May 6, 1947. H. E. BALSIGER ET AL 2,419,940

GRINDING MACHINE

Filed March 3, 1944 5 Sheets-Sheet 1

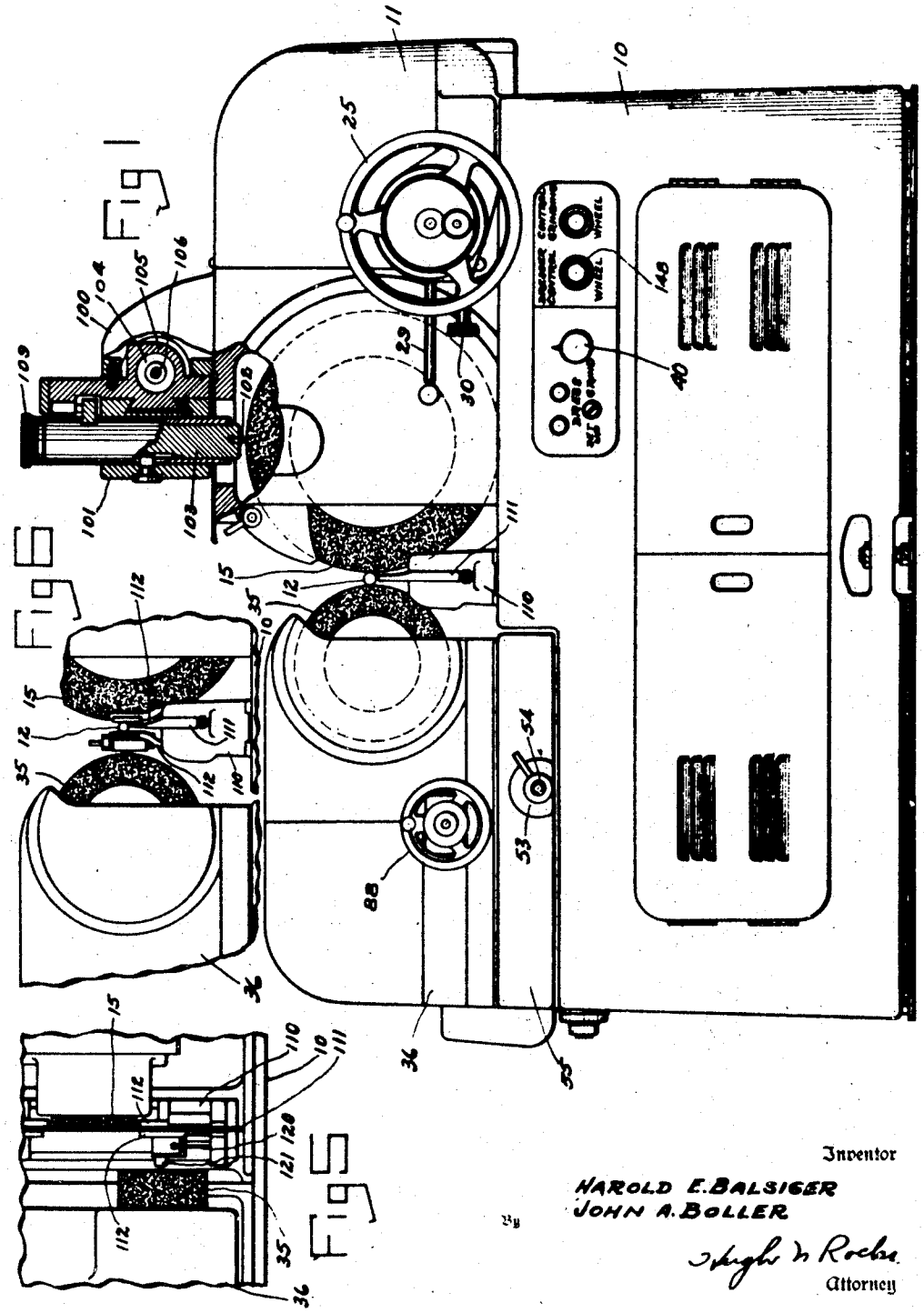


Fig 1

Fig 6

Fig 5

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GRINDING MACHINE

Filed March 3, 1944 5 Sheets-Sheet 2

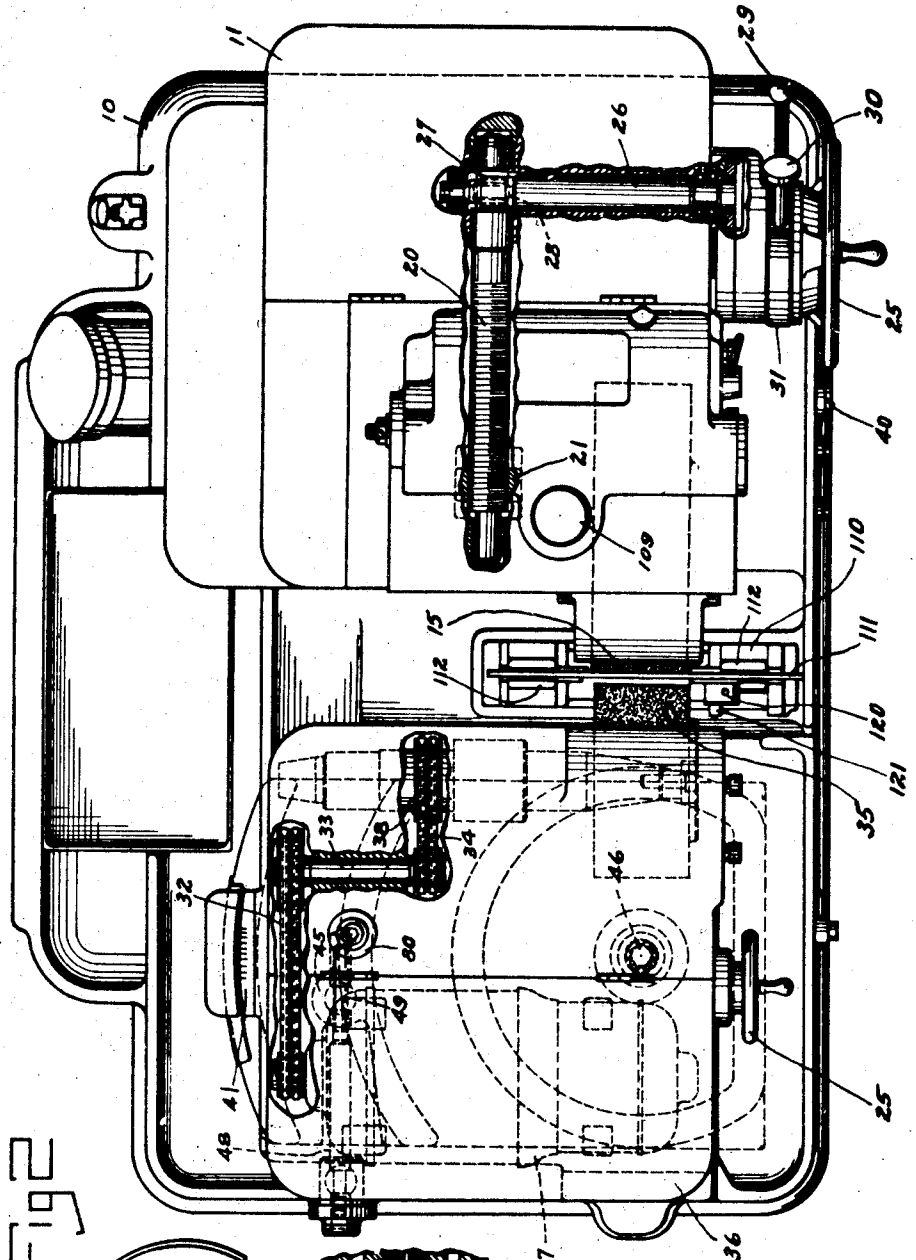


Fig 2

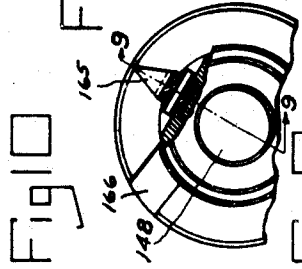


Fig 10

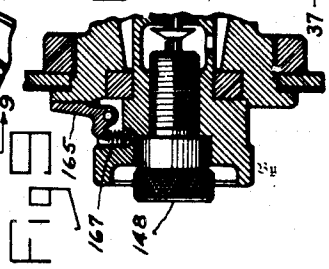


Fig 5

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GRINDING MACHINE

Filed March 3, 1944 5 Sheets-Sheet 3

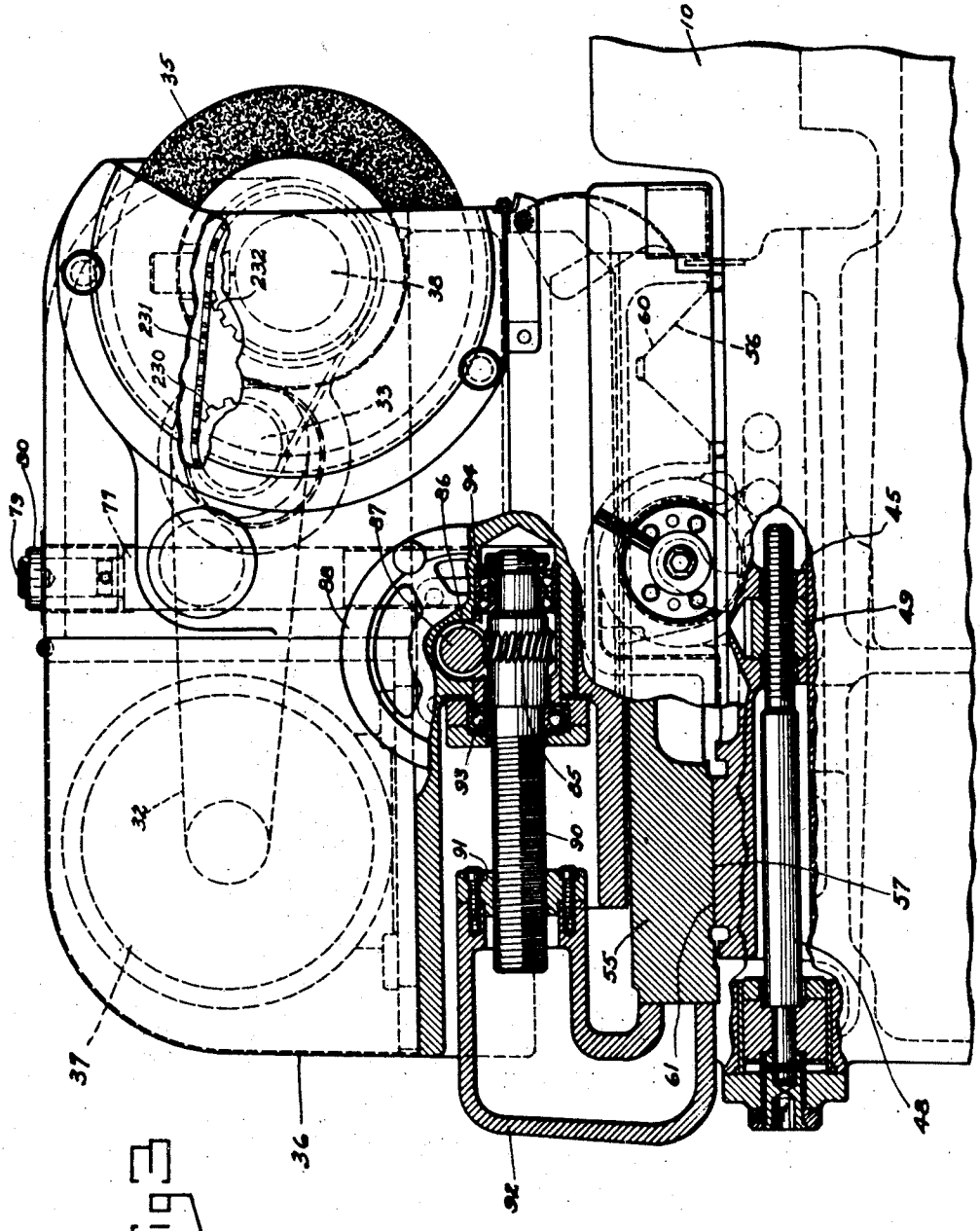


Fig 3

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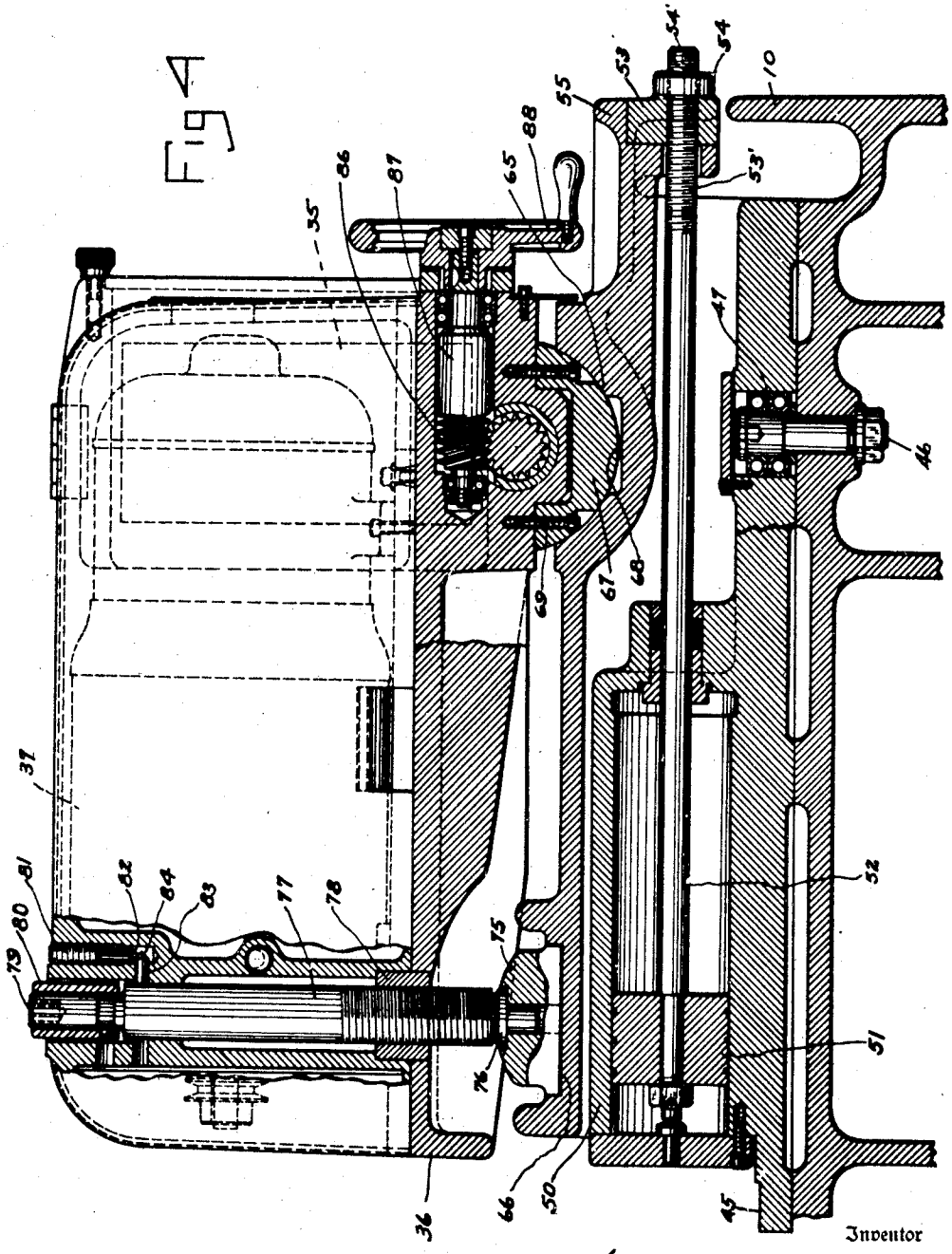
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GRINDING MACHINE

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Fig 4



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GRINDING MACHINE

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Fig 7

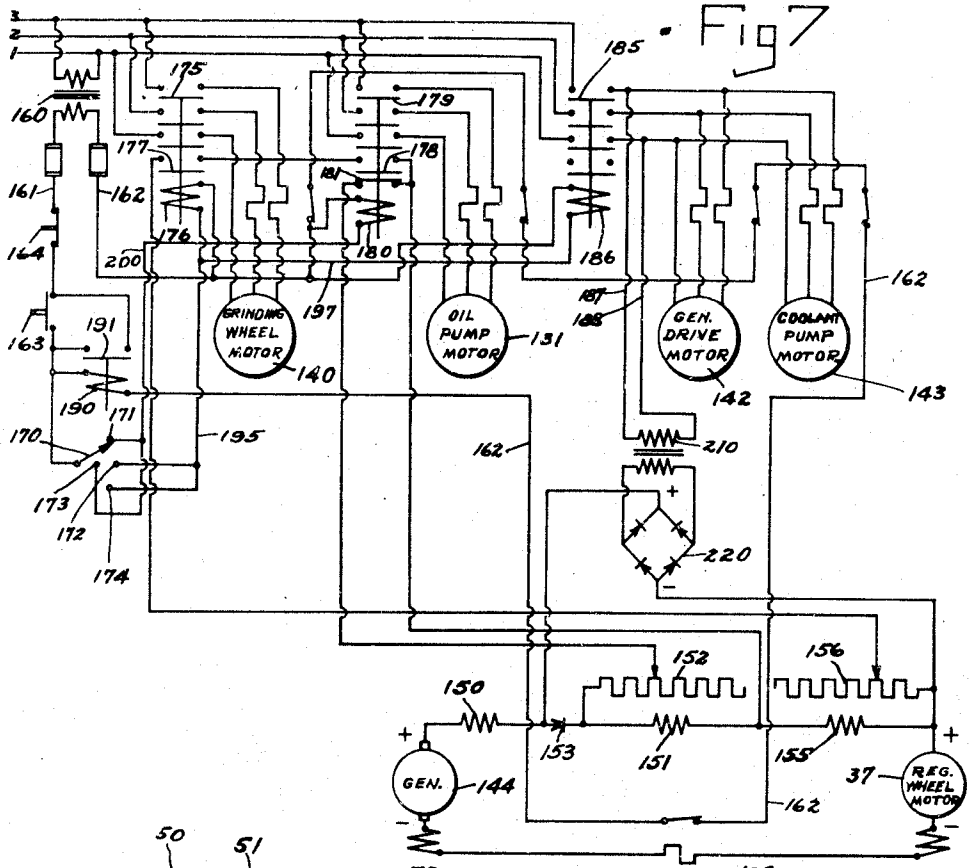
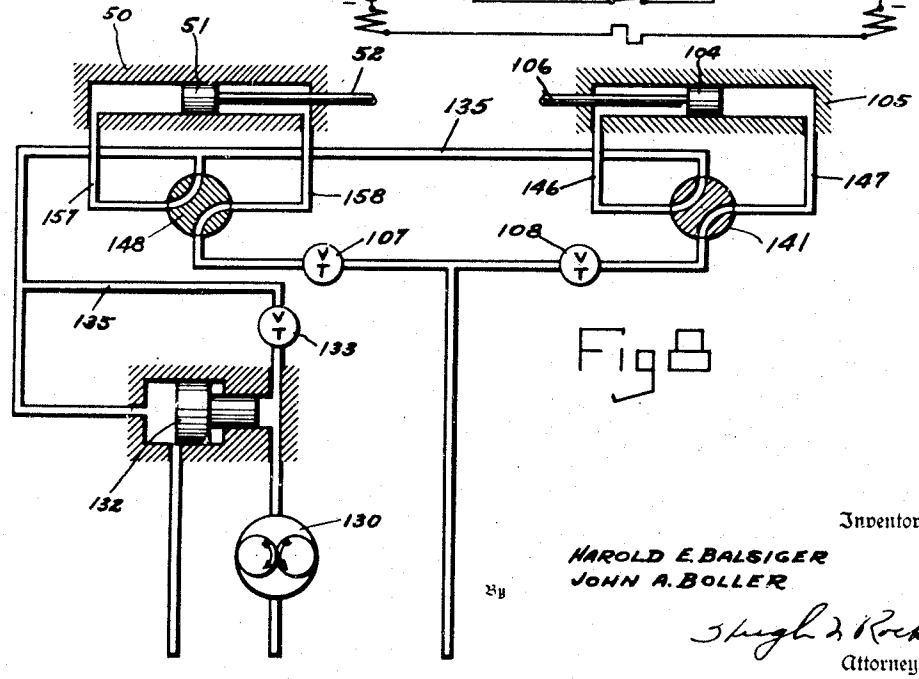


Fig 8



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Patented May 6, 1947

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UNITED STATES PATENT OFFICE

2,419,940

GRINDING MACHINE

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Application March 3, 1944, Serial No. 524,948

21 Claims. (Cl. 51—103)

1

This invention relates to a grinding machine, particularly of the centerless type.

It is an object of this invention to provide a machine of the centerless type having new and improved features of design.

A further object is to provide a novel means for mounting a control wheel support for angular adjustment in a vertical plane.

A further object is to provide a simple means for effecting said angular adjustment.

A further object is to provide a control wheel support which may also be angularly adjusted in a horizontal plane and traversed or adjusted in any angular position.

A further object is to provide a dressing tool for the control wheel permanently mounted on the work rest which is in turn mounted on the bed.

A further object is to provide novel means for varying the speed of the control wheel.

A further object is to provide an improved driving means for said control wheel.

A further object is to provide a simplified control means for all operating conditions.

In the drawings:

Figure 1 is a front elevation.

Figure 2 is a plan view partly broken away to show the grinding wheel feed mechanism.

Figure 3 is an enlarged front elevation of the control wheel support partly in section to show adjusting mechanisms.

Figure 4 is a left end elevation of the control wheel mounting partly in section to show means for tilting and traversing same.

Figure 5 is a partial plan view showing the position of the parts during the dressing of the control wheel.

Figure 6 is a front elevation of the same.

Figure 7 is a wiring diagram.

Fgure 8 is a piping diagram.

Figure 9 is a section on line 9—9 of Figure 10.

Figure 10 is a partial front elevation of the valve knob and latch for the control wheel traverse movement.

Numeral 10 indicates the bed of a machine, 11 a grinding wheel base slidably mounted thereon for movement toward and from a work piece 12. A grinding wheel 15 is rotatably mounted on said base 11. Said grinding wheel may be moved toward and from working position by means of a screw 20, rotatably mounted in said wheel support and engaging a nut 21 secured to said bed. Said screw may be rotated by means of hand wheel 25 acting thru a differential transmission not shown, a shaft 26 having a worm gear 27

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thereon meshing with the teeth of a worm wheel 28 on said screw. Shaft 26 may be rotated either by means of hand wheel 25 or by a handle 29 in ring 31 which may be clamped to hand wheel 25 by means of a clamping bolt 30. The range of movement of handle 29 may be limited by any suitable combination of stop devices. The grindwheel 15 is driven by a motor (not shown) on the wheel base.

Control wheel.—A control wheel 35 is rotatably mounted on a wheel base 36 and driven thru a V belt drive by a variable voltage motor 37 mounted on said base 36.

Said V belt drive includes a jackshaft 33 driven by motor 37 thru V belts 32. A lubricating pump is driven from said jackshaft. V belts 34 connect said jackshaft and the spindle 38 on which control wheel 35 is mounted. Under some conditions an adjustable chain belt drive may be used between said jackshaft and said spindle as shown in Figure 3. However such a drive must be kept free from backlash. So long as a part of the drive is resilient and the drive as a whole is free from lost motion the desired results may be attained.

This structure represents a decided improvement over previous control wheel drives. Such drives consisted of a geared speed change from which the control wheel was driven directly or thru a belt. The favorable characteristics of the belt portion of the drive were decidedly outweighed by the unfavorable characteristics of the geared speed change mechanism.

For example said control wheel rotates at a predetermined speed. As soon as a work piece is introduced into the grinding throat it is picked up by the grinding wheel which tends to rotate the work at the same surface speed as the grinding wheel. The control wheel prevents the rotation of said work at such a speed but in so doing its own speed is increased so that the control wheel is really being partially driven by the grinding wheel thru the medium of the work. Where there is a geared speed change in the control wheel drive, this tendency of the control wheel to be driven by the rotating work piece is suddenly checked when the backlash in said speed chage is taken up. This results in damage to the surface being ground and is directly proportional to the amount of stock being removed. The ability of the grinding wheel to remove stock is thus limited by the characteristics of the control wheel drive. When a drive consisting only of resilient V belts or one in which a combination of V belt and backlash-free-chain belt is used, the belt partially cushions the shock of the change in the

control wheel drive from driving to being driven and transmits to the motor all such changes in speed. Motor 37 is designed for this type of operation and assists in said cushioning action. When said wheel is thus driven the flow of current is reversed and resistance to the reverse flow acts as a dampening brake on the motor. This is generally known as regenerative braking. By using such a drive the amount of stock which may be removed without effecting the ground surface is greatly increased.

Said motor 35 is energized by a variable voltage generator 144 mounted in the bed of the machine and adjusted by means of a rheostat, also in the bed, the handle of which is identified by numeral 40. This type of drive makes possible the slow motor speed required by a control wheel using only the limited reduction available with a belt transmission instead of a geared reduction unit. With only a belt drive between motor and wheel spindle the over running tendency of the wheel is immediately transmitted to the motor and the action cushioned by the effect of the regenerative braking circuit on the motor. Wheel 35 on base 36 may be adjusted angularly in a horizontal plane for grinding tapered surfaces or in a vertical plane for effecting an axial feeding movement of a work piece for thru feed grinding operation. Said control wheel may be adjusted toward and away from the grinding wheel for work pieces of various diameters. Said control wheel may also be moved axially either manually or by power. The means for effecting the above adjustments consists of a member 45 pivotally and slidably mounted at 46 on bed 10 for angular adjustment thereon. The pivot member 46 is set in preloaded ball bearings 47 in order to provide a rigid mounting. Angular adjustment of member 45 is effected by means of screw 48 one end of which is rotatably mounted in the bed 10, the other end of which is threaded and inserted in a nut 49 in member 45. Integral with member 45 is a cylinder 50 in which is slidably mounted a piston 51 having a piston rod 52 one end of which is threaded. Said threaded end has a hollow hexagonal portion 54' into which a wrench may be inserted for rotating said piston rod. Said threaded end 53' fits a nut 53 which is secured to a slide member 55. A lock nut 54 serves to lock slide 55 in adjusted position relative to piston 51.

Member 45 has formed thereon two upwardly facing bearing surfaces, 56 and 57, one V and one flat respectively. Member 55 has corresponding V and flat surfaces 60 and 61 respectively for engaging surfaces 56 and 57 on member 45.

Member 55 has a pair of upwardly facing guide surfaces extending transversely to those on the underside thereof. One of these guides 65 has a curved surface instead of the conventional V. The other guide 66 has a flat surface. A member 67 having a curved surface 68 for mating with guide 65 is secured to the underside of control wheel base 36 by means of screws 69.

The flat guide 66 has slidably mounted thereon a rectangular block 75 in which is inserted a hardened button 76. A vertical adjusting screw 77 threaded in a nut 78 in base 36 rests on said button. The upper end of said screw extends thru the top of base 36 and has a hollow hexagonal portion 79 into which a wrench may be inserted for turning same. A sleeve 80 on said screw is graduated in terms of angles to which the control wheel may be tilted. A clamp for said screw consists of a setscrew 81 having a beveled point 82. One end of a pin 83 engages the surface of screw shaft 77, the other end has a beveled point 84 in contact with point 82. By mounting motor 37 on control wheel base 36 and driving wheel 35 thru resilient V belts the entire drive may be tilted as a unit with said base.

Feed mechanism—control wheel.—The means for adjusting the control wheel toward and from the grinding wheel consists of a feed screw 90 one end of which is threaded in a nut 91. Said nut is mounted on a bracket 92 which in turn is mounted on slide 55. The other end of said screw is supported in base 36 on spaced ball bearings 93 and 94. Between said bearings a worm wheel 85 is mounted on said screw shaft. A worm gear 86 on shaft 87 engages said worm wheel. A handwheel 88 on shaft 87 serves as a means for turning said shaft gears and screw for adjusting base 36 and control wheel 35 toward and from the grinding wheel 15.

Work rest.—The work supporting device consists of a base member 110 mounted directly on bed 10. Said base is slotted to receive a work supporting bar 111. Said bar has a work engaging surface inclined in the direction of the control wheel. Work pieces are held in position just before and after the grinding operation in the case of thru feed grinding by means of guides 112 pivotally mounted on the base 110 and urged toward the work by resilient means not shown.

Dressing device for grinding wheel.—The dressing device for the grinding wheel 15 consists of a bracket 100 attached to base 11. A tool supporting member 101 is slidably mounted on said bracket for a reciprocating movement relative thereto. A diamond tool 102 is mounted on support member 103 which is adjustable vertically and horizontally relative to wheel 15 by means of a knob 109 on a feed screw not shown. The reciprocating movement is effected by a piston 104 in cylinder 105 and connected to member 101 by piston rod 106.

Dressing device for control wheel.—The means for dressing the control wheel consists of a diamond holder in the form of a block 120 mounted on the rear of one of the guides 112. Said block has a diamond tool 121 removably mounted therein in position to engage the surface of control wheel 35.

Hydraulic features.—The hydraulic system consists of two hydraulic motors 50 and 105. Motor 50 provides the traverse movement of control wheel slide 55. Motor 105 receives fluid under pressure simultaneously with the supply to motor 50.

Fluid under pressure is supplied by a pump 130 driven by motor 131. Flow of fluid in said system is held uniform by pressure operated relief valve 132 in conjunction with throttle valve 133 as described in copending application Serial No. 390,432, filed April 25, 1941.

Said fluid under pressure passes from valve 133 thru line 135 and reversing valves 148 and 141. Valve 148 directs fluid to one side or the other of cylinder 50 thru lines 157 and 158. The rate of flow thru said valve is controlled by a throttle valve 107 which is built into valve 148. In the same manner fluid under pressure is directed by valve 141 thru line 146 or line 147 to cylinder 105, the rate of flow being controlled by throttle valve 108. Valve 148 is normally locked in inoperative position by means of a latch 165 pivotally mounted on the knob of said valve and held in slot 166 by spring 167. The reason for

the locked valve is to remind the operator to run wheel 35 back before starting the traverse.

Electrical equipment.—The electrical equipment on our machine is disclosed diagrammatically in Figure 7 and includes a grinding wheel motor 140, an oil pump motor 131, a generator drive motor 142, a coolant pump motor 143, a variable voltage generator 144 driven by motor 142 and a variable voltage motor 37 for driving control wheel 35 and supplied by said generator 144. This variable voltage drive is similar to that shown in Elberty application Patent No. 2,315,511, granted April 6, 1943, and consists essentially of a series generator 144 having series fields 150 and 151 and a rheostat 152 for varying the output of said generator. Said generator is connected to a series type motor 37 having a series field 155 and a resistor 156 which may be set for a predetermined motor speed, in this case a speed suitable for dressing the control wheel and which is substantially higher than the range of speeds used for grinding which are determined by the rheostat 152.

The regenerative braking of motor 37 is accomplished in the following manner. An electric valve 153 is provided in the motor generator circuit between generator 144 and generator series field 151. This valve permits current to flow only from left to right in the excitation circuit, that is, from generator 144 to motor 37. As soon as grinding begins the work is caused to rotate by the action of the grinding wheel 15 and in turn tends to drive the control wheel 35 and its motor 37 at a slightly faster rate than normal. In previous control wheel drives this tendency would be checked before affecting said motor 37, usually by a geared reduction unit. However, back lash in such a unit would cause an abrupt check in this increased speed which would have an undesirable affect on the work being ground. In this invention, only a belt drive connects motor 37 with control wheel 35 and the increase in speed is transmitted directly to the motor. Said motor thus driven becomes a generator. The load on the original generator being reduced, the flow of current thru fields 151 and 155 is also reduced and the normal tendency of the motor is to increase speed. However, rectifier 220 provides the necessary additional excitation for the field windings 151 and 155 to enable said motor to maintain the selected speed and to resist any tendency to increase said speed. The current now generated by the motor will flow from motor 37 thru rectifier 220 back to generator 144 but said current cannot flow back thru field windings 151 and 155 to decrease the excitation. Preventing a decrease in motor excitation is essential to aid in the braking operation for motor 35. Regenerative braking is thus applied to the control wheel drive and functions during the entire grinding operation to provide a smooth running control wheel. This effect is made possible because the variable voltage drive is capable of carrying substantially full load at speeds low enough that even with the limited speed reduction ratio of belt drive the necessary control wheel speeds may be obtained.

Alternating current is supplied to motors 131, 140, 142 and 143 from lines 1, 2 and 3 thru suitable relays. Said relays are energized by current at a lower voltage than that used on the motors. Said current is supplied from lines 1 and 3 thru a transformer 160 to lines 161 and 162. A master start switch 163 and a master stop switch 164 are inserted in line 161. Line 162 is a return line.

A selector switch 170 may be set to determine which motors should be in operation for each of the conditions of setting up, grinding, and dressing. The grinding wheel motor 140 is controlled by a relay 175 actuated by a coil 176. One contact 177 of said relay is connected to a normally open contact 178 in relay 179. Said relay controls oil pump motor 131 and is actuated by coil 180. A normally closed contact 181 in relay 179 includes the rheostat 152 in the variable voltage generator. Said rheostat is set for driving control wheel 35 at a predetermined speed for grinding. Contact 178 in relay 179 and contact 177 in relay 175 when closed complete a circuit which includes resistor 156 in the field circuit of control wheel motor 37. The purpose of this circuit is to drive said control wheel at a relatively high speed for dressing.

A third relay 185 having a coil 186 controls the generator driving motor 142 and coolant pump motor 143 which are connected in parallel. Lines 187 and 188 supply the primary of transformer 210. The transformer secondary 211 supplies rectifier 220 in the variable voltage drive circuit for control wheel 35.

Operation

In order to start the machine, the operator presses master start button 163. This energizes coil 190 of relay 191 to close said relay and direct current to selector switch 170. Said relay also establishes a holding circuit for coil 190. With contact 171 of said selector switch closed, coil 180 would be energized thru line 200 to close relay 179 and start the oil pump motor 131.

The first operation is to set up the machine. For this operation the only motor which might be needed would be the oil pump motor 131. By closing contact 171 of selector switch 170, current is directed thru line 200 to energize coil 180 of relay 179 which closes the circuit to oil pump motor 131. The control wheel 35 may then be adjusted toward the grinding wheel 15 by turning hand wheel 88 until said wheel is in position for a work piece of the desired size. This is determined by adjusting wheel 35 until the work piece has moved up the inclined surface of bar 111 so that the center of the work is in the desired position relative to the center of the wheel. This position may be above or below the centers of wheels 15 and 35 depending on the kind of work to be ground. Work supporting bar 111 may be raised or lowered when necessary by any suitable adjusting means. The desired angle of skew may be obtained at this time by turning screw 77 until said angle is indicated on graduated sleeve 80. If it is desired to grind a tapered work piece, wheel 35 may be so adjusted by turning screw 48 until the desired taper is indicated on a graduated plate 41 on member 45.

Grinding wheel 15 is then shifted forward by hand wheel 25 until it engages a gauge or master work piece at which point ring 31 is clamped to hand wheel 25 by means of clamping bolt 30 and the feed may be effected by moving handle 29 which is mounted in said ring. The extent of movement of said handle in both directions is limited by positive stops.

It is desirable that the wheels 15 and 35 be properly dressed before beginning a grinding operation. For this operation, the selector switch 170 is turned to the dress position. In this posi-

tion contacts 172 and 173 are both closed. Contact 171 actuates relays 175 and 185 to operate wheel motor 140, and generator drive motor 142 and coolant pump motor 143. Contact 173 actuates relay 179 to start oil pump motor 131. Operation of relay 179 opens the contact 181 to thus open the circuit thru rheostat 152 thus removing said rheostat from the circuit of generator field 151. Said rheostat controls the grinding speed of control wheel 35. At the same time, contact 178 is closed inserting resistor 156 in motor field circuit 155. Said resistor 156 is adjusted to cause said motor to run at a relatively high speed suitable for dressing.

Assuming that the wheel 35 has already been tilted to the desired angle of skew, a gauge or finished work piece, while resting on bar 111 is rubbed against the stationary wheel 35 leaving a mark thereon. Said wheel is then withdrawn as described above to a position in line with diamond 121. Said diamond is raised or lowered to the mark on the wheel and reversing valve 148 is shifted to direct fluid to the head end of cylinder 50. The wheel is thus caused to traverse past the diamond 121 with said diamond following the path of travel of the work thereon. Valve 148 is reversed and fluid directed to the rod end of cylinder 50 to return wheel 35 to its original position.

If wheel 35 has been thrown out of alignment with grinding wheel 15 by the skewing adjustment, this condition may be corrected by loosening lock nut 54 and turning shaft 52 in nut 53 by inserting a wrench in the hollow hexagonal head 54'. By this means base 36 may be shifted to place wheel 35 in alignment with grinding wheel 15.

Diamond 102 is always in alignment with the surface of grinding wheel 15. This alignment is maintained of course by periodical adjustment of knob 109. Traverse of the diamond 102 across wheel 15 is initiated by shifting valve 141 to direct fluid under pressure to the head end of cylinder 105. Said diamond then makes a pass across the wheel 15 and is returned to starting position by shifting valve 141 in the opposite direction.

With the dressing and set up operations completed the operator is ready to begin a grinding operation. The selector switch 170 is turned to the position marked grind. In order to clarify the functions of the selector switch they may be listed as follows:

Set up—Oil pump motor only.
Dress—Oil pump, wheel and coolant motor and control wheel.
Grind—Wheel and coolant motors only and control wheel.

Thus in the grinding position contactor 174 is closed to direct current thru line 195 to actuate relay 175 for the grinding wheel motor 140 and thru line 197 to actuate relay 185 for coolant pump motor 143 and generator motor 142 to control wheel motor 37.

For thru feed work the grinding wheel is shifted forward to provide a grinding throat of the desired size, assuming of course that the control wheel 35 has been tilted to the desired angle and the work supporting bar adjusted to the desired height. A work piece 12 may be inserted manually in the grinding throat or may be fed thereto by any suitable loading device. Said work is caused to move axially by the control wheel 35 while being ground by the grinding wheel 15.

For plunge cut grinding the work is placed in the grinding throat either manually or by some sort of loading device. The grinding wheel 15 is moved forward by means of lever 29 or by some suitable power means. The forward movement of said grinding wheel continues to a predetermined position determined by the limit of movement of handle 29 at which point the work should be ground to size. The grinding wheel 15 is then backed off and the work 12 removed from the grinding throat.

We claim:

1. A centerless grinding machine comprising a grinding wheel and a control wheel, a support for said control wheel, a pair of guide surfaces on said support for movement thereof toward and from said grinding wheel, means for effecting said movement, one of said guide surfaces being curved about an axis parallel with said direction of movement and means for tilting said control wheel support on said curved surface away from a vertical position.

2. A grinding machine having a bed, a wheel support thereon movable toward and from a work piece, said support having two guide members, one having a flat surface, the other having a surface curved transversely of the direction of movement of said support, said first member consisting of a separate slide and an adjustable connection between said slide and said support.

3. A grinding machine having a bed, a grinding wheel and a control wheel having opposed peripheral faces, one of said wheels being movable toward the other for a grinding feed, a work rest for supporting a work piece in operative relation to said peripheral faces, a dressing tool mounted on said work rest and means for effecting a traversing movement of said control wheel past said tool.

4. A grinding machine having a bed, a grinding wheel and a control wheel having opposed peripheral faces, one of said wheels being movable toward the other for a grinding feed, a work rest for supporting a work piece in operative relation to said peripheral faces, a dressing tool mounted on said work rest, means for effecting a relative traversing movement between said control wheel and said tool and means to prevent said traversing movement when said wheel is in forward or grinding position.

5. A grinding machine having a bed, a grinding wheel and a control wheel having opposed peripheral faces, one of said wheels being movable toward the other for a grinding feed, work guides for directing a work piece into operative relation to said peripheral faces, a dressing tool mounted on one of said guides and means for effecting a traversing movement of said control wheel past said dressing tool.

6. A grinding machine having a bed, a grinding wheel and a control wheel having opposed peripheral faces, one of said wheels being movable toward the other for a grinding feed, a work rest for supporting a work piece in operative relation to said peripheral faces, a dressing tool mounted in a fixed position on said machine in the same plane as the axis of the work, means for tilting said control wheel so that it causes the work to move axially across the face of the grinding wheel, and means for effecting a traversing movement of said control wheel past said dressing tool whereby to dress said wheel along the path of travel of the work.

7. A grinding machine having opposed grinding and control wheels, supports for said wheels, means for mounting one of said supports for movement toward and from the other, means for effecting angular adjustment of one of said supports in both a vertical and horizontal plane, said support being slidably mounted for a traversing movement, a dressing tool and means for effecting said movement past said dressing tool in any position of angular adjustment.

8. A grinding machine comprising a bed, a swivel table mounted thereon, for angular adjustment relative thereto, a carriage slidably mounted on said table for a traversing movement thereon a wheel base slidably mounted on said carriage for movement transversely relative thereto, spaced guide surfaces on said wheel base, mating guide surfaces on said carriage, one of said guides being cylindrical in shape and means for tilting said base on said cylindrical guides.

9. A grinding machine having opposed grinding and control wheels, supports for said wheels, means actuated by fluid under pressure for effecting a traversing movement of one of said wheels and means for adjusting said wheel in an axial direction relative to said other wheel.

10. A grinding machine comprising a bed, a grinding wheel support, a grinding wheel rotatably mounted thereon, a second wheel support, a control wheel rotatably mounted thereon and peripherally opposed to said grinding wheel, said control wheel base having two guide surfaces for movement toward and from the grinding wheel, one of which is curved about an axis extending transversely of the control wheel axis for movement toward and from the grinding wheel, means for tilting said support on said curved guide surface and means for effecting relative axial movement between said wheels to bring them into proper alignment after tilting.

11. A grinding machine having a bed, a grinding wheel and a control wheel having opposed peripheral faces, one of said wheels being movable toward the other for a grinding feed, a work rest for supporting a work piece in operative relation to said peripheral faces, a dressing tool, means for effecting a relative traversing movement between said tool and one of said wheels, means for driving said wheel at a speed suitable for grinding and also at a speed suitable for dressing, and a common control means for said wheel speed and said traversing means.

12. A grinding machine having a bed, a grinding wheel and a control wheel having opposed peripheral faces, one of said wheels being movable toward the other for a grinding feed, a work rest for supporting a work piece in operative relation to said peripheral faces, a dressing tool, means for effecting a relative traversing movement between said tool and an abrasive wheel including a hydraulic motor, a pump for supplying fluid under pressure to said motor, means for driving said wheel at speeds suitable for grinding and also at a speed suitable for dressing and a common control means for said wheel speed and said fluid under pressure.

13. A grinding machine comprising a bed, a grinding wheel and a control wheel rotatably mounted thereon, a work rest between said wheels, means for effecting axial, transverse and angular adjustment of one of said wheels relative to the other, hydraulic means for effecting one of said movements including a motor driven pump, motors for driving said wheels, means for adjusting the speed of one of said motors for dressing or grinding and means for selectively controlling said motors for each of the conditions of set up, dress and grind.

14. A grinding machine comprising a bed, a swivel table mounted thereon, for angular adjustment relative thereto, a carriage slidably mounted on said table for a traversing movement thereon a wheel base slidably mounted on said carriage for movement transversely relative thereto, spaced guide surfaces on said wheel base, mating guide surfaces on said carriage, one of said guides being cylindrical in shape and means for tilting said base on said cylindrical guides, means for driving said wheel including a motor, driving belts connecting said motor and said wheel, said motor being mounted on said wheel base and tiltable therewith.

15. A grinding machine comprising a bed, a wheel base slidably mounted on said bed, an abrasive wheel rotatably mounted on said base, said wheel base having spaced supporting surfaces, one disposed substantially beneath said wheel and being curved transversely of the direction of movement of said base, the other at the opposite side of said base and comprising a slidable member separate from said base and means for raising and lowering one end of said base relative to said second support member.

16. A grinding machine comprising a supporting member, a wheel base, an abrasive wheel rotatably mounted on said base, means disposed substantially beneath the abrasive wheel for supporting said wheel base on said supporting member so that the wheel base may be tilted in a plane substantially parallel with the axis of the abrasive wheel, and supporting devices located at one side of said supporting means for supporting said wheel base on said support member, said supporting devices including an adjustable means whereby said wheel base may be positively tilted to different set angular positions.

17. A grinding machine comprising a supporting member, a wheel base, an abrasive wheel rotatably mounted on said base, means disposed substantially beneath the abrasive wheel for supporting said wheel base on said supporting member so that the wheel base may be tilted in a plane substantially parallel with the axis of the abrasive wheel, and supporting devices located at one side of said supporting means for supporting said wheel base on said support member, said devices including a curved portion on said base and a flat member independent of said base and spaced from said curved portion.

18. A grinding machine having a bed, a grinding wheel and a control wheel having opposed peripheral faces, one of said wheels being movable toward the other for a grinding feed, a work rest for supporting a work piece in operative relation to said peripheral faces, a dressing tool, hydraulic means for effecting a relative traversing movement between said tool and one of said wheels including a motor driven pump, means including a motor for driving said wheel at a speed suitable for grinding and also at a speed suitable for dressing, and common control means for said motors for changing said wheel speed when said traversing movement is initiated.

19. A centerless grinding machine comprising a bed, wheel supports mounted on said bed, a grinding wheel rotatably mounted on one of said supports, a control wheel mounted on the other of said supports, means for driving said control wheel including a variable voltage drive mechanism consisting of a motor and generator in a

loop circuit, said control wheel and motor being subject to an overhauling load, said loop circuit including a generator series field winding which in response to said overhauling load would normally reduce the motor field strength and cause increased motor speed, and a separate source of current for supplementing the output of the generator for energizing said fields whereby to cause said motor to maintain a uniform control wheel speed and to resist an increase in said speed.

20. A centerless grinding machine comprising a bed, wheel supports mounted on said bed, a grinding wheel rotatably mounted on one of said supports, a control wheel mounted on the other of said supports, means for driving said control wheel including a variable voltage drive mechanism consisting of a motor and generator in a loop circuit, said control wheel and motor being subject to an overhauling load, said loop circuit including a generator series field winding which in response tc said overhauling load would normally reduce the motor field strength and cause increased motor speed, said overhauling load causing said motor to function as a generator, a device for preventing passage thru said fields of a current in the direction of that generated by said motor and thus to counteract the effect of said overhauling load on said control wheel.

21. A grinding machine having opposed grinding and control wheels, supports for said wheels, means for mounting one of said supports for movement toward and from the other, means for effecting angular adjustment of one of said supports in a horizontal plane, said support being slidably mounted for a traversing movement, a dressing tool and means for effecting said traversing movement past said dressing tool in any position of angular adjustment while maintaining a fixed angular relation between the wheel axis and the direction of traverse.

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