Feb. 7, 1950 T. H. LJUNGGREN ET AL 2,496,400

FEED CARRIAGE CONTROL MECHANISM

Filed Oct. 4, 1946 3 Sheets-Sheet 1

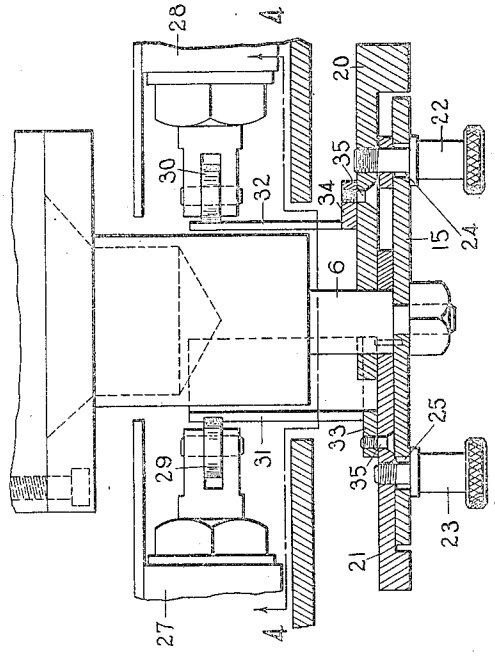


Fig. 2

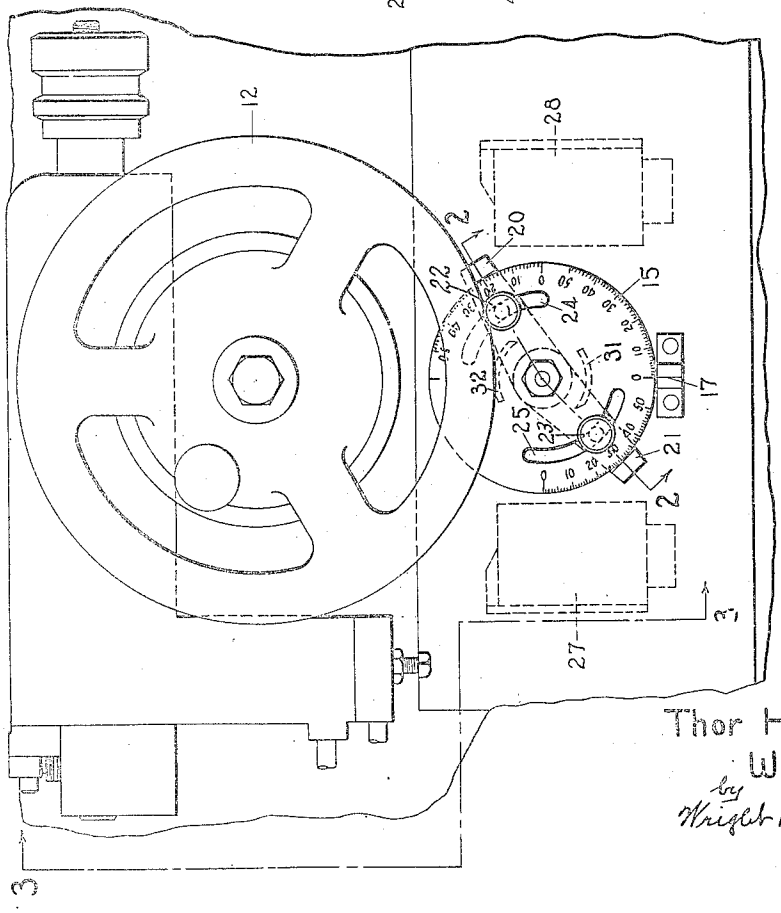


Fig. 1

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Fig. 3

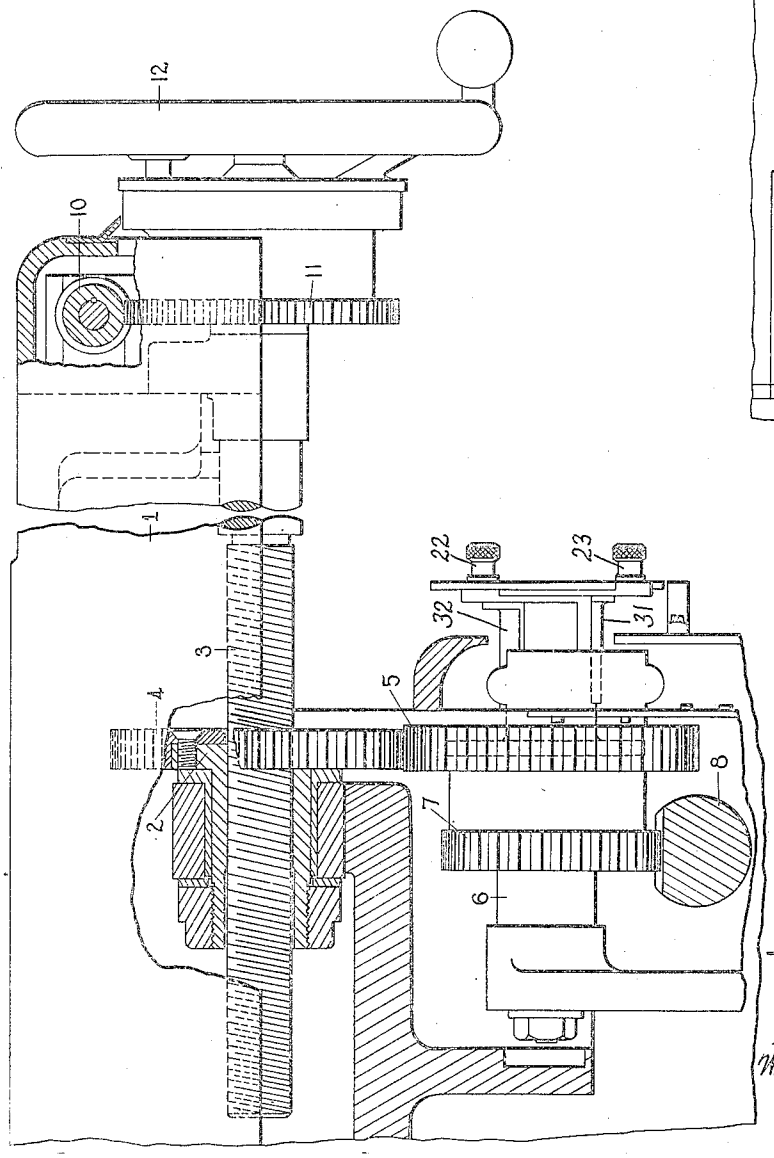
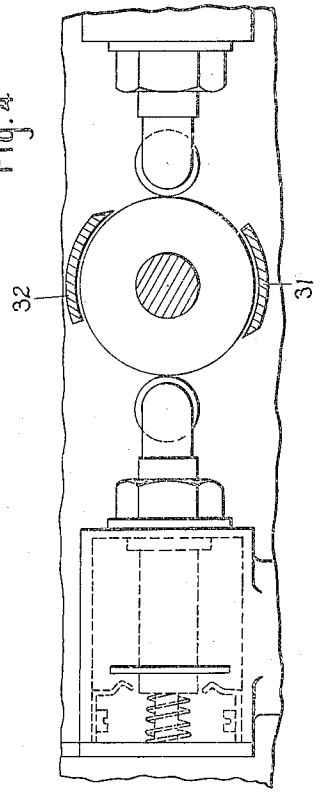


Fig. 4



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Filed Oct. 4, 1946 3 Sheets-Sheet 3

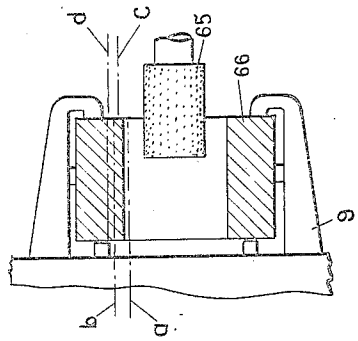
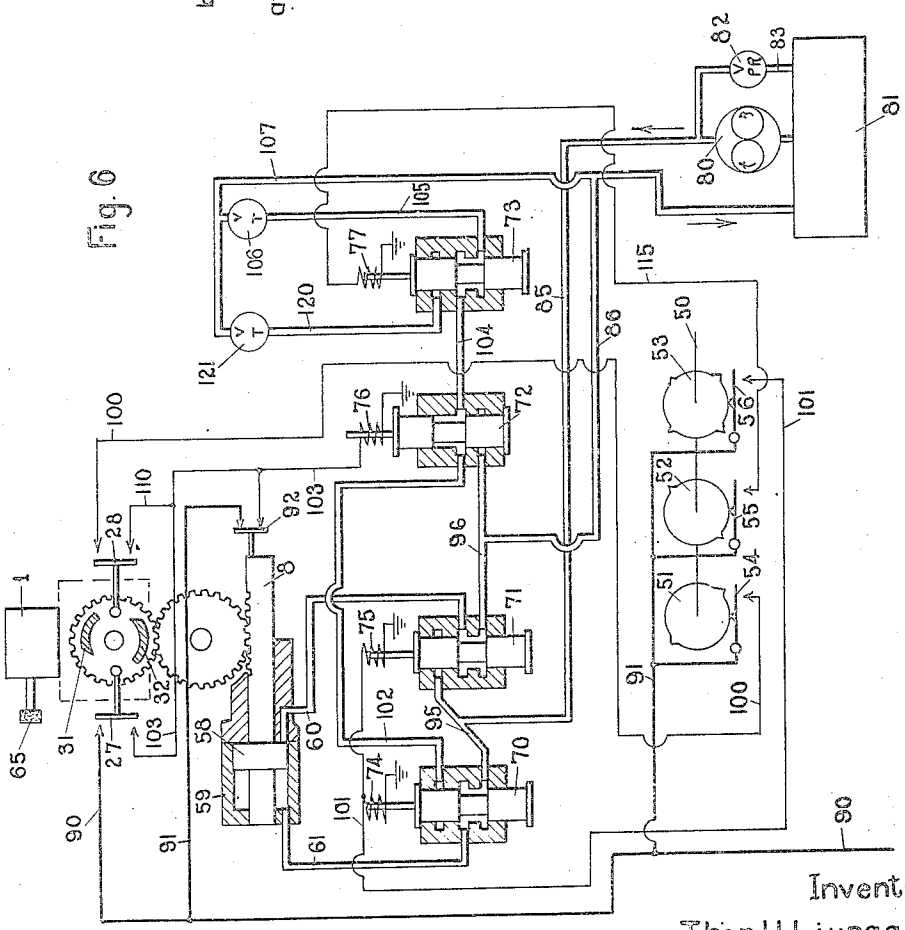


Fig. 5

Fig. 6



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UNITED STATES PATENT OFFICE

2,496,400

FEED CARRIAGE CONTROL MECHANISM

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Application October 4, 1946, Serial No. 701,230

6 Claims. (Cl. 51—165)

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This invention relates to carriage feed mechanism by which devices such as electric switches may be actuated to produce a cycle change in the feed of the carriage, whenever the carriage reaches one or more predetermined feed positions, and has for one object to provide a construction which permits ready adjustment of the device actuating elements to accurate predetermined carriage positions and after accurate predetermined extents of feed from starting positions.

More particularly the invention relates to control of carriage feed mechanism for grinding machines in which the grinding wheel and the work are moved toward each other from a retracted relation at a rapid rate until they are near together but still out of contact, whereupon the rate of feed is reduced to a rate suitable for grinding feed, contact between the work and the wheel being effected while the feed is at the low rate. The grinding action may be divided into two phases, the first being rough grinding at a low rate, reducing the work to a size short of finished size, and the second, a finish grinding which completes the final sizing operation at a feed rate usually slower than the rough grinding rate, the wheel and the work being fully retracted between rough and finish grinding and after finish grinding. The rapid idle feed from the retracted position toward wheel and work contact may therefore be longer for finish grinding than for rough grinding because of the amount of work removed during the rough grinding. The extent of rapid feed for rough and finish grinding is therefore independently adjustable in accordance with this invention.

For a complete understanding of this invention, reference may be had to the accompanying drawings in which

Figure 1 is a fragmentary front elevation of a grinding machine embodying the invention.

Figure 2 is a detail sectional view to a larger scale on line 2—2 of Figure 1.

Figure 3 is a fragmentary view partly in side elevation and partly in central vertical section through the carriage feed mechanism.

Figure 4 is a detail sectional view on line 4—4 of Figure 2.

Figure 5 is a diagrammatic view of the work and grinding wheel showing diagrammatically the amount of stock removed in the rough and finish grinding portions of the cycle and the relative positions of the grinding wheel and work at which the change from rapid idle feed to slow working feed takes place.

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Figure 6 is a diagrammatic view of the feed mechanism and controls.

Referring to the drawings, at 1 is indicated a carriage which may support a work piece or a grinding wheel, or other tool, a grinding wheel being so shown in Figure 6 and the work holder being shown at 9 in Figure 5. This carriage has journaled therein a lead screw 3 threaded into a nut 2 which is journaled in a fixed portion of the machine frame. The nut 2 has fixed thereto a gear 4 with which meshes a gear 5 on a shaft 6. This gear 5 may have integral therewith a second gear 7 with which meshes a rack bar 8. By imparting axial motion to the rack bar 8, it will be evident that the gears 7 and 5 may be rotated, rotating the gear 4 and the nut 2, causing the lead screw 3 and the carriage to be moved axially of the lead screw.

Means may also be provided for rotating the lead screw with reference to the carriage, this imparting a selective feed motion to provide for wheel wear and truing. This additional means may comprise a worm 10 which may be brought into engagement with a worm wheel 11 carried by the lead screw 3. Also the lead screw 3 may have secured thereto, a hand wheel 12 by which it may be turned when the worm 10 is lifted out of engagement with the worm wheel 11. This means for feeding the work carriage comprising the lead screw and nut is a micrometric feeding means actuable for feeding the carriage by accurate increments.

As shown best in Figure 2, the shaft 6 may have fixed thereto a disk 15, which, as shown best in Figure 1, may be graduated around its periphery, the graduations on the disk coacting with a fixed reference mark 17 on the machine frame. By comparison of the scale readings on the disk opposite to the reference line 17, an accurate indication of the extent of feed motion imparted to the carriage as the disk is turned by the action of the rack bar 8 may be readily had.

The shaft 6 has journaled thereon a pair of arms 20 and 21. These arms may be selectively secured at desired angular positions to the disk 15. For this purpose they are shown as provided with thumb screws 22 and 23 which extend through arcuate slots 24 and 25 through the disk 15, these thumb screws being threaded into the arms 20 and 21, respectively. On each side of the shaft 6 are arranged the electric switches 27 and 28 having actuating elements 29 and 30, respectively, and these actuating elements are arranged in the paths of motion of elements

shown as segmental pieces 31 and 32 which extend between the shaft 6 and the switch elements 29 and 30 and which at their forward ends have feet 33 and 34 which are secured to the arms 21 and 20 as by screws 35. In Figure 6 the shaft carrying the arms 20 and 21 is shown geared to the shaft 6 for the sake of clarity of showing and may be actually so made if desired.

It will now be evident that as the carriage is being fed from a starting position, which may be assumed as that where the zero on the disk 15 comes opposite to the fixed indication 17, the arms 20 and 21 are rotated with the disk until such time as one or the other of the segments 31 and 32 contact with and actuate their respective switches. As shown, for example, the arm 20 is arranged to contact its switch element 30 after the disk has been turned twenty graduations, whereupon the switch 28 is closed, while further turning of the disk another ten graduations is necessary to close the switch 27.

In Figure 6 the mechanism is shown embodied in a grinding machine with controls of the type more fully set forth in an application for patent of Thor H. Ljunggren, Serial No. 701,443 filed October 5, 1946, for Internal grinding machine, wherein the various phases of the grinding cycle are controlled by a grinding cycle control mechanism comprising a plurality of rotary switch-actuated devices secured to a common shaft which is rotated step by step to produce the desired phase change of the cycle. A portion of this cycle control mechanism is illustrated in Figure 6 comprising a shaft 50 carrying a plurality of disks 51, 52, and 53, each provided at points on its periphery with projections which at certain angular positions of the shaft 50 may close switches 54, 55 and 56. The rack bar 8, by motion of which the feed mechanism is operated, forms the piston rod of a piston 58 which rides in a fluid pressure cylinder 59 having pipes and passages 60 and 61 communicating with its interior on opposite sides of the piston 58. Motion of the piston 58 to the left from the position of Figure 5 produces feed between the grinding wheel 65 carried by the carriage 1 and the work 66 (see Figure 5), while motion of the piston 58 in the opposite direction acts to retract the wheel from the work.

Control of fluid pressure to and from the cylinder 59 is provided by four valves 70, 71, 72 and 73, each of which is normally in one axial position, though it may be moved to another axial position by energizing an actuating solenoid therefor 74, 75, 76 and 77, respectively, energizing of these solenoids being controlled by closing of the switches 54, 55 and 56. Fluid pressure is supplied from a suitable source, a pump 80 being shown for the purpose, taking hydraulic fluid from a tank 81 and delivering it under pressure determined by the setting of a relief valve 82 in a discharge pipe 83 leading back to the tank, the fluid being delivered at the predetermined pressure to a pressure pipe 85. A discharge pipe 86 leads back to the tank 81.

Electrical energy for energizing the various solenoids 74, 75, 76 and 77 is derived from the line 90, this line leading through a lead 91 to the switches 54, 55 and 56. The line 90 also leads to one terminal of the switch 27 and also communicates through a lead 91 with one terminal of a switch 92, this switch 92 being a safety switch. The mechanism is shown in Figure 6 as in its retracted position, the pressure pipe 85 communicating through a pipe 95, past the valve 70, through the pipe 61 leading to the left hand end of the cylinder 59, and the pipe 60 leading to the right hand end of the cylinder 59 leading past the valve 71 into a pipe 96 communicating with the drain pipe 86.

Assuming that a piece of work is in position in the work holder 9, and the rough grinding operation is to be started, the shaft 50 is turned into the angular position to bring one of the projections on the disk 51 into position to close the switch 54, and to bring one of the projections on the disk 53 into position to close the switch 56. Closing of the switch 54 energizes from the lead 91 and the switch 54, a lead 100 passing to one side of the rough grinding switch 28. The closing of the switch 56 energizes a lead 101 which energizes the solenoids 74 and 75, lifting the valve 70 and 71. Lifting of the valve 71 allows pressure from the pipe 95 to pass the valve 71 into the pipe 60 leading to the right hand end of the cylinder 59, while the lifting of the valve 70 causes the pipe 61 to conduct discharge pressure from the left hand end of the cylinder 59 past the valve 70 and into the pipe 102, which leads to the valve 72. The switch 92 being closed when the feed carriage is in fully retracted position, energizes the lead 103 and energizes the solenoid 76 so that the valve 72 is in lifted position, as shown, the discharge from the pipe 102 then passing around the valve 72 through the pipe 104 to the valve 73 and out through the pipe 105 containing a throttle valve 106 to the main drain pipe 107 leading back to the tank 81. The feed mechanism then starts to move to feed the wheel toward the work, but soon after this is done the switch 92 opens, allowing the valve 72 to drop so that discharge takes place from the pipe 102 through the valve 72 into the pipe 96 and the drain pipe 86 without throttling. The feed thus after predetermined delaying action of switch 92 is at a relatively rapid rate and this takes place until the cam 32 engages and closes the switch 28. This takes place when the grinding wheel 65 has moved toward the work up to the line *a* shown in Figure 5, at which point it is not quite in contact with the work. As soon as this switch 28 is closed, the solenoid 76 is energized from the lead 100 through the switch 28, leads 100 and 103, this lifting the valve 72 and causing the discharge to take place through pipe 104 past the valve 73, through pipe 105 and through the throttle valve 106. The further feed between the wheel and the work up to the limit of rough grinding at the line *b* then takes place at the relative slow rough working feed rate. When this limit *b* is reached, the shaft 50 is turned a further distance so as to allow the switches 54 and 56 to open, conditioning the various valves, except the valve 72, in the position shown in Figure 6, so that the carriage is retracted to its starting position, at which time the switch 92 is closed, lifting the valve 72 so that all the parts except the shaft 50 and its disks is in the position shown in Figure 6. At this point in the cycle, the wheel may be retracted and trued, as is fully described in the Ljunggren application to which attention has heretofore been called, but as this portion of the cycle is not concerned with the present invention it is not here shown.

The finish grinding operation is then initiated, this being done by rotating the shaft 50 until projections on the disks 52 and 53 close the switches 55 and 56. As before noted, closing of the switch 56 lifts the valves 70 and 71, thus causing the piston 58 to be driven in feed direc-

tion, and as soon as the feed starts the valve 72 drops so that the feed takes place at the rapid unrestricted rate. The closing of the switch 55 energizes the lead 115 which energizes the solenoid 77, lifting the valve 73. This connects the pipe 104 past the valve 73 to the pipe 120, in which is placed the throttle valve 121, and after passing this throttle valve the fluid pressure flows to the discharge pipe 107. This throttle valve 121 may be set to restrict the flow more than the throttle valve 106 so that the speed of slow feed for finish grinding, as will later appear, is slower than the feed for rough grinding. The rapid rate feed continues until the cam 31 closes the switch 27, which, it will be noted, is after the closing of the switch 28, but as during the finish grinding feed the lead 100 is not energized, switch 54 being open, nothing happens when the switch 28 is closed. When the switch 27 is closed, however, energy passes from the line 90 through this switch 27 and the lead 103 to the solenoid 76, which thereupon lifts the valve 72 into the position shown in Figure 6, whereupon the discharge from the left hand end of the feed cylinder 59 is compelled to go through the pipe 104, past the lifted valve 73, and through the throttle valve 121.

It will be noted that the limit of fast feed in the finish grinding phase of the cycle may be beyond the limit of fast feed for the rough grinding, for the reason that the stock up to the line *b* was removed during the rough grinding. Limit of fast feed before the wheel can contact the work during the finish grinding may thus be at the point *c*, and from this point *c* the wheel is moved with the slow finish grinding feed to the finish size position at *d*, at which point the feed is stopped by any suitable means, and the grinding operation has been completed.

The switch 92 has a delaying function of particular importance in connection with certain high rate production work. This switch is normally open, but it is held closed by the rack bar 8 when the rack bar is in the retracted position of Figure 6, so that the discharge from the cylinder 59 when the feed action is started, is throttled. After a short travel of the rack bar 8 toward the left, the switch 92 opens and the desired quick approach movement in transverse direction between the wheel and the work takes place. Because of the delaying action of the switch 92, the grinding wheel and the work have had time to arrive at approximately the relative overlapping axial positions of Figure 5 before the wheel can contact with the work, so that any risk that the wheel will bump its corner against the corner of the work piece on entering the work is eliminated.

It will be noted that the rough and finish grinding actions alternate so that the switch actuating elements 31 and 32 become effective alternately, the cycle mechanism automatically selecting alternate switches to be effected during the feed actuations.

From the foregoing description of an embodiment of this invention, it should be evident to those skilled in the art that various changes and modifications may be made without departing from its spirit or scope.

We claim:

1. In combination with a movable carriage and micrometric means for feeding said carriage including a rotary shaft turnable through an angular extent proportional to the amount of feed of said carriage from a starting position, means for turning said shaft, a pair of switches located on opposite sides of said shaft, a disk fixed to said shaft, a pair of arms each pivoted on said shaft, means for selectively locking said arms independently to said disk in desired angular positions, and an element projecting from each of said arms between said shaft and switches in position to actuate said switches on feed of said carriage to positions corresponding to the angular settings of said arms relative to said disk.

2. In combination with a movable carriage and micrometric means for feeding said carriage including a rotary shaft turnable through an angular extent proportional to the amount of feed of said carriage from a starting position, means for turning said shaft, a pair of switches adjacent to said shaft, a disk fixed to said shaft, a pair of arms each pivoted on said shaft, means for selectively locking said arms independently to said disk in desired angular positions, an element projecting from each of said arms between said shaft and switches in position to actuate said switches on feed of said carriage to positions corresponding to the angular settings of said arms relative to said disk, and means controlled by the actuation of one or the other of said switches depending upon whether rough or finish grinding is to be effected to slow the action of said feeding means.

3. In combination, a work support and a grinding wheel support, one of said supports comprising a movable carriage, means for moving said carriage to produce feed and retracting motions between a wheel on said wheel support and work on said work support, means including a pair of independently adjustable slow speed controls selectively made operative or inoperative for controlling the speed of such carriage motion in feed direction, means effective when said carriage reaches independently selectable positions in feed direction to render a correspondingly slow speed control effective for the remainder of such feed motion and means automatically controlling said carriage moving means to retract the carriage on the completion of each such feed motion.

4. In combination, a work support and a grinding wheel support, one of said supports comprising a movable carriage, means for moving said carriage to produce feed and retracting motions between a wheel on said wheel support and work on said work support, means including a pair of independently adjustable slow speed controls selectively made operative or inoperative for controlling the speed of such carriage motion in feed direction, means effective when said carriage reaches independently selectable positions in feed direction to render a correspondingly slow speed control effective for the remainder of such feed motion, and means for selecting said controls alternately.

5. In combination, a work support and a grinding wheel support, one of said supports comprising a movable carriage, means for moving said carriage to produce feed and retracting motions between a wheel on said wheel support and work on said work support, hydraulically actuated means for moving said carriage to relatively feed and retract said wheel and work, a pair of independently adjustable flow limiting elements, means actuated automatically when said carriage reaches a predetermined position short of contact between the wheel and work when moving in feeding direction from a starting position during a rough grinding operation to interpose one of said elements into the hydraulic circuit with said

actuated means to slow the feed speed to a rough working speed and for interposing said other element at another predetermined position of said carriage short of contact between the wheel and work during the next feed which is a finish grinding feed of said carriage from said starting position to reduce the rate of feed to finish grinding feed speed.

6. In combination, a work support and a grinding wheel support, means for relatively moving said supports to cause a wheel on said wheel support to move relatively axially to work on said work support into and out of overlapping relation therewith and to traverse the work, means for relatively moving said supports transverse to said axial motion to feed said wheel relative to the work first at a rapid rate from a retracted position toward the work and then at a slower rate into feeding contact and working feed, and

means for delaying the initiation of said rapid feed after the start of relative motion of said wheel and work from retracted to overlapping relation to insure such overlapping relation before said wheel contacts the work.

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