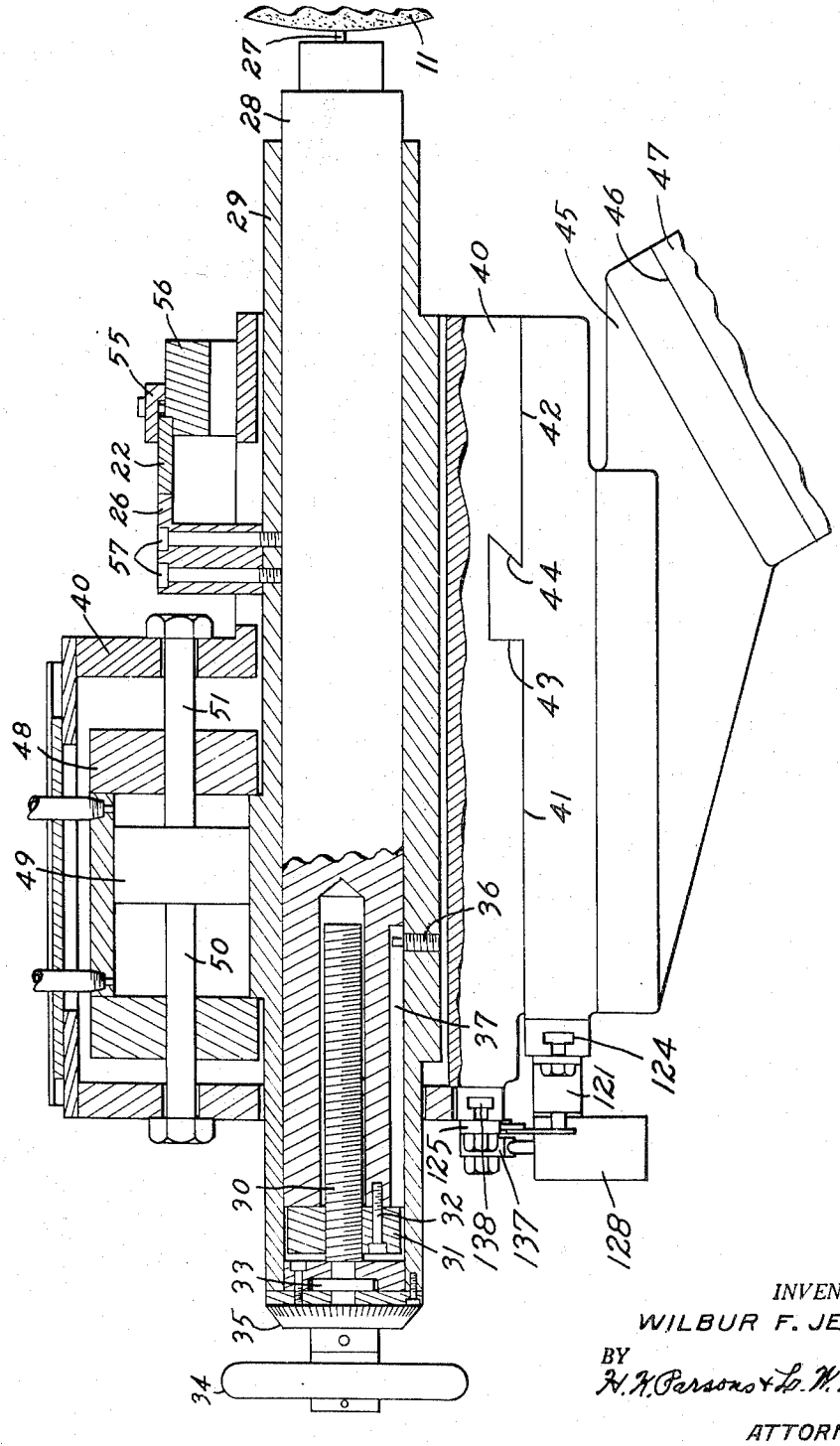


Fig. 4

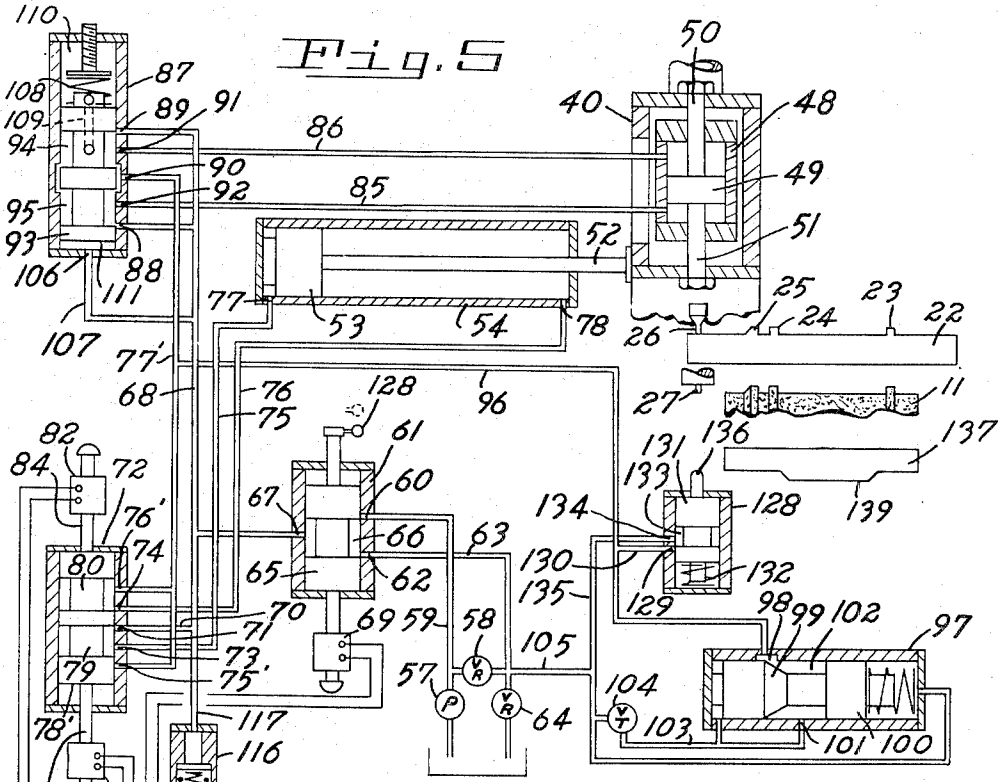
INVENTOR.
WILBUR F. JESSUP
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H. H. Parsons & L. W. Wright.
ATTORNEYS.

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Fig. 5



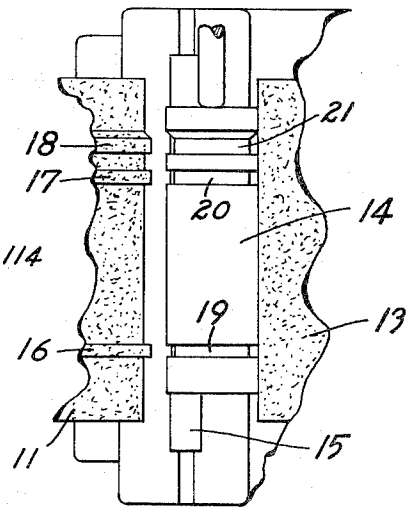


Fig. 6

INVENTOR.
WILBUR F. JESSUP
BY
N. K. Parsons & L. W. Wright
ATTORNEYS.

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BOOSTER FOR TEMPLATE CONTROLLED TRUING MECHANISM

Wilbur F. Jessup, Cincinnati, Ohio, assignor to The Cincinnati Milling Machine Co., Cincinnati, Ohio, a corporation of Ohio

Application August 22, 1955, Serial No. 529,827

9 Claims. (Cl. 125—11)

This invention relates to truing mechanisms for grinding machines and more particularly to an improved profile truing mechanism.

One of the objects of this invention is to provide an improved template controlled truing mechanism which will automatically negotiate rises and falls in the shape of the template including right angle turns.

Another object of this invention is to provide an improved hydraulically operated template controlled truing mechanism.

A further object of this invention is to provide an improved traversing control mechanism for feeding a template controlled truing tool which is automatically responsive to changes in resistance to feeding caused by sharp changes in the shape of the template to effect a boosting action to assist the template in moving the tool when sharp changes in direction are encountered.

Another object of this invention is to provide an improved mechanism for automatically advancing and retracting a truing tool during its feeding movement in response to changes in the shape of the template being followed and to cooperatively interrelate said mechanism with the feeding mechanism.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof, and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

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

Figure 1 is an elevational view of a grinding machine embodying the principles of this invention.

Figure 2 is an end view of the truing mechanism as viewed on the line 2—2 of Figure 1.

Figure 3 is a plan view of the truing mechanism as viewed on the line 3—3 of Figure 1.

Figure 4 is a sectional view through the truing mechanism as viewed on the line 4—4 of Figure 2.

Figure 5 is a diagrammatic view of the hydraulic control circuit.

Figure 6 is a detail view as viewed on the line 6—6 of Figure 1.

In the grinding of profile work pieces by the infeed grinding method in centerless grinding machines, the grinding wheel is provided with a profile shape corresponding to the shape to be produced in the work. The shaping of the grinding wheel is accomplished by means of a truing tool which is traversed across the face of the grinding wheel, and as the wheel wears, it is dressed periodically to maintain the accuracy of the shape. This is usually accomplished by utilizing a truing tool connected to a follower which engages a fixed template so that by traversing the follower across the template it determines the movements of the tool toward and from the grinding wheel.

In the case of templates having very gradual changes in direction it is possible to maintain the follower in contact with the template by simple spring means, for instance, and the template will thereby cause or force the truing tool to move toward and from the grinding wheel as traverse of the template progresses. In cases, however, where the changes in the template are sharp, and especially where right angle shoulders are encountered, it is impossible to utilize this method, especially if it is to be done automatically. It will be obvious that when a right angle shoulder is encountered, the template is helpless to move the follower, and the feeding or traversing movement of the truing tool must be stopped in order to effect the necessary advance or retraction of the truing tool.

By means of this invention, an auxiliary power means or booster is provided for assisting the template in moving the truing tool over the sharp rises and falls of the template, and this means is cooperatively interrelated with the traversing mechanism so that the feeding movement will stop at such critical times.

This is accomplished by providing a power feeding mechanism which is responsive or sensitive to changes in load resistance to a sufficient extent that the rate of feeding movement will change as the resistance changes, and automatic means responsive to such changes will apply a boosting force to the follower to assist its movement in whichever direction it is supposed to move.

In Figure 1 of the drawings there is shown a grinding machine, indicated generally by the reference numeral 10, having a grinding wheel 11 which constitutes a suitable machine for application of the principles of this invention. The machine illustrated is a conventional centerless grinder having a bed 12 upon which the grinding wheel 11 is mounted for power rotation, and a regulating wheel 13 is mounted in opposition to the grinding wheel on suitable slides for adjustment toward and from the grinding wheel. The work, such as the work piece 14, is suitably supported on a work rest 15 situated between the wheels for holding the work piece in proper grinding relation with respect to the centers of the wheels.

This invention deals with the art of grinding profiled work pieces and more particularly to means for dressing the grinding wheel to a shape complementary to the shape to be ground on the work piece. More particularly, this invention deals with grinding shapes which require angular shoulders to be formed on the grinding wheel, and shapes involving right angular shoulders cannot be trued automatically by conventional truing mechanisms, especially those of the template controlled variety.

In Figure 6 there is shown the extreme condition in which the grinding wheel 11 is provided with annular square ribs 16, 17 and 18 for grinding grooves 19, 20, and 21 in the work piece 14 as well as the cylindrical surface thereof, and a template 22 shown in Figures 3 and 5 is provided with corresponding ribs 23, 24, and 25 for guiding a follower 26 which correspondingly moves a truing tool 27 toward and from the grinding wheel 11. As shown in Figure 4, the truing tool 27 is mounted on the end of a cylindrical support 28, which is slidably mounted in a housing 29, for adjustment by a screw 30 threaded in a nut member 31 secured to the end of the member 28 by suitable screws 32. The screw 30 is anchored in the end of the member 29 against axial movement by a suitable rib 33 and is provided with a hand wheel 34 and suitably graduated dial 35 for effecting the necessary adjustments of the support 28. A set screw 36 mounted in the member 29 projects into a spline 37 formed in the periphery of the member 28 to prevent rotation thereof.

As shown in Figure 2, the housing 29 is supported

on opposite sides by anti-friction bearings 38 and 39 in a supporting housing 40. This housing 40, as shown in Figure 4, is slidably supported by bearing surfaces 41 and 42, and guide surfaces 43 and 44 formed on the top of a bracket, indicated generally by the reference numeral 45 and attached at 46 to a fixed part 47 of the machine.

The housing 29 has a cylinder 48 formed integral therewith as shown in Figure 4, and this cylinder contains a piston 49 from which piston rods 50 and 51 extend in opposite directions and are connected at opposite ends to the housing 40. From this construction it will be noted that the piston 49 is held against movement by its connections to the housing 40, and therefore the cylinder 48 and member 29 constitute the moving elements in moving the truing tool toward and from the grinding wheel.

In order to traverse the truing tool across the face of the grinding weel 11 as shown in Figure 2, the housing 40 is connected by a piston rod 52 to a piston 53 contained in a cylinder 54. The cylinder is attached to one end of the fixed bracket 45. It will now be seen that the piston and cylinder 53, 54 effect traverse of the truing tool across the face of the wheel, and the cylinder, piston 48, 49 effect movement of the truing tool toward and from the grinding wheel. As shown in Figures 3 and 4, the template 22, which is a removable item, and other templates may be substituted therefor, is clamped by a clamping shoe 55 to a fixed part 56 of the housing 40. The follower 26 is attached by screws 57 to the member 29. It will now be seen, as shown in Figure 4, that the follower 26 will move with the slide 40 across the wheel and will be moved with the truing tool support 29 toward and from the grinding wheel.

Fluid pressure is supplied to the cylinders 48 and 54 by a pump 57, Figure 5, having a relief valve 58. The delivery from the pump 57 is connected by channel 59 to port 60 of a start and stop valve 61. This valve has an exhaust port 62 which is connected by channel 63 to a low pressure relief valve 64 which is set just high enough to maintain fluid in the system. The start and stop valve has a plunger 65 in which is formed a valve groove 66 which is of such width that in one position such as shown it will close the port 60 and open the port 62 and thereby connect it to the outgoing port 67, or in the up position of the plunger 65 the port 62 will be closed and the port 67 connected to the pressure port 60 whereby fluid will now be delivered to channel 68. The plunger 65 is adapted to be actuated automatically by an electric solenoid 69.

The pressure channel 68 has a branch connection 70 to port 71 of a reversing valve 72 for the traversing cylinder 54. This valve has ports 73 and 74 which are connected by channels 75 and 76 to ports 77 and 78 located in opposite ends of the cylinder 54. The valve also returns ports 75' and 76' which are connected to a return line 77'. The valve plunger 78' of the valve 72 is a conventional reversing valve plunger having grooves 79 and 80 for reversing the flow to the cylinder 54. This plunger is adapted to be shifted in opposite directions by electric solenoids 81 and 82, which are connected by piston rods 83 and 84 to opposite ends of the valve plunger. It will now be seen that dependent upon the position of the valve plunger 78' the piston 53 will be moved forward or backward to reciprocate the housing 40 carrying the follower 26 parallel to the face of the grinding wheel 11. When the follower 26 engages a steep rise or a perpendicular shoulder the resistance to movement of the slide 40 will increase, and means have been provided which are responsive to changes in resistance to automatically differentiate the pressures on opposite sides of the piston 49 to effect a boost to the movement of the follower 26 whenever it meets too great a resistance and is therefore unable to follow the template.

To this end the opposite ends of the cylinder 48 is connected by channels 85 and 86 to a second reversing valve 87 which may be termed a reaction valve. This valve has ports 88 and 89 to which the pressure line 68 from the pump is connected.

It also has a center port 90 which is connected to the return line 77' from the reversing valve 72 for the traversing slide. Between the ports 89 and 90 is a port 91 to which the line 86 is connected, and between the ports 90 and 88 is a port 92 to which the line 85 is connected. The valve plunger 93 has annular grooves 94 and 95 which are slightly greater in width than the spacing between ports 89 and 90, and 90 and 88, to permit a small predetermined center flow from the ports 88 and 89 which are at the higher pressure, that is, of the pump, to the port 90 which is at a lower pressure. When the valve plunger 93 is in a center position the lines 85 and 86 and the opposite ends of the cylinder 48 are filled with fluid pressure, all at equal pressure so that the piston 49 is held stationary.

The line 77', which is the return line from the traversing cylinder 54, is connected by channel 96 to a pressure reducing valve 97 having a port 98 which is throttled by the taper spool 99 on the valve plunger 100. The valve 97 has a port 101 which is in constant communication with the annular groove 102 in the plunger 100, and connected by channel 103 to a throttle valve 104 having a return line 105, going to the low pressure relief valve 64. It should now be evident that the traversing cylinder 54 is supplied by the pump 57 through the reverse valve 72, and that the rate of movement of its piston 53 is controlled by the trottle valve 104 placed in the return line from the cylinder whereby the forward pressure on the piston 53 is always a constant pressure as determined by the relief valve 58.

The reaction valve 87 has a port 106 at one end connected by channel 107 to the pump line 68 whereby there is always a constant pressure acting on one end of the valve plunger 93 to shift it against the resistance of an adjustable spring 108 mounted in the opposite end of the valve housing. The plunger has an interdrilled passage 109 in one end which connects the annular groove 94 to the end chamber 110 containing the spring 108. Therefore, the constant pump pressure in the end chamber 111 is opposed by the fluid pressure in chamber 110 plus the pressure of the spring 108. Normally, these are so adjusted that when the piston 53 is not moving the valve plunger 93 will be in a center position.

Since it is obvious that a slight unbalance of the pressures in the opposite ends of the cylinder 48 are necessary to produce and maintain a small force component on the follower 26 against the template 22 in order that it will always maintain contact with the template, the spring 108 is adjusted slightly to take care of this condition.

In the operation of the device there will be a constant forward pressure on the piston 53 to effect traverse of the slide and the pressure at the return port 78 and channel 76 will, of course, be lower than the forward pressure dependent upon work load and the friction to be overcome. So long as the work load and opposing friction, such as the friction between the follower and template remain constant, the pressure drop across the piston 53 will remain constant, and the pressure at port 90 of the reaction valve will be constant. If now the load increases caused by the follower encountering a sharp rise on the template 22 the back pressure in the return line 77' will drop, causing a drop in pressure at the port 90 of the reaction valve. This will cause a drop in pressure in the chambers 94 and 95 but a drop in pressure in the chamber 94 will cause a drop in pressure in the

chamber 110, causing the valve plunger 93 to shift upward as viewed in Fig. 5. This will increase the opening of port 89 and decrease the opening at port 90 and since the pressure at the port 89 is greater than the pressure at the port 90, there will be a flow of fluid through the port 89 and thereby into the line 86 to shift the cylinder 48 and thereby the follower 26 away from the grinding wheel and cause it to rise against any surface that it is abutting.

Likewise, if the back pressure in line 77' should increase the pressures in chambers 94 and 95 of the reaction valve would rise, and the rise in pressure in chamber 94 would be communicated to the chamber 110 and cause shifting of the valve in a direction to close port 89 and open port 88. This would increase the pressure in line 85 and cause movement of the cylinder 49 and follower 26 toward the template. It will now be seen that the reaction valve is sensitive to changes in load on the traversing piston 53 caused either by increases or decreases in friction between the follower 26 and the template 22, or by engagement of the follower with a shoulder.

For automatic operation an electrical control circuit has been provided for controlling actuation of the various solenoids, and, as shown in Figure 5, the solenoid 69 is connected to control switch 111, the solenoid 81 is connected to the control switch 112, and the solenoid 82 is connected to the control switch 113. One side of these switches is connected by line 114 to one side of a transformer 115. Energization of the other side of the circuit is partially controlled by a pressure switch 116 having a channel 117 connected to the pump line 68 whereby when the line is under full pressure, the pressure switch will be closed interconnecting line 118 from one side of the transformer 115 to line 119.

The switch 113 is operated by a relay 120 in series with a dog actuated control limit switch 121. Similarly, the switches 111 and 112 are controlled by a relay 122 operated by a limit switch 123.

As shown in Figure 2, the limit switches 121 and 123 are suitably secured in a T-slot 124 formed on the base 45 for trip operation by control dogs 125 and 126 carried by the cross slide 40. Normally, the slide 40 has a starting position such as that shown in Figure 2 to the left of the grinding wheel 11, as viewed in that figure, and it will be noted that the dog 126 is in a position to close the limit switch 123. With the control circuit energized and the pressure switch closed this would normally close switches 111 and 112 and thereby energize solenoids 69 and 81. The energization of solenoid 69, however, shifts the stop valve 61 to a stop position. Therefore, to start the cycle the operator actuates the starting switch 127 which breaks the circuit to the solenoid 69 whereby the operator by means of the lever 123 can manually shift the stop valve to a running position. As soon as the table starts to move and the dog 126 has released the limit switch 123, the operator may release the starting button 127 whereby the circuit is set up for the next cycle, but the switches 111 and 112 will open, and the slide movement will continue.

When the dog 125 actuates the limit switch 121 and closes the circuit to the relay 120, the switch 113 will be closed to energize the solenoid 82 and shift the reversing valve 78' which will cause hydraulic reversal of the slide. This reversal will cause the dog 125 to leave the limit switch 121 whereby the switch 113 will open but the reversing valve will still remain in the same position. At the end of the return stroke the limit switch 123 will again be operated, and this time will cause reversal of the valve 78' but will also actuate the stop valve to cut off the flow of fluid to the cylinder whereby the slide will stop. If it is desired that the cycle continue, the operator merely presses the starting button 127 whereby upon reversal the solenoid 69 will not be actuated, and so the table will reverse and continue through another cycle.

Attention is invited to the fact that where the shape of the template is straight that it may be desirable to have a faster rate of movement of the diamond relative to such portions, and therefore means have been provided for increasing the rate of movement independent of the setting of the rate throttle valve 104. This is accomplished by providing a by-pass valve, or it may be designated a rapid feed valve 128 which has an inlet port 129 connected by a branch line 130 to the return line 96 leading to the pressure reducing valve 97. This valve has a plunger 131 which is normally held in the position shown by a spring 132 so that an annular groove 133 formed in the valve body will be in position to close the port 129 and open the port 134 which is connected by a by-pass line 135 to channel 105 whereby when the plunger 131 is depressed the ports 129 and 134 will be interconnected and the returning fluid through channel 96 will be directly bypassed to line 105 without going through the throttle valve 104. The plunger 131 has an extension 136 and the valve is so positioned in the T-slot 124 of the base of the machine that it will engage a template 137 mounted in the T-slot 138 of the traversing slide 40. By proper shape of contour 139 of the template 137 the valve 128 may be operated as desired during the stroke of the traveling slide.

There has thus been provided a new and improved apparatus which makes possible the use of a template to control the movement of a truing tool toward and from a grinding wheel to profile the same regardless of sharp angles or turns in the shape of the profile. The booster mechanism operates to help withdrawal and to effect advance of the tool, and the mechanism is operative regardless of which direction the tool is traversed across the wheel.

What is claimed is:

1. In a truing device having a traversible slide mounted on a support, a cross slide carrying a truing tool mounted on the traversible slide for movement normal to the direction of movement of the traversible slide, a template mounted on said support, a follower mounted on the cross slide in engagement with said template, the combination of hydraulic means for feeding the traversible slide, means to hydraulically bias said cross slide to maintain engagement of said follower with said template and create a normal frictional load on said hydraulic feeding means, and means responsive to variation in said load to vary said bias and cause movement of the cross slide in a direction to reestablish said normal load.

2. In a truing device having a traversible slide mounted on a grinding wheel support, a cross slide mounted on the traversible slide and carrying a truing tool for movement normal to the direction of movement of the traversible slide, the combination of opposed hydraulic pressure means for holding the cross slide operatively in engagement with a template carried by said support, hydraulic means for feeding the traversible slide, means to bias said opposed pressures including a reaction valve operatively connected to control said opposed hydraulic pressures, and means responsive to a change in load on said hydraulic feeding means to shift said valve.

3. In a truing device having a traversible slide mounted on a support, a cross slide carrying a truing tool mounted on the traversible slide for movement normal to the direction of movement of the traversible slide, a fixed template carried by said support and extending parallel to said traversible slide, a follower carried by the cross slide and frictionally engaging said template, the combination of hydraulically actuated means for feeding the traversible slide including a rate valve for maintaining a back pressure on said actuated means, opposed hydraulic means effective on said cross slide for

maintaining engagement of the follower with the template whereby when the follower engages a shoulder on the template the load on said traversible slide is increased and the back pressure drops, and means responsive to said drop in pressure for biasing said opposed pressures.

4. A truing device having a traversible slide mounted on a fixed support, a feed cylinder mounted on said fixed support and operatively connected to said traversible slide, said feed cylinder having pressure and return lines, a throttle in said return line for creating a back pressure in said line to control the rate of movement of the traversible slide, a cross slide mounted on the traversible slide for movement normal to the direction of movement of the traversible slide, a follower mounted on the cross slide in engagement with a template mounted on the fixed support, means to hydraulically bias said cross slide to maintain engagement of said follower with said template, and means responsive to changes in pressure in said return line for varying the bias of said hydraulic means.

5. In a truing device having a traversible slide mounted on a support, a cross slide mounted on the traversible slide for movement normal to the direction of movement of the traversible slide, a truing tool carried by the cross slide, a template and follower, one of which is mounted on said support, and the other on the cross slide, the combination of hydraulic means for feeding the traversible slide including a reverse valve having a return line, a rate valve in said return line causing back pressure therein, biased hydraulic pressure means operatively connected to said cross slide for maintaining frictional contact of said follower with said template and create a load on said feeding means whereby a substantial change in said load will produce a change in said back pressure, and means actuable in response to a change in said back pressure to change the bias of said hydraulic pressure means.

6. In a truing device having a traversible slide mounted on a support, a cross slide guided on the traversible slide for movement normal to the direction of movement of the traversible slide, a truing tool on the cross slide, a template mounted on said support, a follower mounted on the cross slide, the combination of hydraulic means for feeding the traversible slide including a reverse valve having a return line, a rate valve in said return line causing back pressure in said line, a piston and cylinder operatively connected to said cross slide, means to connect pressure to opposite sides of said piston including a reaction valve for differentiating the pressures on opposite sides of said piston for maintaining frictional contact of said follower with said template and create a load on said feeding means whereby a substantial change in said load will produce a change in said back pressure, and means connecting said back pressure to said reaction valve to cause movement thereof in response to changes in said back pressure.

7. A truing device having a traversible slide mounted on a fixed support, a feed cylinder mounted on said fixed support and operatively connected to said traversible slide, said feed cylinder having pressure and return lines, a throttle in said return line for creating a back pressure therein to control the rate of movement of the traversible slide, a cross slide mounted on the traversible slide for movement in a direction normal thereto, a follower mounted on the cross slide in engagement with a template mounted on the fixed support, means to hydraulically bias said cross slide to maintain engagement of said follower with said template, means responsive to pressure changes in said return line for varying the bias of said hydraulic means, and automatically controlled means to bypass said throttle valve to effect a faster rate of movement of the traversible slide.

8. In a truing device having a traversible slide mounted on a support, a cross slide carrying a truing tool mounted on the traversible slide for movement normal to the direction of movement of the traversible slide, a template mounted on said support, a follower mounted on the cross slide in engagement with said template, the combination of hydraulic means for feeding the traversible slide including a reverse valve having a return line, trip operable electrical means for shifting said reverse valve, biased hydraulic pressure means operatively connected to said cross slide for maintaining frictional contact of said follower with said template and create a load on said feeding means whereby a substantial change in said load will produce a change in said back pressure, means actuable in response to a change in said back pressure to change the bias of said hydraulic pressure means, and trip dogs carried by said traveling slide for operation of said trip operable means.

9. In a truing device having a traversible slide mounted on a grinding wheel support, a cross slide mounted on the traversible slide for movement normal to the direction of movement of the traversible slide, a truing tool carrier mounted on said cross slide, means to adjust said carrier relative to the cross slide, the combination of opposed hydraulic pressure means for holding the cross slide operatively in engagement with a template carried by said support, hydraulic means for feeding the traversible slide, means to bias said opposed pressures including a reaction valve operatively connected to control said opposed pressures, and means responsive to a change in load on said hydraulic feeding means to shift said reaction valve.

No references cited.