Nov. 7, 1939. B. A. KEARNS 2,178,875

CONTINUOUS TRUING MECHANISM

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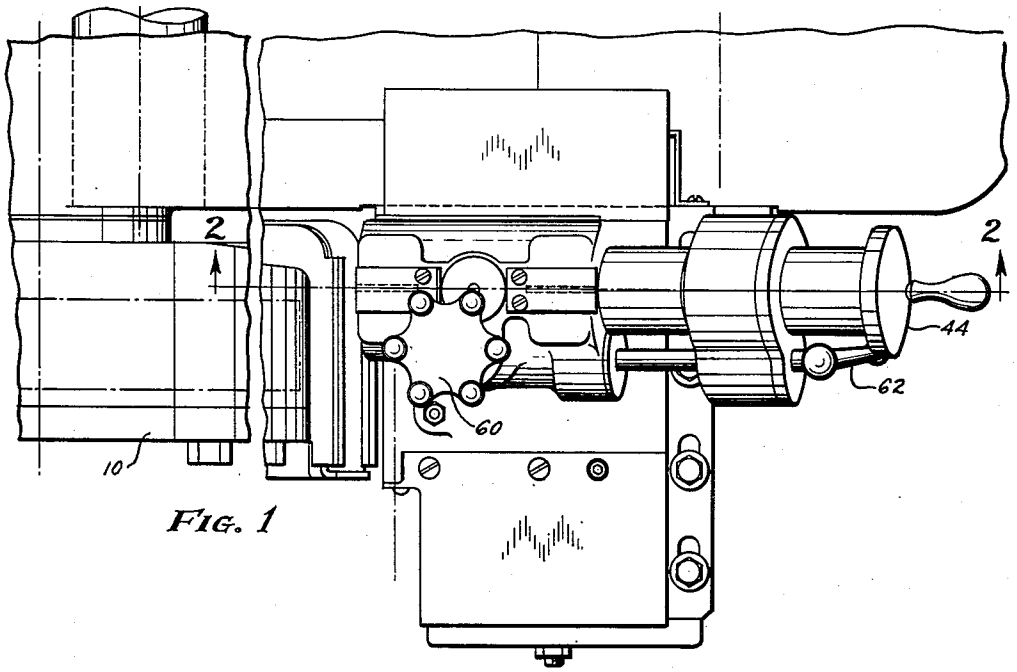


FIG. 1

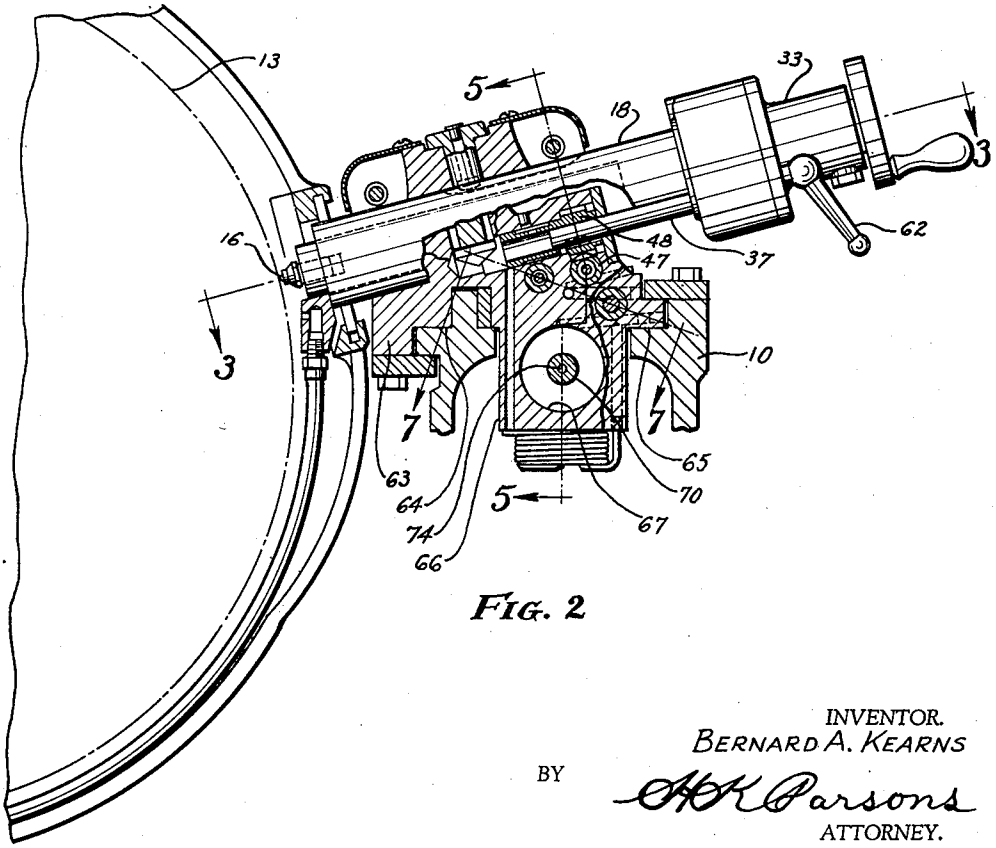


FIG. 2

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CONTINUOUS TRUING MECHANISM

Filed Sept. 3, 1937 5 Sheets-Sheet 2

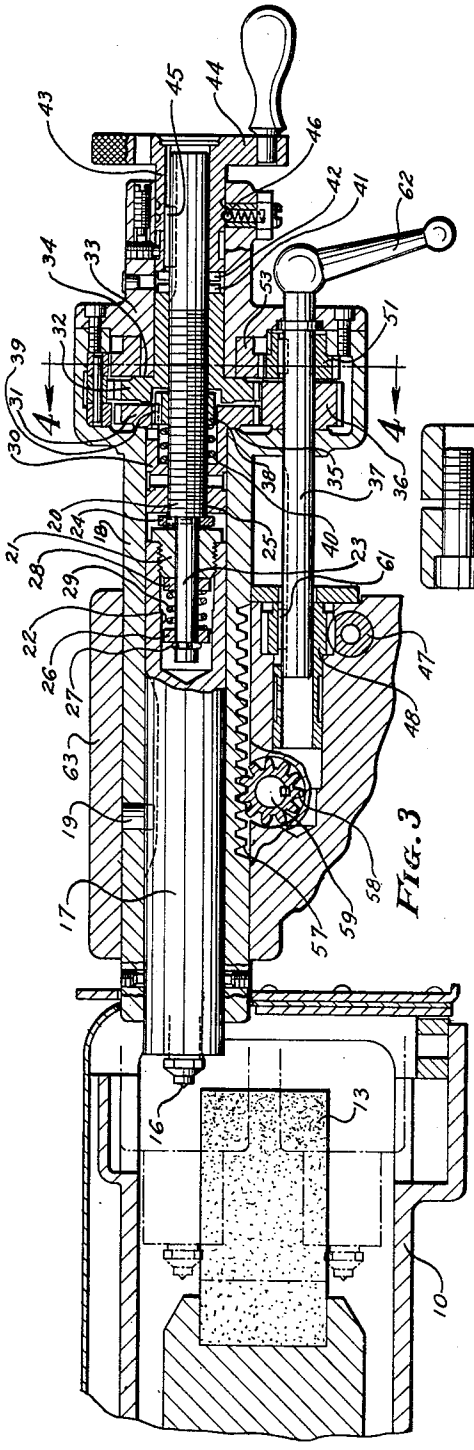


FIG. 3

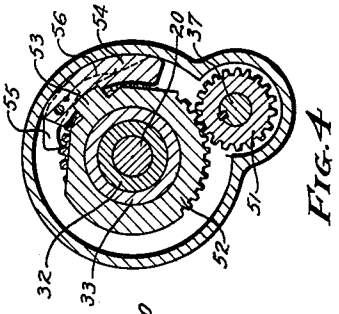


FIG. 4

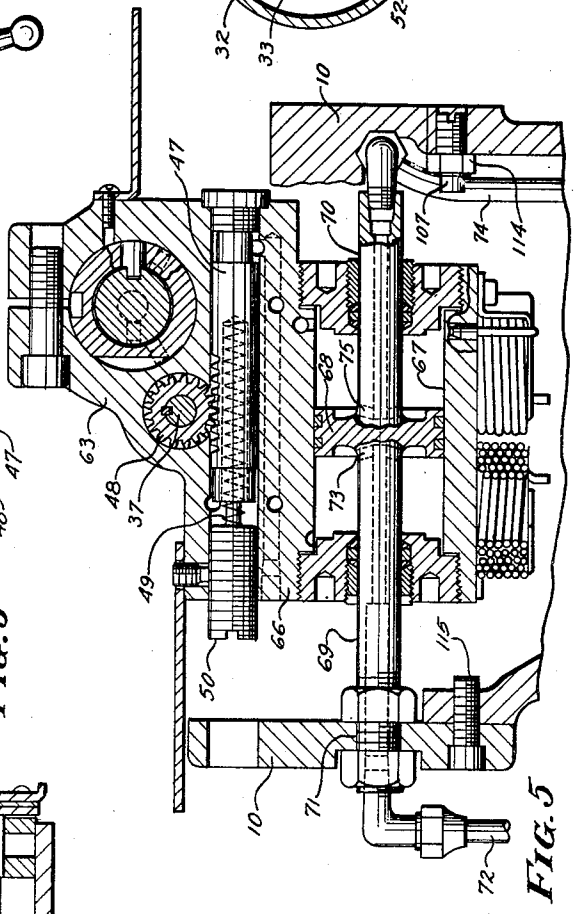


FIG. 5

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CONTINUOUS TRUING MECHANISM

Filed Sept. 3, 1937 5 Sheets-Sheet 3

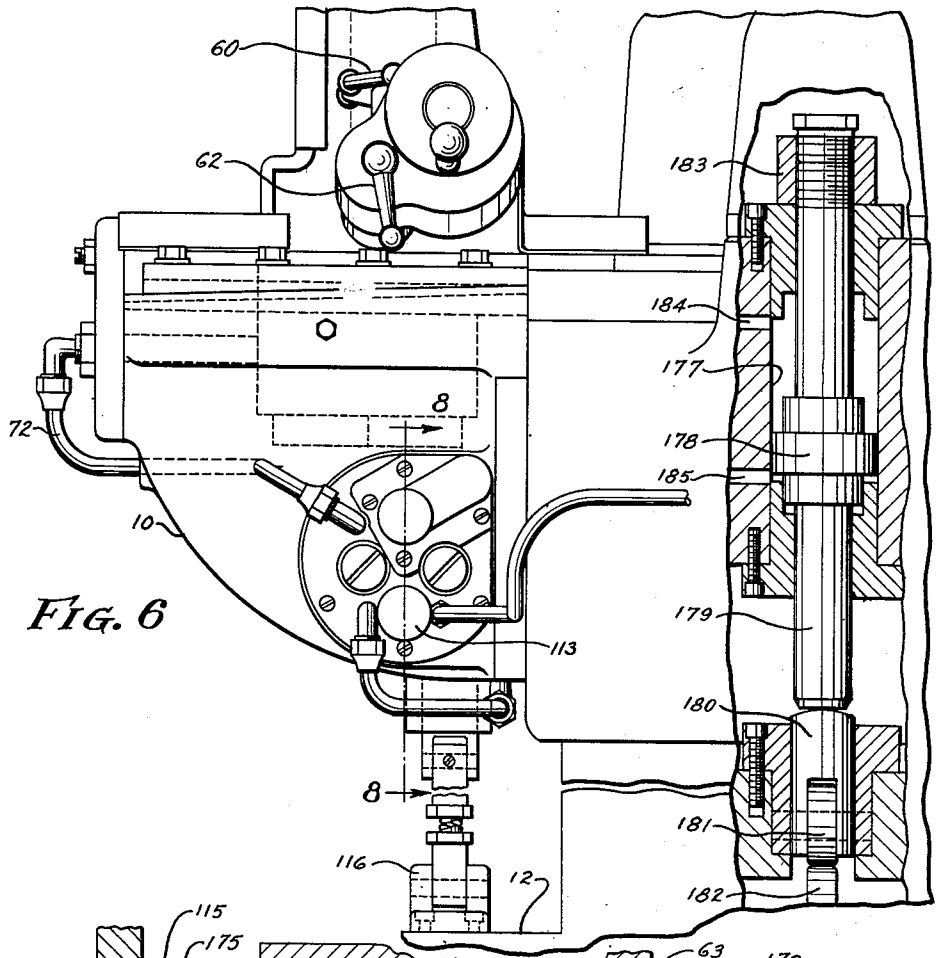


FIG. 6

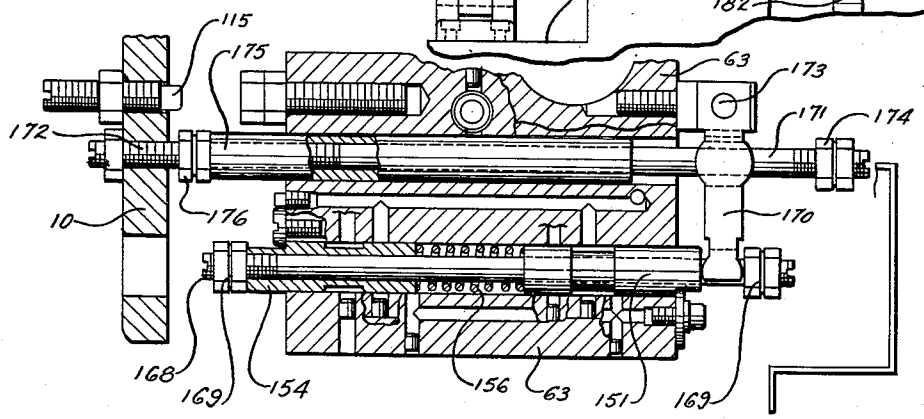


FIG. 7

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CONTINUOUS TRUING MECHANISM

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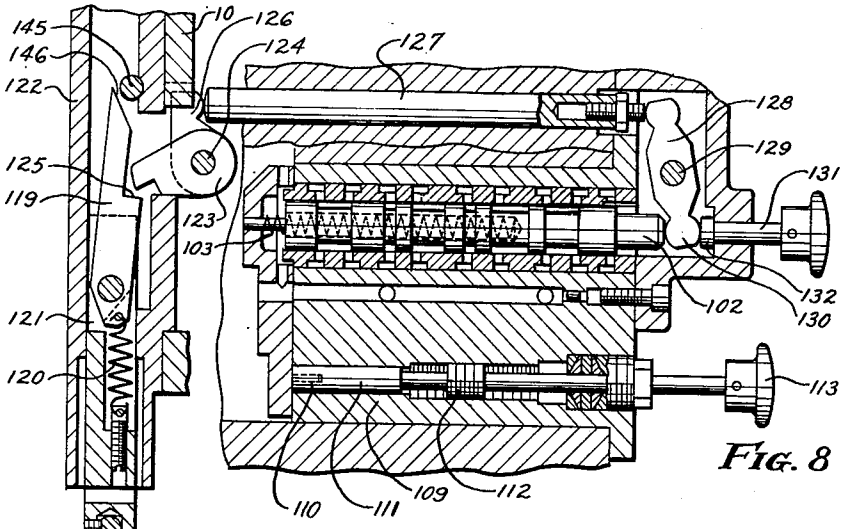


FIG. 8

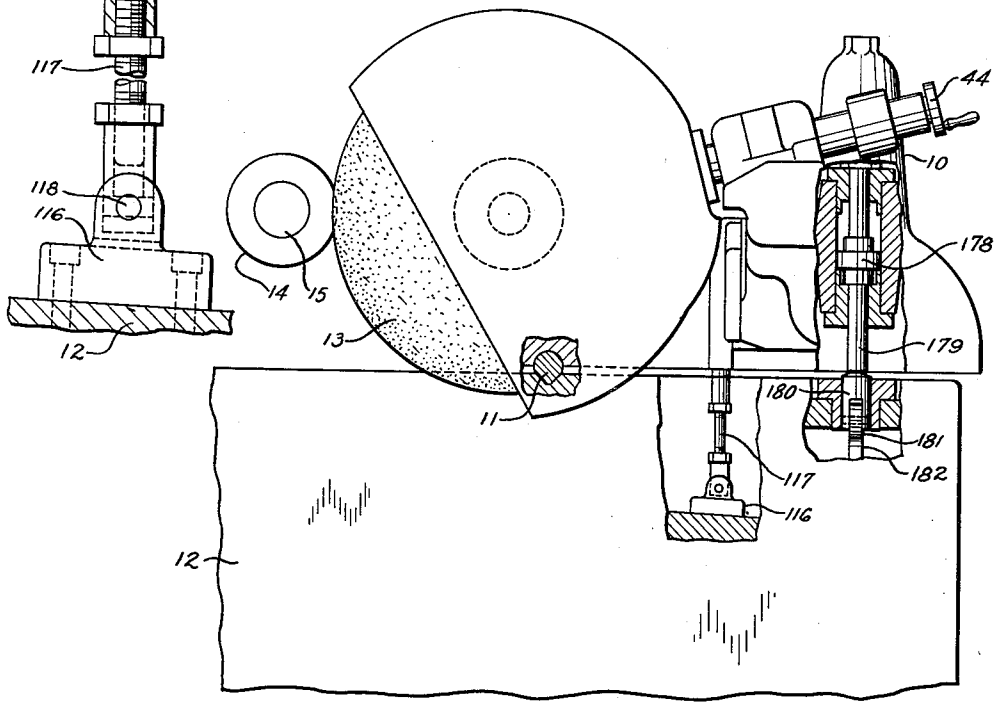


FIG. 9

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CONTINUOUS TRUING MECHANISM

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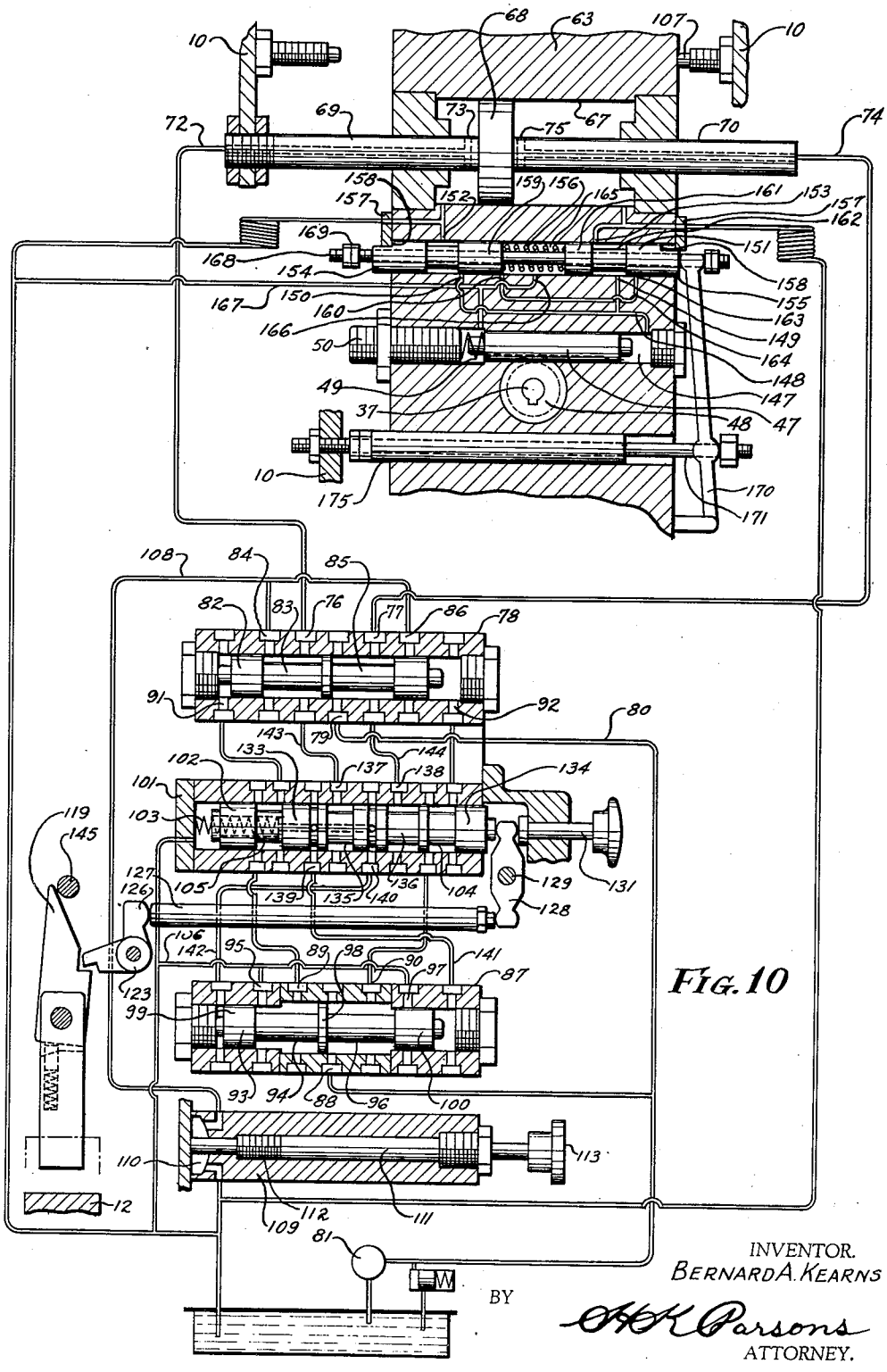


FIG. 10

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Patented Nov. 7, 1939

2,178,875

UNITED STATES PATENT OFFICE

2,178,875

CONTINUOUS TRUING MECHANISM

Bernard A. Kearns, Cincinnati, Ohio, assignor to Cincinnati Grinders Incorporated, Cincinnati, Ohio, a corporation of Ohio

Application September 3, 1937, Serial No. 162,239

15 Claims. (Cl. 51—262)

This invention relates to grinding machines and more particularly to improvements in wheel truing mechanisms therefor.

One of the objects of this invention is to provide an automatic mechanism for keeping the grinding wheel of a grinding machine continuously trued without attention on the part of the operator.

Another object of this invention is to provide a truing mechanism which will automatically function during the non-grinding time of an automatic cycle machine, whereby continuous production of the machine may be maintained.

A further object of this invention is to provide an improved one-stroke cycle truing mechanism.

An additional object of this invention is to provide a truing mechanism which is automatically energized by the separating movement between the wheel and the work, and which will complete a truing stroke before the wheel engages the next work piece.

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 illustrative of one embodiment thereof, but it will be understood that any modifications may be made in the specific structural details within the scope of the appended claims without departing from or exceeding the spirit of the invention.

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

Figure 1 is a plan view of a mechanism embodying the principles of this invention as applied to a grinding machine.

Figure 2 is a sectional view on the line 2—2 of Figure 1.

Figure 3 is a section on the line 3—3 of Figure 2.

Figure 4 is a detail section of the ratcheting mechanism as viewed on the line 4—4 of Figure 3.

Figure 5 is a sectional view as viewed on the line 5—5 of Figure 2.

Figure 6 is an end elevation partly in section as viewed from the right of Figure 2.

Figure 7 is a section taken on the line 7—7 of Figure 2.

Figure 8 is a sectional view taken on the line 8—8 of Figure 6.

Figure 9 is a side elevation of a grinding machine having an oscillatable wheel support.

Figure 10 is a diagrammatic view of the hydraulic control circuit.

In the grinding machine of the type shown in United States Patent No. 2,025,885, the principal elements of which are shown in Figure 9 of the present drawings, the grinding wheel housing is pivoted below the grinding wheel axis, whereby, through oscillation of the housing the grinding wheel may be moved toward and from a work piece. Such a machine has power means for moving the wheel through an automatic cycle starting with a rapid traverse advancing movement of the wheel to bring the same up to the work, a feeding movement to effect a grinding of the work to prescribed size, and a rapid return movement. It is desirable in such a machine to maintain the surface of the wheel parallel at all times to the axis of rotation of the work, and to keep the corners of the wheel sharp. With ordinary mechanisms now available, production on the machine must be stopped while the truing operation is being performed. This invention deals with a mechanism whereby the wheel is continuously trued after each work piece, and during the idle time of the machine cycle which is provided for changing the work.

Briefly, this invention contemplates a mechanism which will cause a truing diamond to execute one pass or stroke across the face of the grinding wheel for each cycle of the machine; and includes a control mechanism which is automatically tripped upon separation between the grinding wheel and the work to start a slide carrying the diamond. After the truing has been completed, the slide hits a positive stop and comes to rest. In addition, an infeed mechanism is provided which automatically feeds the truing diamond towards the wheel after passing out of engagement therewith, and at the end of the stroke, whereby the parts are conditioned to start the next stroke.

As shown diagrammatically in Figure 9, the wheel head housing 10 is pivotally supported by trunnions 11 on the bed 12 of the machine in such a manner that movement of the housing in a counterclockwise direction about the trunnion will cause the grinding wheel 13 to move into engagement with a work piece 14 supported in a rotatable chuck 15 carried by the bed 12. It will be obvious that movement of the housing in a clockwise direction will effect separation between the grinding wheel and the work, and it is this movement which is utilized to initiate operation of the truing mechanism.

Referring to Figure 3 of the drawings, the diamond or truing tool 16 is mounted in the end of a holder 17, which is reciprocably mounted in

a support 18, the latter being slidably mounted for movement in a bore formed in the cross slide 63. A key 19 serves to prevent relative rotative movement between the holder and the support.

The support 18 carries the mechanism for feeding the holder, and thereby the truing tool, toward and from the periphery of the grinding wheel 13. This mechanism includes a screw 20 which is connected without axial backlash to the holder 17 and in a manner that the screw may rotate without causing rotation of the holder. This connecting means comprises a plug 21, which is threaded in the end of a bore 22 in the holder, and the plug has an axial hole through which passes the reduced end 23 of the screw. A second washer 26 is mounted on the end of the reduced portion 23 and held against movement in one direction by a groove and ring construction 27. A third washer 28 is mounted on the reduced portion 23 in abutting relation to the inner end of the plug, and a spring 29 is interposed between the washers 26 and 28 whereby the spring continuously urges the screw in a direction to hold the washer 24 against one side of the plug 21 and the washer 28 against the other end of the plug. This establishes a non-backlash connection while permitting rotation of the screw with respect to the holder 17.

The screw is threaded in a nut 30 which has a gear 31 formed integral with one end thereof. A second gear 32 is supported for free rotation with respect to the screw and in abutting relation to the gear 31. The support 18 has a removable bonnet 33, and the dimension between the face 34 of the bonnet and the face 35 of the support is made such that upon assembly it will hold the two gears in abutting relation, and with just enough freedom to permit rotation of one with respect to the other.

The two gears 31 and 32 intermesh with a common idler gear 36 supported for free rotation on shaft 37. The gears 31 and 32, however, have a one-tooth differential whereby upon rotation of the gear 32 through one complete revolution, the gear 31 will be advanced one revolution plus one tooth.

In order to prevent backlash between the screw and nut 30, a second nut 38 is threaded on the screw and connected by a key 39 with the gear 31 for rotation thereby. A spring 40 is interposed between the nut 30 and the nut 38 to eliminate backlash therebetween.

The gear 32 is the driving gear for causing rotation of the screw and thereby the feeding of the holder 17 toward and from the grinding wheel. This gear may be actuated manually or automatically. For manual operation the hub of the gear is provided with clutch teeth 41 for interengagement with clutch teeth 42 formed on the hub 43 of the manually operable hand wheel 44. The hub of the hand wheel is keyed at 45 to the end of the screw 20 whereby, when the clutch teeth are disengaged, the screw will be rotated relative to the nut to effect a relatively fast traversing movement of the holder 18; but when the clutch teeth are engaged, rotation of the hand wheel will cause rotation of the gear 32, and due to its interconnection with the gear 31 through idler 36, will cause an opposite direction of rotation of the nut 30 as respects the direction of rotation of the screw, and a relatively slow feeding movement will result.

A spring pressed detent 46 is provided for holding the hand wheel in either one of its two axial positions. During automatic operation of the device, it is desirable that the truing tool be indexed axially a small amount toward the grinding wheel after each truing stroke and this is effected by a ratcheting mechanism.

As shown in Figure 5, an hydraulically reciprocated rack plunger 47 is slidably mounted in a bore in the slide 63 in intermeshing relation with a pinion 48 keyed to the shaft 37. A spring 49 is interposed between the end of the plunger and an adjustable set screw 50, which is threaded in the end of the plunger bore, for returning the plunger to the position in which it is shown in Figure 5 after the hydraulic pressure has been released. The set screw 50 is adjustable to determine the length of the stroke of the plunger 47 and thereby the amount of the indexing movement.

The shaft 37, as shown in Figure 3, has a pinion 51 keyed to the end thereof, and intermeshing, as shown in Figure 4, with a mutilated gear 52. This gear has a lug 53 projecting therefrom into engagement with an oscillatable shoe 54 which carries a pivoted pawl 55. A leaf spring 56 carried by the shoe serves to hold the pawl into engagement with the teeth of gear 32. It will now be apparent that when fluid pressure shifts the plunger 47 to the left, as viewed in Figure 5, that the shaft 37, as viewed in Figure 4, will be rotated in a clockwise direction, thereby causing a counterclockwise direction of rotation of gear 52, and movement of the pawl 55 in a direction to cause rotation of the gear 32. This in turn will cause rotation of the gear 31 in the same direction through the idler 36 and thereby a feeding movement of the screw and connected holder.

The range of movement of the truing tool must be a considerable amount due to the difference between the maximum and minimum sizes of grinding wheel, but it is not desirable that the holder itself be capable of this range of movement because the overhang would be too great. Means have therefore been provided whereby after a certain limited movement of the holder with respect to the support 18, the support itself may be moved inward and the holder retracted, whereby it will be in a position to start a new series of infeeding movements.

The mechanism for adjusting the support 18 comprises a series of rack teeth 57 which are formed longitudinally along one side of the support, and a pinion 58, which is rotatably mounted in the slide 63 in intermeshing relation with the rack teeth. The pinion is keyed to the end of a shaft 59 which extends to the top of the housing and provided with a hand wheel 60, as more particularly shown in Figure 1. It will now be apparent that by rotation of the hand wheel 60, the support 18 may be longitudinally adjusted. Since the gear 48 is carried by the slide 63 and the gear 51 is carried by the support 18, the shaft 37 is provided with a spline connection 61 with the gear 48 whereby longitudinal adjustment of the support may be made without interfering with the driving connection between pinions 48 and 51.

The shaft 37 may be provided with a hand lever 62 for manual actuation of the ratchet mechanism.

The truing tool, and ratcheting mechanism therefor, is carried by the cross slide 63, which, as shown in Figure 2, is supported on guide surfaces 64 and 65 formed on the housing 10. The slide 63 has a portion 66 depending between the guide surfaces in which is formed a cylinder 67. A piston 68 is contained in this cylinder, and has piston rods 69 and 70 projecting through both ends of the cylinder. The piston rod 69 is per-

manently connected at 71 to the housing 10. This results in the cylinder being the moving member, and the piston the stationary member. The piston rod 69 has an axial bore formed therein which constitutes part of a supply channel 72, and this bore terminates in a port 73 through which fluid is supplied to one end of the cylinder. The piston rod 70 also has an axial bore therein forming part of channel 74 and terminating in a port 75 through which fluid is supplied to the other end of the cylinder.

As shown in Figure 10, the channels 72 and 74 are connected to ports 76 and 77 of a reversing valve 78. This valve has a pressure port 79 to which fluid is delivered through channel 80 from a pump or other suitable source of pressure 81. A plunger 82 is reciprocably mounted in the valve housing, and has a first annular groove 83, by means of which port 76 may be alternately connected to the pressure port 79 or to an exhaust port 84; and a second annular groove 85 by means of which port 77 may be alternately connected to pressure port 79, or exhaust port 86.

The shifting of this valve is pilot controlled by a pilot valve 87, which has a pressure port 88, and a pair of ports 89 and 90 which are normally connected to ports 91 and 92 respectively located in opposite ends of the reversing valve housing 78. The pilot valve plunger 93 has a first annular groove 94 formed therein for alternately connecting port 89 to pressure port 88 or exhaust port 95; and a second annular groove 96 for alternately connecting port 90 to pressure port 88 or exhaust port 97. The spool 98, which separates the annular grooves, is larger in diameter than the end spools 99 and 100 of the plunger, whereby, when the plunger is shifted and passes the central position, a pressure differential will be created causing the spool to automatically complete its shifting movement. This produces the same effect as a load and fire mechanism.

A starting valve 101 is interconnected between the reversing valve 78 and its pilot valve 87. When the plunger 102 of this valve is in the position shown, and in which it is normally held by a spring 103 interposed between one end of the plunger and the valve housing, the port 90 of the pilot valve is connected by an annular groove 104 in the plunger 102 to the port 92; and the port 89 is interconnected by an annular groove 105 to port 91 of the reversing valve 78. From this it will now be seen that in the position of the parts, that pressure fluid from pump 81 is flowing through port 88, annular groove 96 and port 90 of the pilot valve to the right hand end of the reversing valve thereby shifting the plunger thereof to its extreme left position, and the other end of the reversing valve is connected through annular groove 105 of the starting valve, and ports 89 and 95 of the pilot valve, to a return line 106. This will result in pressure from port 79 of the reversing valve flowing through port 77 and channel 74 to the right hand end of cylinder 67 causing the slide 63 to move toward the right, as viewed in Figure 10, since the cylinder is the moving element, until the slide abuts a positive stop 107. Fluid in the other end of the cylinder is exhausted through channel 72 and interconnected ports 76 and 84 of the reversing valve, to return channel 108.

In order to control the rate of movement of the slide, the channel 108 has interposed therein a throttle valve 109, in which is formed a narrow slit 110 which is intersected by an adjustable plunger 111. The plunger 111 is threaded at 112 in the casting, and provided with an operating knob 113 whereby the end of the plunger may be adjusted to determine the size of the opening between the end of the plunger and the housing to thereby vary the rate of exhaust from the cylinder 67 and thus the rate of movement of the slide 63.

As shown in Figure 5, the adjustable stop 107 may consist of a set screw which is threaded in the housing 10, and provided with a lock nut 114 to thereby variably determine one end of the stroke of the truing tool, and a second adjustable positive stop 115 is provided for determining the other end of the stroke. When the slide 63 engages either one of these positive stops, it is held in that position by the fluid pressure which moved the slide, and until the reversing valve is shifted again. Means have been provided whereby this shifting of the reversing valve will take place immediately after the grinding wheel passes out of engagement with the work on its return stroke. This mechanism is more particularly shown in Figures 6 and 8 and comprises a pillow block 116 which is fastened to the bed 12 of the machine to which an adjustable link 117 is connected by means of a pin 118. This link has a pawl 119 pivotally supported in the upper end thereof and normally urged in a clockwise direction by a spring 120. The upper end of the link has a sliding fit at 121 in a tubular guide portion 122 which depends from the oscillatable wheel housing 10.

It should now be apparent that the link 117 and pawl 119 remain stationary as respects vertical movement, and that the guide 122 moves vertically with respect to the link as the wheel moves toward and from the work. Since this mechanism is located on the opposite side of the trunnion 11 from the work, it will be apparent that when the wheel is retracted from the work that the guide 122 will move downward, as viewed in Figure 8. A bell crank lever 123 is pivotally mounted at 124 for movement with the tubular guide, and has one arm projecting within the bore for engagement with a shoulder 125 formed on the side of the pawl 119.

Thus, as the housing moves downward, the bell crank 123 is rotated in a clockwise direction whereby the arm 126 of the bell crank will shift a rod 127 which is in continuous engagement therewith, toward the right, as viewed in Figure 8, and oscillate a lever 128, which is pivotally supported in the middle by a pin 129. The end 130 of the lever 128 is interposed between the end of the plunger 102 and a manually operable plunger 131, which has a head 132 formed thereon for limiting axial movement thereof, whereby the spring 103 normally holds these parts in engagement with one another in the position shown in Figure 8 and normally holds the rod 127 shifted to the left. But when the bell crank 123 is rotated clockwise, the rod 127 shifts the starting plunger 102 to the left, as viewed in Figure 8, against the resistance of spring 103.

This results in the spools 133 and 134 on the plunger 102 disconnecting the ports 91 and 92 of the reversing valve from ports 89 and 90 respectively of the pilot valve 87 whereby the pilot valve plunger may now be shifted without causing any immediate change in the position of the reversing valve plunger. Shifting of the starting valve plunger 102 also results in annular grooves 135 and 136 interconnecting ports 137 and 138 respectively to ports 139 and 140. Ports 139 and 140 are connected by channels 141 and 142 re-

spectively to opposite ends of the pilot valve housing 87. In addition, ports 137 and 138 are connected by channels 143 and 144 to ports 76 and 77 of the reversing valve plunger 78. This results in the opposite ends of the pilot valve plunger being connected to channels 72 and 74 which lead to the cylinder 67, and therefore will be under pressure or exhaust in accordance with the conditions existing in channels 72 and 74.

It will be remembered from the previous description, that the channel 74 was under pressure and the slide 63 was being held against the positive stop 107, and therefore, with the set up of the parts as shown, when the plunger 102 is shifted to the left, channel 144 will be under pressure whereby, upon the interconnection of ports 138 and 140, fluid will flow to the left hand end of the pilot valve housing and shift the plunger thereof to the right. This will cause pressure port 88 to become interconnected with port 89, and port 90 to become interconnected with the exhaust port 97. The result will be that when the plunger 102 is returned to its normal position that fluid will now flow to the left end of the reversing valve, and shift the same to the right, and thereby connect pressure to the left end of cylinder 67, whereby the slide 63 will move to the left and feed the truing tool across the wheel.

The return of the starting valve to its normal position is effected almost immediately after it is shifted to the right, by means of a simple mechanism shown in Figure 8. In other words, as the housing 10 moves downward, it rotates the bell crank 126 a sufficient amount to shift the starting valve 102, after which a pin 145 engages the bevelled end 146 of the pawl 119 and rotates the same in a counterclockwise direction against the resistance of spring 120, and thereby withdraws the shoulder 125 out of engagement with the end of the bell crank, whereby the spring 103 continuously acting on the end of the starting valve plunger 102, may return the parts to their original position.

Thus the return movement of the grinding wheel is utilized to initiate the feeding movement of the truing tool across the face of the wheel, and after the movement has been once started it will continue until the slide hits the positive stop.

Attention is invited to the fact that the ports 137 and 138 will alternately be under pressure dependent upon the position of the reversing valve plunger, so that when the starting valve is shifted one time, it will admit pressure to one end of the pilot valve 87; and when it is shifted the next time, it will admit pressure to the other end of the pilot valve. It thus becomes possible to reverse the position of the pilot valve each time the starting valve plunger is shifted. For set up purposes and the like, the manually operable plunger 131 has been provided whereby the starting valve may be shifted at will by the operator to initiate a stroke of the truing tool.

As previously mentioned, the truing tool is axially indexed a small amount near the end of its stroke, but after it has passed out of engagement with the grinding wheel. The mechanism for initiating this action is more particularly shown in Figures 7 and 10. As shown in Figure 10, one end of the bore 147 which contains plunger 47 is connected by channel means 148 to two ports 149 and 150 of a trip controlled valve indicated generally by the reference numeral 151. This valve has two ports 152 and 153 which are connected by channel means to opposite ends of cylinder 67, whereby these ports are under pressure or exhaust depending upon the conditions existing in the opposite ends of the cylinder. The plunger of this valve is divided into two parts 154 and 155 which are held separated by a spring 156 interposed between the adjacent ends of the plungers. Abutment plates 157 engaging shoulders 158 on the plungers limit their outward movement. When these plungers are in their extreme positions, a spool 159 on plunger 154 closes port 160 and opens a drain port 160. Also a spool 161 on plunger 155 closes port 153; and an annular groove 162 in plunger 155 interconnects port 149 with an exhaust port 163. The exhaust port 163 is connected by an interdrilled channel 164 to exhaust port 160. This permits any fluid in the end of cylinder 147 to be exhausted through channel 148, interconnected ports 149 and 163, channel 164, port 160 to the space 165 existing between the adjacent ends of the plungers, and this space is continuously connected to reservoir by means of a centrally located port 166 which is never closed and to which is connected the return channel 167 leading to reservoir.

A shifter rod 168 extends axially through these two plungers and is provided with a pair of lock nuts 169 on each end thereof. The bifurcated end of a lever 170 embraces the rod 168 between one set of lock nuts and the plunger 151. The lock nuts are sufficiently spaced apart that the two plungers may be moved to their outward positions, as shown in Figure 7, while still providing room for the end of lever 170 between the end of plunger 151 and the lock nuts attached to that end of the rod. The rod is supported for free axial movement with respect to the plungers. The purpose of this construction is that when the lever 170 is rotated in a clockwise direction, as viewed in Figure 7 and corresponding to a counterclockwise direction, as viewed in Figure 10, the plunger 151 will be shifted to the left a sufficient amount to close the exhaust port 163 and interconnect ports 153 and 149, whereby pressure existing in the right hand end of cylinder 67 will be delivered to the cylinder 147 and cause the plunger 47 thereof to be shifted to the left and thereby index the truing tool. On the other hand, as the lever 170 is rotated in the opposite direction, the rod 168 will be pulled toward the right without disturbing the position of plunger 151, but will shift the plunger 154 toward the right thereby closing exhaust port 160 and interconnecting ports 152 and 150 whereby, when pressure is existing in the left hand end of cylinder 67, it will flow through cylinder 147 and cause an axial indexing movement of the truing tool. Thus regardless of the direction of movement of the trip lever 170 it will cause an indexing movement of the truing tool whereby the truing tool may be indexed at each end of its stroke.

Actuation of the trip lever 170 is effected by a trip rod 171 which is permanently fixed at 172 to the housing 10. The trip lever 170 is pivotally mounted at 173 on the slide 63 and therefore moves with it. The rod 171 has a pair of lock nuts 174 threaded on one end, and the lever 170 has a hole through which the rod 171 passes, so that the lever may move along the rod during movement of the slide 63. When it engages the lock nuts 174 which are held in a fixed position, it is caused to be rotated in a clockwise direction, as viewed in Figure 7.

A sleeve 175 is mounted on the rod 171 and held against axial movement in one direction by a pair

of lock nuts 176 which are threaded on the trip rod 171. The result is that when the slide 63 moves toward the left, as viewed in Figure 7, the lever 170 engages the end of the sleeve which forms a sort of shoulder thereby causing the lever 170 to be rotated in a counterclockwise direction, as viewed in Figure 7, and thereby cause actuation of the plunger 154. It will be noted that a considerable space exists between the end of the sleeve 175 and the lock nuts 174 whereby the slide 63 may move a sufficient distance to carry the truing tool across the face of the wheel, before the lever 170 is rotated to actuate either plunger 151 or 154, and cause fluid operation of plunger 47 and the connected indexing mechanism.

Briefly, the operation of the device is as follows. The grinding wheel is oscillated toward and from the work support to automatically grind the work to desired size by some form of suitable mechanism, which may comprise for instance a cylinder 177 formed in the wheel housing, Figures 6 and 9, and containing a piston 178 having a piston rod 179 which projects through both ends of the cylinder. The lower end of the piston rod may engage a follower 180 having a roller 181 riding on the periphery of a feed rate control cam 182. The upper end of the piston rod may be provided with an adjustable nut 183. It will now be apparent that if fluid pressure is admitted through port 184 to the upper end of cylinder 177, that the piston 179 will be held in engagement with the cam and that the grinding wheel housing will move upward in a counterclockwise direction about the trunnion 11 to rapidly move the grinding wheel up to the work. Following this the cam 182 may be rotated to move the grinding wheel at a feeding rate into the work and thereby reduce the same to size. Upon completion of the grinding operation a sudden drop may be provided in the cam 182, and fluid pressure may be admitted to the port 185 whereby the wheel head will be suddenly retracted from the work.

At the beginning of the retractive movement the trip rod for the starting valve will be actuated by the pawl 119 and the starting valve will be momentarily shifted to cause shifting of the pilot valve plunger during which time both ends of the reversing valve will be blocked. Immediate return of the starting valve will reconnect both ends of the reversing valve housing to the pilot valve, which now, in its new position, will cause shifting of the reversing valve plunger, and initiation of a feeding movement of slide 63, the rate of which will be determined by the setting of the feed rate control throttle 109. After the truing tool has passed out of engagement with the grinding wheel, and before the slide 63 hits either one of the positive stops, the trip rod 174 will cause rotation of lever 170, and thereby a shifting of one of plungers 151, 154 to cause fluid actuation of the truing tool indexing mechanism. Since all of this truing mechanism is carried by the oscillating wheel slide, it will be apparent that the truing action can go on while the wheel housing is being returned to permit replacement of the work, as well as during the rapid advancing movement of the next grinding cycle. The mechanism has been designed so that the truing action is completed by the time that the grinding wheel engages the next work piece. Thus the mechanism provided is capable of keeping the wheel trued at all times during the operation of the machine, and that there is no necessity for holding up production on the machine at any time to true the grinding wheel thereof.

I claim:

1. In a grinding machine having a work support, a rotatably supported grinding wheel, and means for effecting a continuously repeating cycle of movement of the grinding wheel toward and from the work support to effect production grinding of successive work pieces, the combination of means for continuously truing the grinding wheel, including a truing tool supported for movement across the face of the grinding wheel, automatic means operable once during a cycle of the machine for causing the truing tool to make a single unidirectional stroke across the face of the grinding wheel, and means for effecting a reverse stroke of the truing tool during the succeeding cycle.

2. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel, and means to effect relative movement between said supports to effect an infeed grinding cycle, the combination of a truing tool supported on the grinding wheel support for movement across the face of the grinding wheel, power operable means for reciprocating said tool, including a control circuit having a spring returned starter, an automatically releasable trip, means operable thereby for momentarily shifting said starter to determine the direction of movement of said truing tool, means to reversely shift the starter to initiate said movement and means for positively stopping said tool at the end of one stroke.

3. In a grinding machine having a work support, and a grinding wheel power movable through an automatic cycle to effect grinding of a work piece to predetermined size, the combination of means for truing said wheel after grinding each work piece, including a fluid reciprocable truing tool, an hydraulic control circuit therefor, including a reversing valve, a pilot valve, means controlled by the position of the pilot valve for determining the position of the reversing valve, means in the reversing valve for predetermining the position of the pilot valve, and means normally disconnecting said reversing valve from said pilot valve whereby the truing tool will stop at the end of a given stroke.

4. In a grinding machine having a work support, and a grinding wheel power movable through an automatic cycle to effect grinding of a work piece to predetermined size, the combination of means for truing said wheel after grinding each work piece, including a fluid reciprocable truing tool, an hydraulic control circuit therefor, including a reversing valve, a pilot valve, means controlled by the position of the pilot valve for determining the position of the reversing valve, means in the reversing valve for predetermining the position of the pilot-valve, means normally disconnecting said reversing valve from said pilot valve whereby the truing tool will stop at the end of a given stroke, and a trip operable mechanism for shifting said last named means at the beginning of the non-grinding part of said cycle whereby the grinding wheel may be trued while the work is being changed.

5. In a grinding machine having a work support and a grinding wheel support, the combination of a fluid operable truing tool carried by said grinding wheel support, a fluid control circuit for said truing tool, including a reversing valve for changing the direction of movement of the truing tool, power operable means for shifting

said reversing valve, a starting valve normally disconnecting said power operable means from the reversing valve, and means to actuate said starting valve and cause said power operable means to shift said reversing valve, and thereby effect movement of the truing tool on a single stroke across the face of the grinding wheel.

6. In a grinding machine having a work support and a grinding wheel support, the combination of a fluid operable truing tool carried by said grinding wheel support, a fluid control circuit for said truing tool, including a reversing valve for changing the direction of movement of the truing tool, power operable means for shifting said reversing valve, a starting valve normally disconnecting said power operable means from the reversing valve, means to actuate said starting valve and thereby cause shifting of said reversing valve to effect movement of the truing tool, and a positive stop for limiting the length of said movement.

7. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel, and means to effect relative movement between said supports to effect an infeed grinding cycle, the combination of a truing tool supported on the grinding wheel support, fluid operable means for reciprocating said tool across the face of the grinding wheel, a control circuit therefor including a spring returned starting valve, automatically releasable trip operable means for positively shifting said starting valve to initiate movement of the truing tool, means for positively stopping said tool at the end of a stroke, a fluid operable ratcheting mechanism for indexing the truing tool toward the grinding wheel, and valve means trip operable by the truing tool prior to engagement with said positive stop for energizing said last named fluid operable means.

8. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative movement between said supports for performance of a grinding operation, the combination of a truing tool supported on the grinding wheel support for movement across the face of the grinding wheel and means for controlling the movement of said truing tool including a source of hydraulic actuating fluid, a reversible hydraulic motor actuable thereby and coupled with the truing tool, and valve means intervening the source of fluid and said motor, including a first valve for reversing the fluid connections to the motor, a second valve, hydraulic connections between said valves alternatively connectible to place either of said valves in positioning control with respect to the other, and means for effecting such alternative connections.

9. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative movement between said supports for performance of a grinding operation, the combination of a truing tool supported on the grinding wheel support for movement across the face of the grinding wheel and means for controlling the movement of said truing tool including a source of hydraulic actuating fluid, a reversible hydraulic motor actuable thereby and coupled with the truing tool, and valve means intervening the source of fluid and said motor, including a first valve for reversing the fluid connections to the motor, a second valve, hydraulic connections between said valves alternatively connectible to place either of said valves in positioning control with respect to the other, and means for effecting such alternative connections, said means including a multiple connection control valve.

10. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative movement between said supports for performance of a grinding operation, the combination of a truing tool supported on the grinding wheel support for movement across the face of the grinding wheel and means for controlling the movement of said truing tool including a source of hydraulic actuating fluid, a reversible hydraulic motor actuable thereby and coupled with the truing tool, and valve means intervening the source of fluid and said motor, including a first valve for reversing the fluid connections to the motor, a second valve, hydraulic connections between said valves alternatively connectible to place either of said valves in positioning control with respect to the other, and means for effecting such alternative connections, said means including a multiple connection control valve, and means for yieldingly maintaining said last-mentioned valve in a normal position effecting a control connection from the second to the first-named valve for maintaining a selected uni-directional urge of the truing device motor.

11. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative movement between said supports for performance of a grinding operation, the combination of a truing tool supported on the grinding wheel support for movement across the face of the grinding wheel and means for controlling the movement of said truing tool including a source of hydraulic actuating fluid, a reversible hydraulic motor actuable thereby and coupled with the truing tool, and valve means intervening the source of fluid and said motor, including a first valve for reversing the fluid connections to the motor, a second valve, hydraulic connections between said valves alternatively connectible to place either of said valves in positioning control with respect to the other, and means for effecting such alternative connections, said means including a multiple connection control valve, and means for yieldingly maintaining said last-mentioned valve in a normal position effecting a control connection from the second to the first-named valve for maintaining a selected uni-directional urge of the truing device motor, and trip operated means actuable by supporting movement of the work and grinding wheel supports for effecting an alternative positioning of the multiple connection control valve.

12. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative movement between said supports for performance of a grinding operation, the combination of a truing tool supported on the grinding wheel support for movement across the face of the grinding wheel and means for controlling the movement of said truing tool including a source of hydraulic actuating fluid, a reversible hydraulic motor actuable thereby and coupled with the truing tool, and valve means intervening the source of fluid and said motor, including a first valve for reversing the fluid connections to the motor, a second valve, hydraulic connections between said valves alternatively connectible to place either of said valves in positioning control with respect

to the other, means for effecting such alternative connections, said means including a multiple connection control valve, means for yieldingly maintaining said last-mentioned valve in a normal position effecting a control connection from the second to the first-named valve for maintaining a selected uni-directional urge of the truing device motor, trip operated means actuable by supporting movement of the work and grinding wheel supports for effecting an alternative positioning of the multiple connection control valve, additional means actuable by continued relative movement of the supports for counteracting the effect of said trip means whereby said control valve will be yieldingly restored to normal position, means for effecting minute feeding adjustments of the truing tool with respect to its support including a hydraulically reciprocable plunger, conduits extending from the plunger to the hydraulic motor for effecting translation of the truing tool support, and means actuable by motor effected movement of the support for effecting alternate couplings of the opposite sides of the motor with one terminus of the plunger whereby successive uni-directional actuating impulses are imparted to the plunger.

13. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative approach and retraction of said supports for performance of a grinding operation, the combination of a truing tool supported adjacent the grinding wheel for movement transversely of the operative face of the grinding wheel, and power operable means for controlling the feed and translation of said tool including a hydraulically actuable motor, a source of fluid under pressure adapted for utilization in actuation of said motor, valve means for effecting individual reversals of the motor including a reversing valve mechanism and a temporarily energizable valve for effecting momentary hydraulic actuation of the reversing valve mechanism, and trip means operable on relative retraction of the work and grinding wheel supports for energizing said temporarily energizable valve.

14. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative approach and retraction of said supports for performance of a grinding operation, the combination of a truing tool supported adjacent the grinding wheel for movement transversely of the operative face of the grinding wheel, and power operable means for controlling the feed and translation of said tool including a hydraulically actuable motor, a source of fluid under pressure adapted for utilization in actuation of said motor, valve means for effecting individual reversals of the motor including a reversing valve mechanism and a temporarily energizable valve for effecting momentary hydraulic actuation of the reversing valve mechanism, trip means operable on relative retraction of the work and grinding wheel supports for energizing said temporarily energizable valve, means for effecting incremental feeding movements of the truing tool in the direction of the plane of the operative face of the grinding wheel, and means actuable by movement of the truing device translating motor for diverting a portion of the actuating fluid therefrom for actuation of the said feed mechanism.

15. In a grinding machine having a work support, a rotatable grinding wheel, a support for said grinding wheel and means to effect relative approach and retraction of said supports for performance of a grinding operation, the combination of a truing tool supported adjacent the grinding wheel for movement transversely of the operative face of the grinding wheel, and power operable means for controlling the feed and translation of said tool including a hydraulically translating motor, a source of fluid under pressure adapted for utilization in actuation of said motor, valve means for effecting individual reversals of the motor including a reversing valve mechanism and a temporarily energizable valve for effecting momentary hydraulic actuation of the reversing valve mechanism, trip means operable on relative retraction of the work and grinding wheel supports for energizing said temporarily energizable valve, means for effecting incremental feeding movements of the truing tool in the direction of the plane of the operative face of the grinding wheel, and means actuable by movement of the truing device translating motor for diverting a portion of the actuating fluid therefrom for actuation of the said feed mechanism, said diverting means including selector devices for successively correspondingly coupling fluid from opposite sides of the translating motor with the feed mechanism whereby uni-directional feeding movement is imported to the truing tool.

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