Aug. 19, 1969 A. T. PARRELLA ET AL 3,461,612

GRINDING MACHINE

Filed Oct. 18, 1966 5 Sheets-Sheet 1

Fig. 1

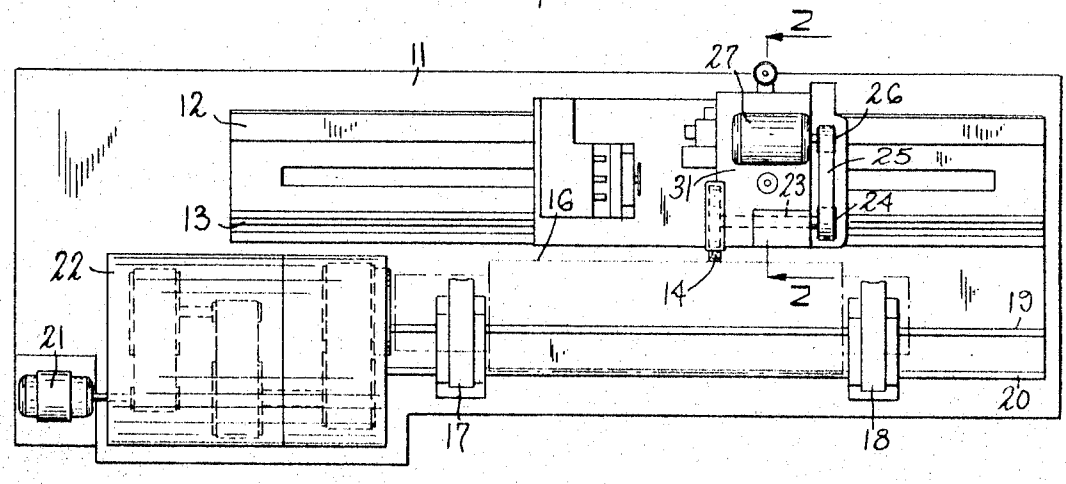
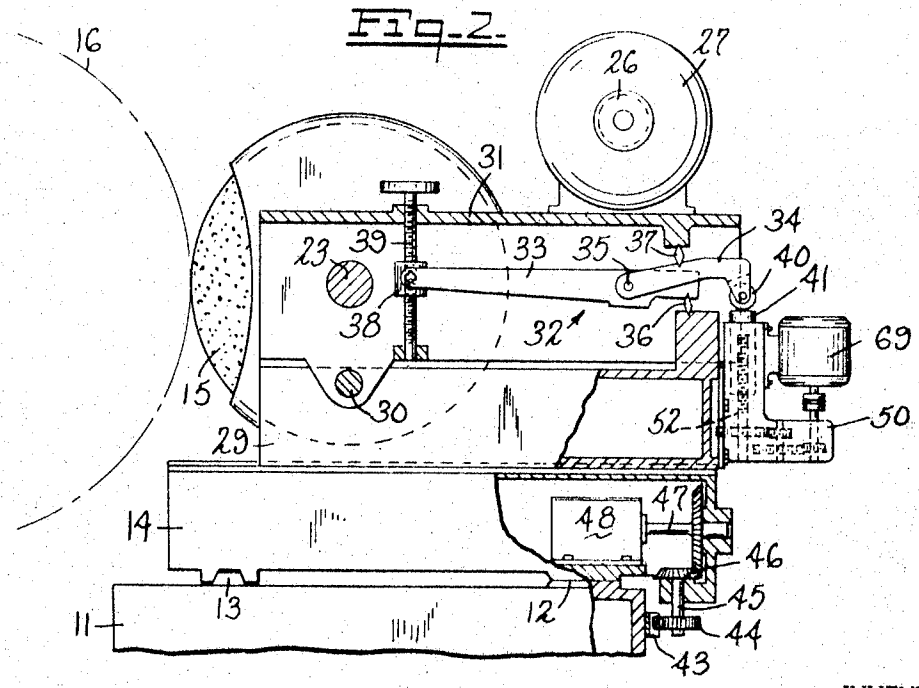


Fig. 2



INVENTORS

Alfred T. Parrella
Paul Palubniak
Gene R. Gagliardi

BY DeLio and Montgomery

ATTORNEYS

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Fig. 4.

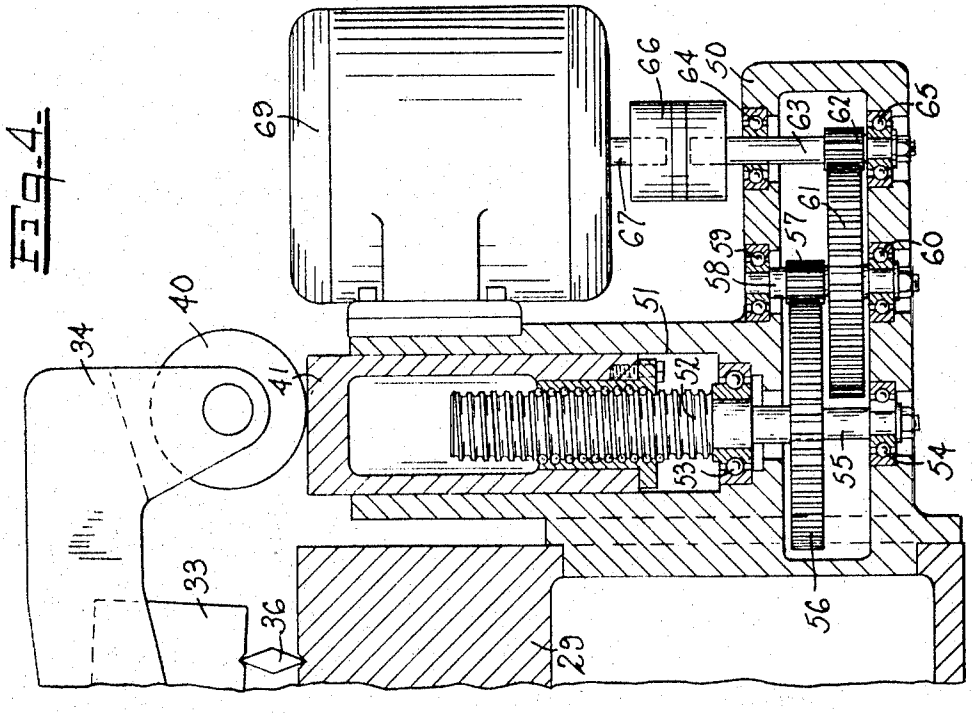
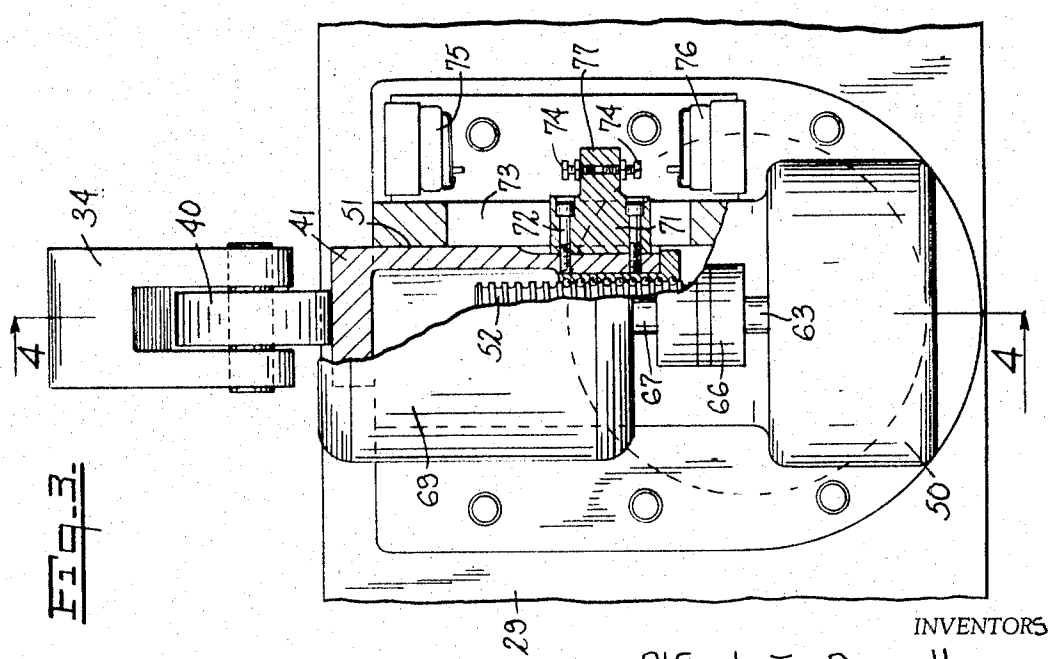


Fig. 3.



INVENTORS

Alfred T. Parrella
Paul Palubniak
Gene R. Gagliardi

BY

DeLio and Montgomery

ATTORNEYS

Aug. 19, 1969 A. T. PARRELLA ET AL 3,461,612

GRINDING MACHINE

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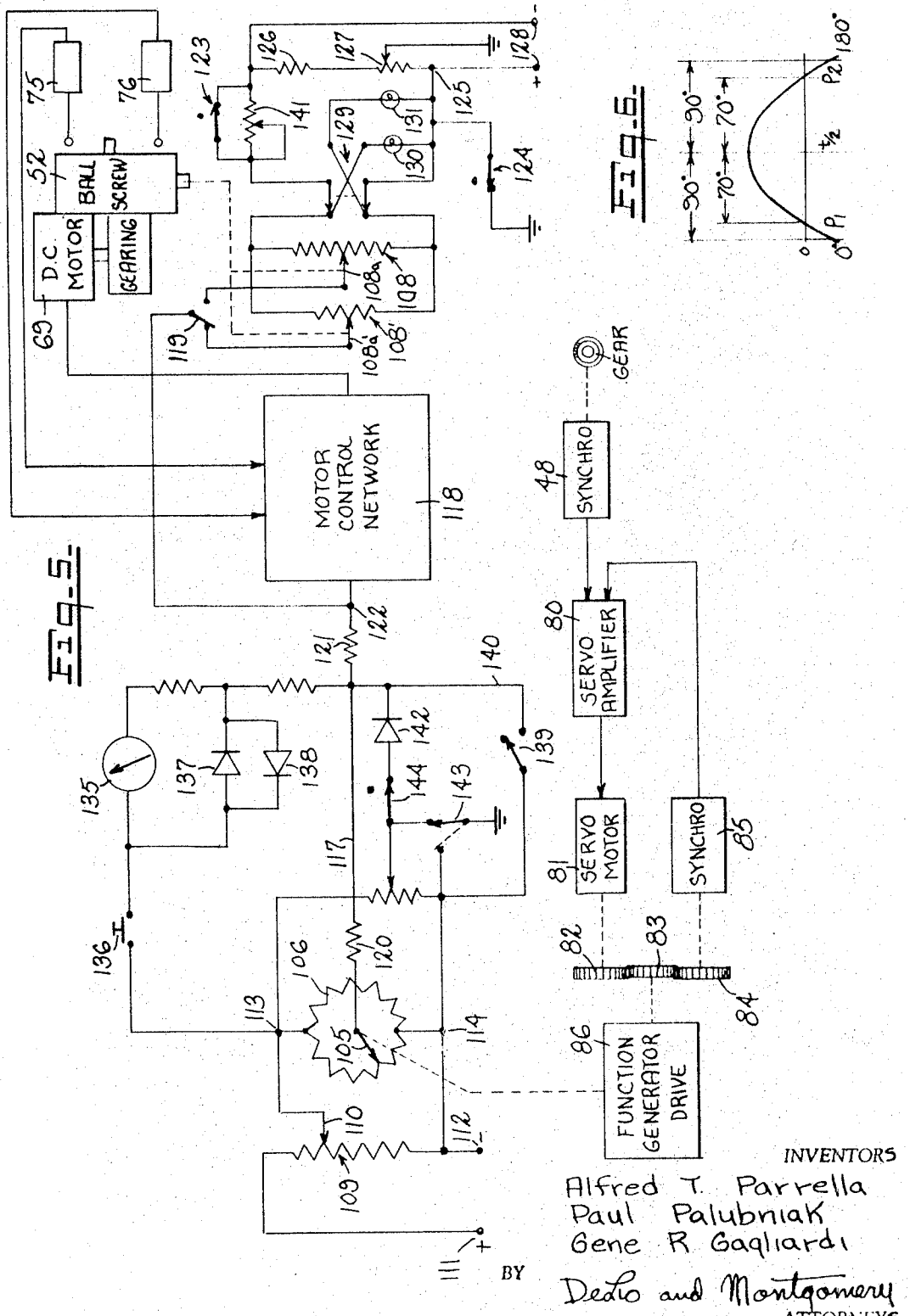


Fig. 5

Fig. 5

INVENTORS

Alfred T. Parrella

Paul Palubniak

Gene R. Gagliardi

BY

Dedio and Montgomery

ATTORNEYS

Aug. 19, 1969 A. T. PARRELLA ET AL 3,461,612

GRINDING MACHINE

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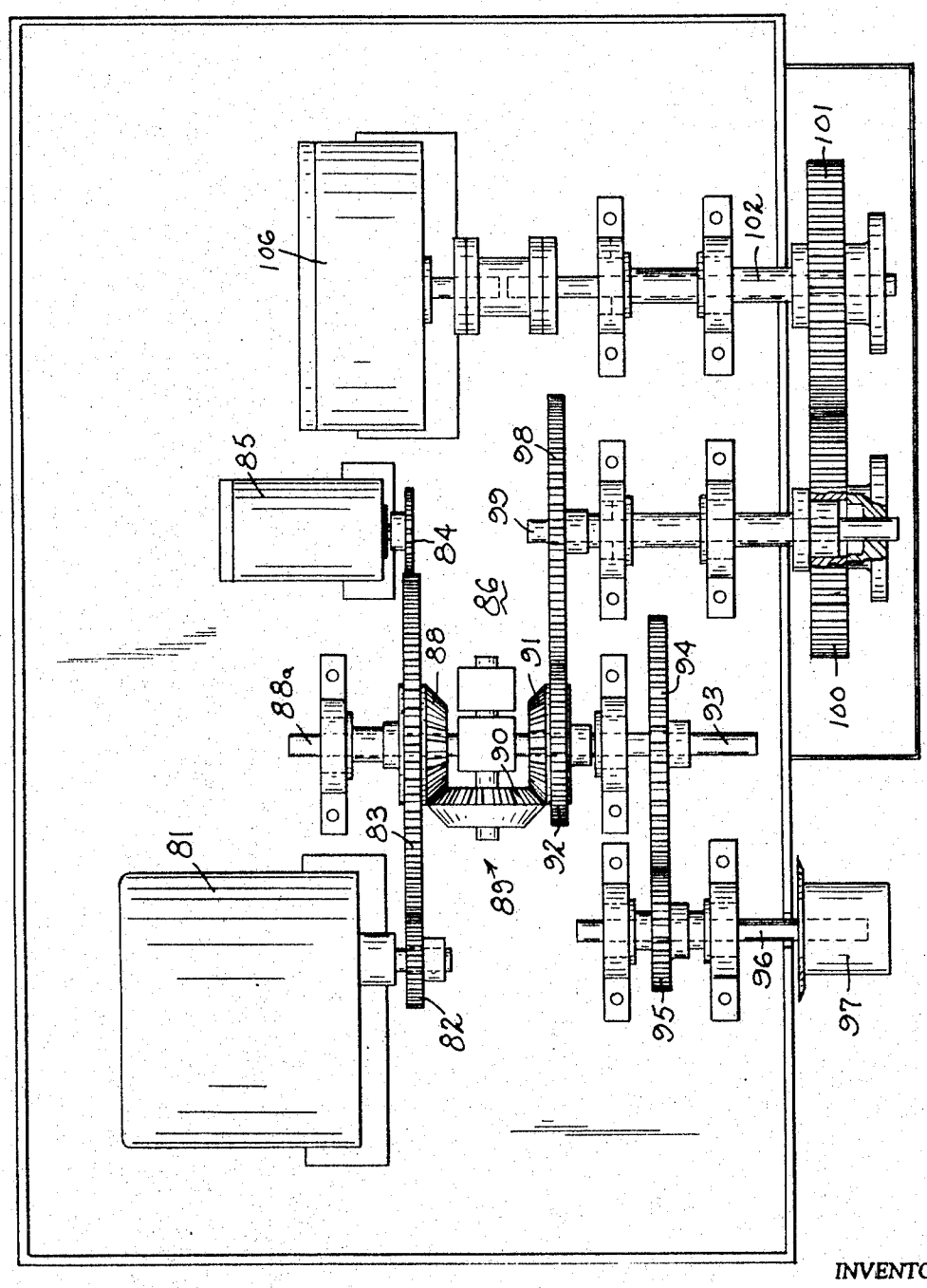


Fig. 7

INVENTORS

Alfred T. Parrella
Paul Palubniak
Gene R. Gagliardi

BY DeLio and Montgomery
ATTORNEYS

Aug. 19, 1969 A. T. PARRELLA ET AL 3,461,612

GRINDING MACHINE

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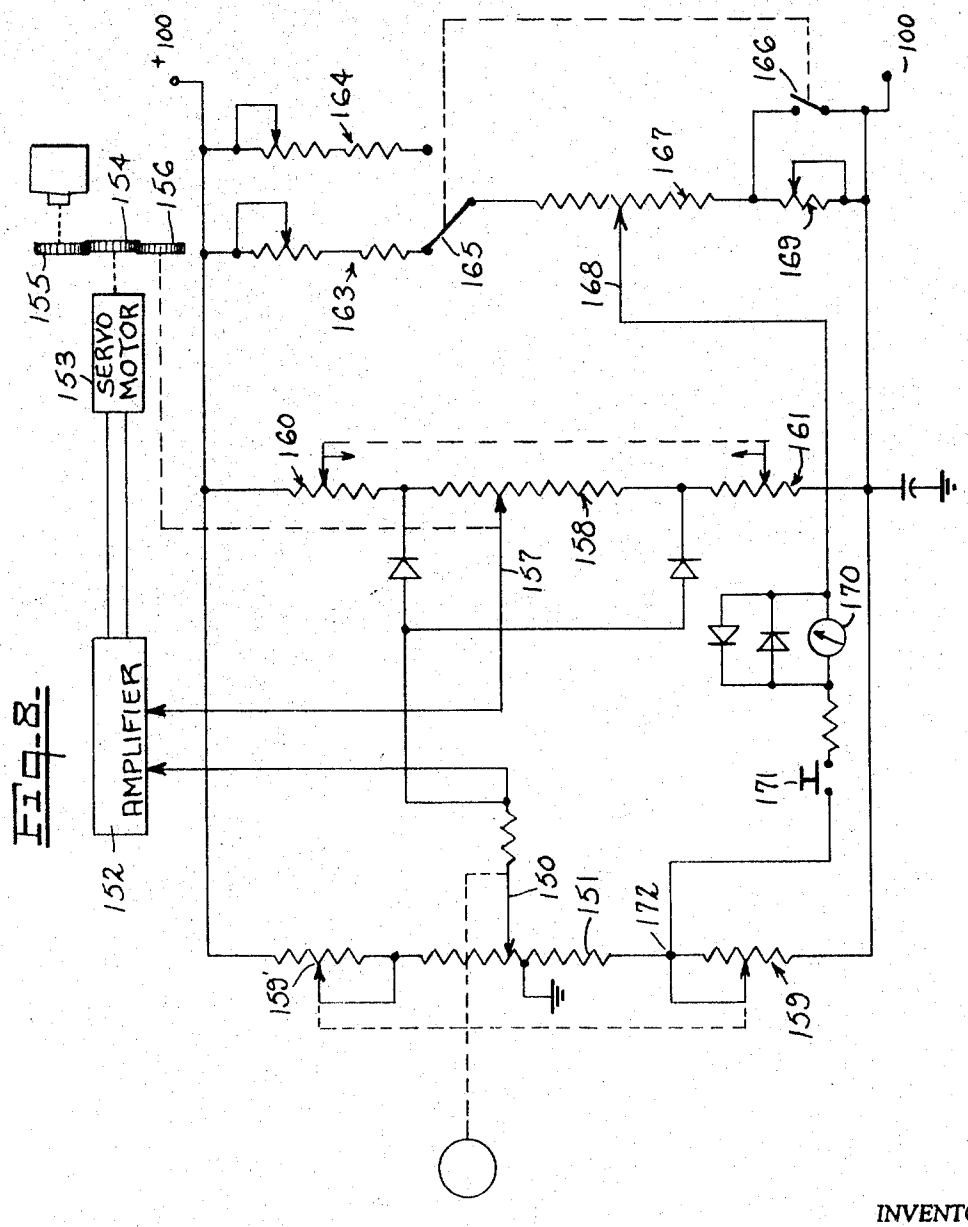


Fig. 8.

INVENTORS

Alfred T. Parrella
Paul Palubniak
Gene R. Gagliardi

BY DeLio and Montgomery
ATTORNEYS

United States Patent Office 3,461,612
Patented Aug. 19, 1969

3,461,612

GRINDING MACHINE

Alfred T. Parrella, Newtown, Paul Palubniak, Easton, and Gene R. Gagliardi, Bethany, Conn., assignors to Farrel Corporation, Ansonia, Conn.

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Int. Cl. B24b 5/16, 49/10, 51/00
U.S. Cl. 51—49 11 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for controlling the movement of a grinding wheel as it moves along the length of a cylindrical workpiece to define a crown thereon where the grinding wheel head is tilted toward and away from the roll by a linearly movable piston under control of a generated crown signal.

This invention relates to grinding machines, and more particularly relates to grinding machines adapted to grind or regrind elongated cylindrical objects such as calender rolls.

A roll grinding machine adapted to grind or refinish calendar rolls generally comprises a bed having a carriage movable longitudinally along the length thereof so that the grinding wheel carried on said carriage may sweep the length of a roll or other workpiece. Mounted on the carriage and movable laterally with respect to the direction of motion of the carriage is a subbase member, and mounted to this base member is a platform which may be referred to as a grinding wheel head. The grinding wheel head is usually pivotally mounted to the base so that by pivoting thereof a grinding wheel may be tilted to precisely advance it and retract it small distances with respect to the workpiece. This tilting action is very precisely controlled to effect the depth of cut of the grinding wheel into the workpiece and, also, to so control the position of the grinding wheel as it sweeps the length of the workpiece as to provide a crown or contour of other than that of a cylinder to the roll. This tilting action is such that relatively large degrees of motion may be controlled through suitable transmission means to produce a very small degree of motion of the controlled object, the grinding wheel, and thus minimizes any errors in the system due to tolerances, etc.

The present invention provides a new and improved technique of controlling pivotal or tilting motion of a grinding wheel head in timed relationship to travel of the grinding wheel along the length of a roll. The invention provides means for tilting or pivoting the wheel head in accordance with a programmed contour. In accordance with the invention means may be provided to vary the programming means to establish predetermined coordinate movement of the grinding wheel.

The invention further provides a new and improved force-producing means having only linear motion which subjects the grinding wheel head to a pivotal force to provide advance of the grinding wheel, or which supports the grinding wheel while it is allowed to retract at a controlled rate. The invention also provides new and improved electrical programming means for predetermining the coordinate movement of a grinding wheel as it grinds along the length of a roll to establish a predetermined crown on the roll.

Accordingly, an object of this invention is to provide a roll grinding apparatus having new and improved means for imparting a crown or other non-linear contour to the face of a roll.

Another object of this invention is to provide a new and improved crowning mechanism for a roll grinder

wherein the crown to be ground on a roll may be easily predetermined.

Another object of this invention is to provide a new and improved roll crowning mechanism for a roll grinder in which the movement of the grinding wheel toward and away from a roll being ground may be very precisely controlled to accurately grind a desired contour on a roll.

A further object of this invention is to provide a new and improved control network for effecting programmed movement of a movable member which tilts the grinding head of a grinding machine.

A still further object of this invention is to provide a new and improved electrical control system for programming the crown to be ground on a roll of predetermined length.

Still further objects of the invention are to increase the range of a crown which may be automatically ground on a roll, provide for remote predetermination of the crown, and provide greater flexibility in selection of a crown to be ground on a roll.

The features of the invention which are believed to be novel are set forth with particularity and definitely claimed in the concluding portion of this specification. The invention, however, both as to its organization and operation, together with further objects and advantages thereof may best be appreciated by reference to the following detailed description taken in conjunction with the drawings, in which:

FIG. 1 is a plan view of a roll grinding machine which may embody the invention;

FIG. 2 is a sectional view in elevation as seen in the plane of line 2—2 of FIG. 1;

FIG. 3 is an elevational view partially cut away as seen from the right side of FIG. 2;

FIG. 4 is a sectional view seen in the plane of line 4—4 of FIG. 3;

FIG. 5 is a diagram, partly schematic and partly in block form of a network for electrically programming a crowning movement of a grinding wheel as it sweeps the length of a calender roll;

FIG. 6 is a representation of a function which may be programmed by the network of FIG. 5;

FIG. 7 is a plan view of a gearing arrangement which is utilized in conjunction with the mechanisms of FIGS. 1–4 and the network of FIG. 5; and

FIG. 8 is a schematic diagram of a network which may be utilized in conjunction with the network of FIG. 5 to electrically program a desired crown on a calender roll.

A roll grinding machine 10 in which the invention may be embodied generally comprises a bed 11 having ways 12 and 13 thereon upon which a carriage 14 is movable along the length thereof so as to sweep a grinding wheel 15 along the length of a workpiece such as a calender roll 16. The calender roll is rotatably mounted in neck rests 17 and 18, which are movably mounted on ways 19 and 20 on bed 11. The roll 16 may be rotated through a drive mechanism which comprises a drive motor 21 and suitable reduction gearing (not shown) located in housing 22. Grinding wheel 15 is rotatably driven through a shaft 23 having thereon a pulley 24 which is driven by a belt 25, in turn, driven by a pulley 26 on the shaft of a grinding wheel motor 27.

A platform or subbase 29 is carried on carriage 14 and is coordinately movable with respect to the direction of travel of carriage 14 on bed 11. Pivotally mounted to platform 29 by means of a shaft 30 is a grinding wheel head carriage 31 which rotatably supports shaft 23 and grinding wheel 15, and also carries thereon grinding wheel motor 27.

Carried in wheel head 31 and subbase or platform 29 is a wheel head tilting mechanism 32 which may comprise a pair of levers 33 and 34 pivotally connected to each other by a pin 35. Lever 33 rests at one end thereof about an edge 36 and thereby may react against platform 29. Lever 34 bears against an edge 37 intermediate the ends thereof and reacts therethrough against wheel head 31. The other end of lever 33 may be pivotally supported on a travelling nut 38 on a lead screw shaft 39. However, for purposes of this disclosure the left-hand end (as viewed in FIG. 2) of lever 33 may be considered to be pivotally mounted in a fixed position. One end of lever 34 carries a roller 40 which rests on a vertically movable plunger or piston 41. It will be noted that if piston 41 is moved upwardly, lever 34 will rotate about edge 37 and pivot pin 35 will tend to move in a generally downward direction, carrying lever 33 therewith. However, inasmuch as lever 33 is supported at both ends thereof it will not move, and lever 34 will pivot about pin 35 and exert an upward force on edge 37 to move grinding wheel head 31 in a counterclockwise direction about pivot pin 30. Inasmuch as pivot pin 30 is mounted below the rotative axis of grinding wheel 15 and below grinding wheel head 31, the grinding wheel 15 will then be advanced or tilted toward roll 16.

It may thus be seen that the lever 34 acts to raise or rotate grinding wheel head 31 about pivot pin 30 when plunger or piston 41 rises. Conversely, when piston 41 is lowered lever 34 will pivot in a clockwise direction about pin 35 and grinding wheel head 31 will rotate clockwise about pivot pin 30 to retract wheel 15 from a workpiece.

Mounted to or defined on bed 11 is a rack 43 which engages a pinion 44 carried on a shaft 45 which is connected as at 46 to the shaft 47 to a position indicating means such as a synchro-transformer 48. Alternatively, shaft 45 may be connected through suitable gearing (not shown) to effect a desired reduction. In this manner, the rotation of shaft 45 as carriage 14 moves along ways 12 and 13 is determinative of the position of carriage 14 and more specifically grinding wheel 15 with respect to the length of ways 12 and 13.

Mounted to the back of subbase 29 is a housing member 50 which includes a guide channel 51 for piston 41. Piston 41 is coupled to a rotatable shaft 52 through a ball nut 52*a*, non-rotatively secured to piston 41. Shaft 52 is rotatably supported in housing 50 by means of bearing assemblies 53 and 54 about shaft portion 55 thereof. Fast on shaft 55 is a gear 56 which is connected to a pinion 57 on a shaft 58 rotatably supported in housing 50 by bearing assemblies 59 and 60. A gear 61 is also mounted on shaft 58 and engaged by a pinion 62 on another shaft 63 which is rotatably supported in housing 50 by bearing assemblies 64 and 65. Shaft 63 by means of a flexible or other suitable coupling 66 is connected to the shaft 67 of a motor 69. Motor 69 when energized, as will hereinafter be explained, rotates shaft 52 through the described gear train and, dependent upon the direction of rotation, elevates or lowers piston 41.

Piston 41 is prevented from rotating by means of keys 71 (only one shown) secured thereto as by means of bolts 72 and extending into guide slots 73 (only one shown) defined in housing 50.

Limiting means may also be carried by key 71 in the form of stops 74 adapted to operate upper and lower limit switches 75 and 76, respectively, to place limits on the movement of wheel 15 in either direction.

Stops 74 may be headed bolts threadably received in a lug portion 77 of key 71 and are longitudinally adjustable therein to predetermine limiting positions of piston 41, and hence the limits of the crown which may be ground on a roll.

The position of the grinding wheel head and, hence, the grinding wheel along bed 11 is sensed by syncro-transformer 48 (FIG. 5) which supplies a cyclically varying signal to a servo amplifier 80. Amplifier 80 applies a driving signal to a servomotor 81 having a gear 82 on the shaft thereof which is coupled by means of a gear 83 to a gear 84 on the shaft of syncro-transmitter 85 which supplies a feedback signal to servo amplifier 80. In this manner, servomotor 81 is driven at a controlled rate proportional to movement of carriage 14 on bed 11.

Motor 81 is a function generator drive motor adapted to drive a function generator which provides a signal that varies in amplitude in a predetermined manner with the position of the carriage on bed 11 and hence with respect to the length of a roll being ground. As herein described, the function generator is a potentiometer adapted to generate a cosine function (FIG. 6) and is driven through a grear drive 86.

With reference to FIG. 7, which more fully illustrates drive 86, motor 81 by gear 82 thereon drives gear 83 which is nonrotative with respect to a bevel gear 88 on a shaft 88*a*. Bevel gear 88 forms part of a differential 89 which also comprises bevel gears 90 and 91. Bevel gear 91 is nonrotative with respect to a gear 92 mounted to shaft 93. Shaft 93 also has a gear 94 mounted thereon. Gear 94 is engaged by a pinion 95 on a shaft 96 having an adjusting knob 97 thereon which provides a center adjustment as hereinafter explained. Gear 92 engages a gear 98 on a shaft 99 adapted to receive a change gear 100 thereon. Gear 100 engages with another change gear 101 on a shaft 102 which drives the contact arm 105 (FIG. 5) of a function generating potentiometer 106.

In FIG. 7, it may be seen that the normal connection for driving is from function generator drive motor 81 through gears 82 and 83, differential 89 to gear 92, gear 98, shaft 99, change gears 100, 101 and shaft 102. Also it will be apparent that the center adjustment knob 97 on shaft 96 provides a means for a setting of the function generator by means of the drive through gears 95, 94, shaft 93, gears 92, 98, change gears 100, 101 and shaft 102. This may be accomplished without rotation of the shaft of motor 81, due to differential 89. As will hereinafter be described, this adjustment is utilized to set the contact arm a predetermined position on potentiometer 106. Reference is again made to FIG. 5. Motor 69 drives ball screw 52 and, hence, piston 41 at a rate and in a direction determined by the absolute magnitude and voltage level of an error signal applied to a motor speed control network 118. The error signal is the sum of an input signal from the contact arm 105 of function generator potentiometer 106 and a feedback signal from one of a pair of potentiometer 108 or 108'.

A voltage is established across a voltage divider 109 by means of connection of terminals 111 and 112 to a suitable source, not shown, and the setting of contact arm 110 thereon determines the magnitude of the voltage which appears across function generator potentiometer 106 between terminals 113 and 114. This will also determine the maximum crown to be ground on the roll 16. As contact arm 105 is driven by motor 81 through 360°, the voltage appearing at line 117 will vary between a predetermined minus voltage at terminal 114 and a positive voltage at terminal 113 which is determined by the setting of contact arm 110 on voltage divider 109.

The manner in which this voltage will vary, that is, its waveform with respect to time or travel of carriage 14 on bed 11 will be determined by the shape of the crown it is desired to grind on a roll. The function generator potentiometer 106 may be constructed to yield any desired waveform. For example, it may yield a cosine waveform as shown in FIG. 6 or it may be constructed to yield a trapezoidal waveform. For purposes of disclosure the crown to be ground will be considered to be derived from the waveform of FIG. 6.

As the voltage at wiper arm 105 varies, the signal to motor speed control 118 varies and, hence, the output signal to motor 69 varies to drive motor 69 at a rate proportional to the magnitude of the voltage, and in a direction determined by the level of voltage with respect to a reference level (which may or may not be zero).

Ball screw **52** upon rotation thereof drives the contact arms **108***a* and **108***a'* of two feedback potentiometers **108** and **108'**, respectively. Both of these potentiometers serve the same purpose, and differ only in range, depending upon the range of the absolute magnitude of the crown to be applied to the roll. Selector switch **119** is positioned to connect the appropriate potentiometer and a feedback signal is applied to motor control **118**.

The potentiometers **108** and **108'** are linear and the sum of the input voltage and feedback voltages will define a waveform with respect to time that at time *t*/2, FIG. 6, passes through a reference voltage level and reverses direction of motor **69**. The motor control **118** and motor **69** are of the type which are responsive to both voltage magnitude for speed control, and voltage direction (with respect to a reference voltage level) for direction of operation. A suitable drive of this type is a General Electric Company "Thymatrol" drive using a two-field direct current motor.

It will be noted that resistances **120** and **121** are in series with one of potentiometers **108** or **108'**, and the voltage at point **122** will therefore depend on the voltage drop across a circuit from arm **105** through resistances **120**, **121** (arm **108***a* or **108***a'*), and resistance **141** (if in circuit). Thus the waveform at point **122** will follow the function of FIG. 6 modified by the linear voltage feedback from one of potentiometers **108** or **108'**.

Voltage is supplied across the potentiometers **108** and **108'** from a source defined by resistances **126** and **127** connected across terminals **128**. The polarity of the voltage applied to potentiometers **108** and **108'** may be reversed by means of a double pole reversing switch **129** depending upon whether the crown to be ground is concave or convex. Included in circuit with switch **129** are indicator lights **130** and **131** to indicate the type of crown which has been selected. Selector switches **123** and **124** may be included to permit a selection in the crown range as hereinafter described.

The network of FIG. 5 further includes an indicating instrument or meter **135** arranged to indicate the voltage appearing across function generator potentiometer **106** and contact arm **105**, when switch **136** is closed. This circuit further includes a pair of free wheeling diodes **137** and **138** for protection of meter **135**.

Additionally, a crowning disabling switch **139** is provided which when closed to line **140** shorts out function generator potentiometer **106**. Still further, a clamping circuit comprising a diode **142** and switches **143** and **144** are provided to select a predetermined range or section of the function to be generated by potentiometer **106**.

For example, when switches **143** and **144** are closed in the positions shown, diode **142** will conduct and hold terminal **125** essentially at ground so long as the voltage picked off wiper arm **105** is negative.

It should be further understood that this clamping could be achieved by connecting selected points of function generator potentiometer **106** through resistors to terminal **114** or directly to ground to establish zero potential at points disposed a predetermined number of degrees on either side of terminal **114**.

Reference is again made to FIG. 6 which illustrates the function generated by potentiometer **93**. In some cases it may be desired to utilize this full wave for roll crowning purposes. In such cases this is referred to as a 90° crown. In other instances, it may be desired to utilize only a portion of the wave for roll crowning purposes, for example, that portion residing within points P_1 and P_2, referred to as a 70° crown.

When only a 70° crown is desired, switches **123** and **124** are opened to insert resistance **141** in series with potentiometers **108** and **108'** and disconnect point **125** from ground. This decreases the range of the feedback signal consistent with the range of the input signal between points P_1 and P_2 (FIG. 6), and further sets the voltage limits of the feedback voltage range, i.e., point **125** is returned to positive voltage instead of ground through switch **124**.

Assume now that a roll, such as roll **16**, is placed on the roll grinder **10**, and it is desired to grind a crown thereon which is predetermined by plus and minus 70° of a cosine wave, as indicated in FIG. 6. First, the grinding wheel is moved to the midpoint of the roll. Then center adjusting knob **97** (FIG. 7) is turned with switch **136** closed until meter **135** indicates a maximum voltage. At this time, contact arm **105** has been set at terminal **113**, which is the midpoint of potentiometer **106**, to coincide with the center of the roll where the magnitude of the crown, either concave or convex, will be greatest.

Also at this time, change gears **100** and **101** have been selected in accordance with the length of the roll. Then the crown magnitude adjustment is made by the setting of contact arm **110** on voltage divider **109** and the type of crown, i.e., concave or convex, is set by the polarity of the voltage applied to terminals **111** and **112**. Also switch **129** is set for the selected type of crown, one of indicator lamps **130** or **131** will indicate this selection. If desired, the reversal of polarity of terminals **111** and **112** may be ganged to switch **129**. Switches **123** and **124** are opened. This sets the voltage range across potentiometers **108** and **108'** for a 70° crown. Selector switch **119** is closed to the approprate terminal to select the appropriate one of potentiometers for the range of crown magnitude desired.

The grinding wheel is now moved to one end of the roll. This movement, through the drive **86**, positions arm **105** on potentiometer **106** to commence generating the desired wave at point P_1 (FIG. 6). The change gears **100** and **101** will turn arm **105** so that point P_2 of the wave form of FIG. 6 is reached at the other end of the roll.

Now as the grinding wheel sweeps along the length of the roll, arm **105** will move in timed relation with movement of carriage **14** and generate a signal as shown in FIG. 6 between points P_1 and P_2. This will move piston **41** in accordance therewith to tilt the grinding wheel to follow a generated crown function.

If it is desired to generate a 90° cosine wave for crowning purposes, switches **123** and **124** are closed, and switches **143** and **144** are open.

The limit switches **75** and **76**, as shown in FIG. 5, are arranged to shut down motor **69** through control **118** if predetermined limits of travel of piston **41** are reached or exceeded.

In another embodiment of the invention the roll length may be electrically set thus eliminating the need for change gears and the function generator drive **86**.

In FIG. 8, pinion **44** on rack **43** drives the contact arm **150** of a potentiometer **151** having a grounded center tap. Arm **150** is connected to an amplifier **152** which applies a driving signal to servo motor **153**. Motor **153** has a gear **154** on the shaft thereof which engages a gear **155** on the shaft of the function generator potentiometer. Gear **154** also engages a gear **156** which drives the contact arm **157** of a feedback potentiometer **158**. Arm **157** applies a position feedback signal to amplifier **152**. As the carriage **14** moves along the bed of the machine, there is an error voltage between arms **150** and **157**. This error voltage through amplifier **152** drives motor **153** and the contact arm **105** of function generator potentiometer **106**.

The network of FIG. 8 is basically a bridge circuit connected between positive and negative potentials. The arm including potentiometer **151** also includes ganged potentiometers **159** and **159'**. This arm provides a means to set the end points or the length of the roll, or otherwise stated, provides an electrical representation thereof.

The arm of the bridge containing potentiometer **158** also includes ganged potentiometers **160** and **161** which move inversely to each other. This bridge arm provides a means for centering or nulling the function generator contact arm **105** with a roll center.

The network of FIG. 8 also includes means for selecting a portion of the function or the complete function of FIG. 6. Resistance arms **163** and **164** provide such means through selector switches **165** and **166**. For example, resistance arm **163** may be utilized when a 90° crown is desired and resistance arm **164** when a 70° crown is desired. Resistance arms **163** and **164** are connectable to a potentiometer **167** and a resistance **169**. Resistance **169** may be short-circuited by switch **166**, which is ganged to switch **165** and closed when a 90° crown is selected. Arm **168** is connected through a null meter **170** and switch **171** to a point **172** between potentiometers **151** and **159**. Potentiometer **167** together with resistance arms **163** and **164** are utilized to aid in setting a roll length into potentiometer **151** for a predetermined crown.

In operation, the operator sets switches **165** and **166** for a selected crown. Then he sets arm **168** for a desired roll length. For this purpose, potentiometer **167** may be calibrated in inches, say, from thirty to three hundred. He will then depress switch **171** and set potentiometers **158** and **159** to null meter **170**. This reads the roll length into the network. The operator then closes switch **136** and observes the meter **135** across the function generator potentiometer. The potentiometers **160** and **161** are then adjusted until meter **135** is nulled or reads maximum depending upon the calibration thereof. This centers the contact arm of the function generator potentiometer with the grinding wheel at the midpoint of the roll length.

The carriage is then moved along the bed to position the grinding wheel at one end of the roll. This movement positions the carriage position potentiometer arm **150**, feedback potentiometer arm **157** and function generator potentiometer arm **105** to generate the desired crowning function as the carriage, and thus the grinding wheel, move along the length of the roll.

When the crown follows the function set forth in FIG. 6 and only the 70° portion of that function is utilized it will be apparent that the function generator potentiometer **106** will rotate less for a 70° crown than for a 90° crown where the roll length is the same. Accordingly, the servo motor **153** which drives the function generator potentiometer **106** will rotate a lesser total amount for a 70° crown than for a 90° crown. These differences are compensated for by changing the voltage across resistor or potentiometer **167** through selector switches **165** and **166**.

From the foregoing it will be apparent that the present invention provides a means for programming a predetermined crown to be ground on a roll. While a potentiometer has been disclosed as a preferred means for generating a desired function with respect to position of a grinding wheel along the length of a roll face, it is to be understood that other function generating means may be employed.

Moreover, the waveform of the function may be predetermined to have any desired shape. For example, the potentiometer **105** of FIG. 5 may be so connected in circuit that it may easily be removed and replaced with another potentiometer. Alternatively, the potentiometer could be driven through a cam or other eccentric drive interposed between function generator drive **86** and the contact arm **85** so that any desired movement of arm **105** could be programmed merely by changing cams. It is to be further understood that the desired crown form may be generated from any suitable generating means and the invention is not to be construed as limited to the particular function generating means illustrated.

It may thus be seen that the objects of the invention set forth above as well as those made apparent from the preceding description are efficiently attained. While preferred embodiments of the invention have been set forth for purposes of disclosure, other embodiments of the invention as well as modifications to the disclosed

embodiments thereof may occur to those skilled in the art. Accordingly, the appended claims are intended to cover all embodiments of the invention and modifications thereof which do not depart from the spirit and scope of the invention.

What is claimed is:

1. In a roll grinding apparatus having a bed, a carriage movable along the length of the bed and a roll thereon to be ground, a wheel head mounted to said carriage and movable transversely to a roll on said machine, a grinding wheel on said wheel head, power-operated means for moving said wheel head toward and away from the roll, and means for moving said carriage along said bed; means for generating a signal having a waveform varying in time and representative of a desired crown to be ground on a roll, means for coupling said signal to said power-operated means to cause said power-operated means to move said wheel head transversely with respect to the length of the roll in accordance with the generated signal as said carriage is moved along said bed.

2. The apparatus of claim 1 wherein said means for generating is a potentiometer having a contact arm driven in response to movement of said carriage along said bed.

3. The apparatus of claim 2 wherein said potentiometer is selected to generate a predetermined waveform in the travel of said grinding wheel along the face of a roll, and means selected in accordance with the length of a roll for driving said contact arm of said potentiometer at a predetermined rate.

4. The apparatus of claim 1 further including means for selecting a predetermined portion of the generated waveform to be applied to said power-operated means.

5. In a roll grinding machine having a bed, a carriage movable along the length of the bed and a roll thereon to be ground, a wheel head pivotally mounted to said carriage for tilting movement toward and away from the roll; a vertically movable member mounted on said carriage and having an upper surface supporting said wheel head thereon, an electric motor arranged to raise and lower said movable member, said movable member comprising a piston, guide means mounted to said carriage and guiding said piston in vertical movement thereof, a nut non-rotatably secured to said piston, a screw shaft engaging said nut and upon rotation thereof adapted to vertically move said piston, transmission means interconnecting said motor and said shaft, means for detecting movement of the carriage along the bed, means responsive to said detecting means for generating an electric signal which varies with the position of said carriage as a function of a desired contour to be ground on a roll, and means for coupling the generated signal to said motor.

6. In a roll grinding machine having a bed, a carriage movable along the length of the bed and a roll thereon to be ground, a wheel head pivotally mounted to said carriage for tilting movement toward and away from the roll; a vertically movable member mounted on said carriage and having an upper surface supporting said wheel head thereon, power-operated means arranged to raise and lower said movable member in a linear path, means for detecting movement of the carriage along the bed, means responsive to said detecting means for generating an electric signal which varies with the position of said carriage as a function of a desired contour to be ground on a roll, and means for coupling the generated signal to said power-operated means.

7. In a roll grinding machine having a bed, a carriage movable along the length of the bed and a roll thereon to be ground, a wheel head mounted to said carriage and movable transversely to a roll on said machine; power-operated means responsive to a signal input for moving said wheel head, means for generating a first electrical signal having a waveform varying in time corresponding to a crown to be ground on a roll, means

providing a second signal indicative of the position of the wheel head along the length of the bed and means for regulating the operation of said power-operated means in accordance with a summation of said signals as the carriage is moved along the length of a roll on said machine.

8. The invention of claim **7** further including first circuit means for establishing a third electrical signal indicative of the length of a roll to be ground, second circuit means for providing a fourth signal indicative of the position of the wheel head with respect to the length of a roll, and means responsive to the third and fourth signals for operating said means for generating.

9. The invention of claim **8** wherein said first circuit means comprises a potentiometer having a contact arm driven through movement of said carriage on said bed, means for establishing a voltage across said potentiometer indicative of the length of a roll on the bed, said second circuit including a potentiometer having a contact arm movable in response to the variations in the generated waveform.

10. In a roll grinding machine having a bed, a carriage movable along the length of the bed and a roll to be ground, a wheel head mounted to said carriage and movable transversely to a roll on said machine; power-operated means for moving said wheel head toward and away from the roll, means for moving said carriage along said bed, means responsive to movement of said carriage on said bed for generating a signal having a waveform varying in time and representative of a crown to be ground on a roll, means for coupling said

signal to said power-operated means to cause said power-operated means to move said wheel head transversely of said roll in accordance with the generated signal as said carriage is moved along the length of said bed, and means for selecting a portion of the waveform of the signal to be applied to said power-operated means.

11. A roll grinding machine having a bed, a carriage movable along the length of the bed and a roll to be ground, a wheel head pivotally mounted to said carriage, power-operated means for tilting said wheel head toward and away from a roll supported on said machine, means for detecting movement of the carriage along the bed; means responsive to said detecting means for generating an electric signal which varies with the position of the carriage as a function of a desired contour to be ground on a roll, means coupling said detecting means to said generating means, and means for controlling said power-operated means in accordance with said signal.

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JAMES L. JONES, JR., Primary Examiner

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