

Nov. 10, 1931.

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1,831,085

ROLL GRINDING MACHINE

Filed Dec. 10, 1928

5 Sheets-Sheet 1

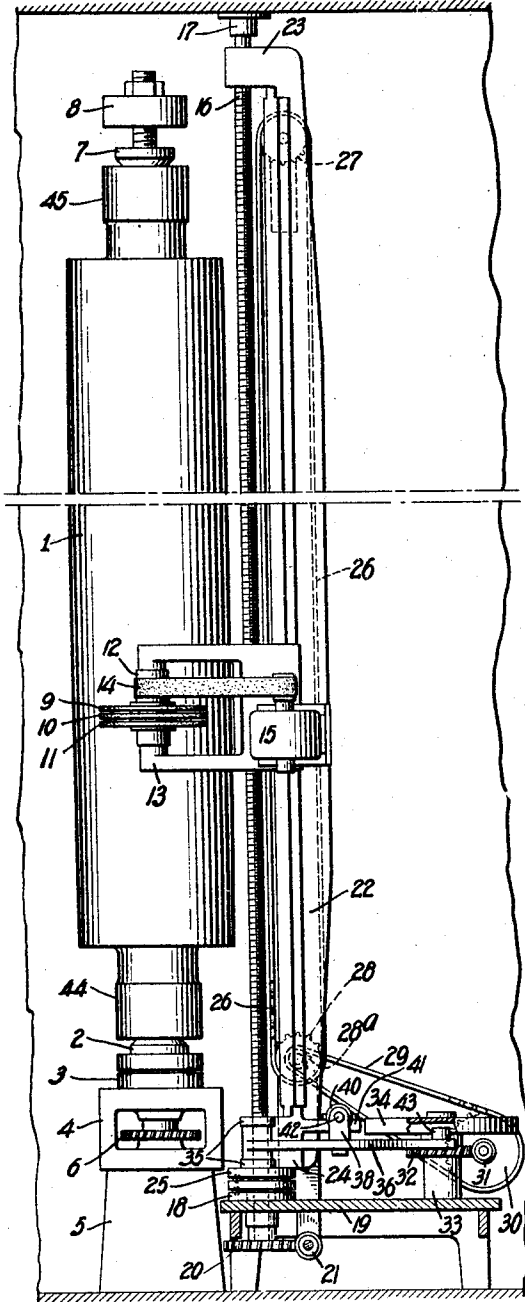


Fig. 1.

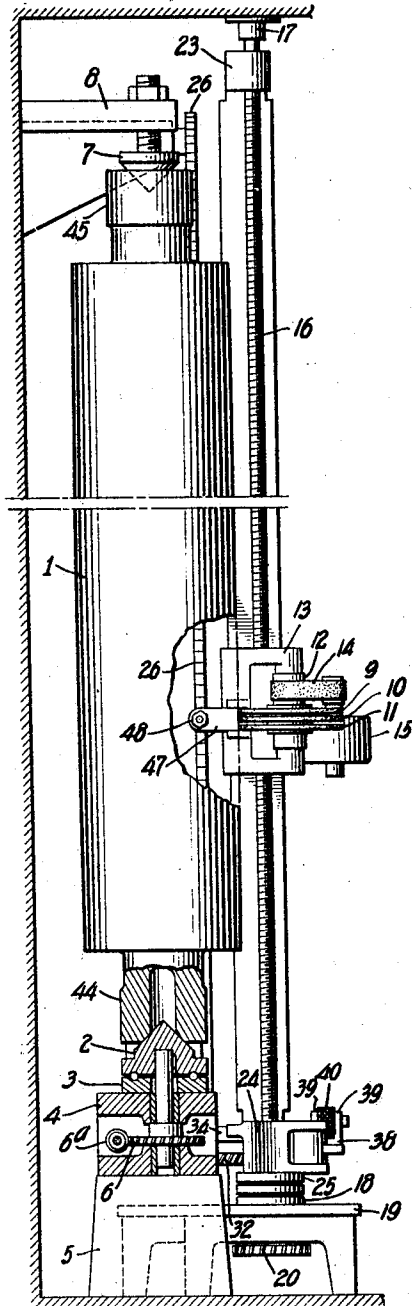


Fig. 2.

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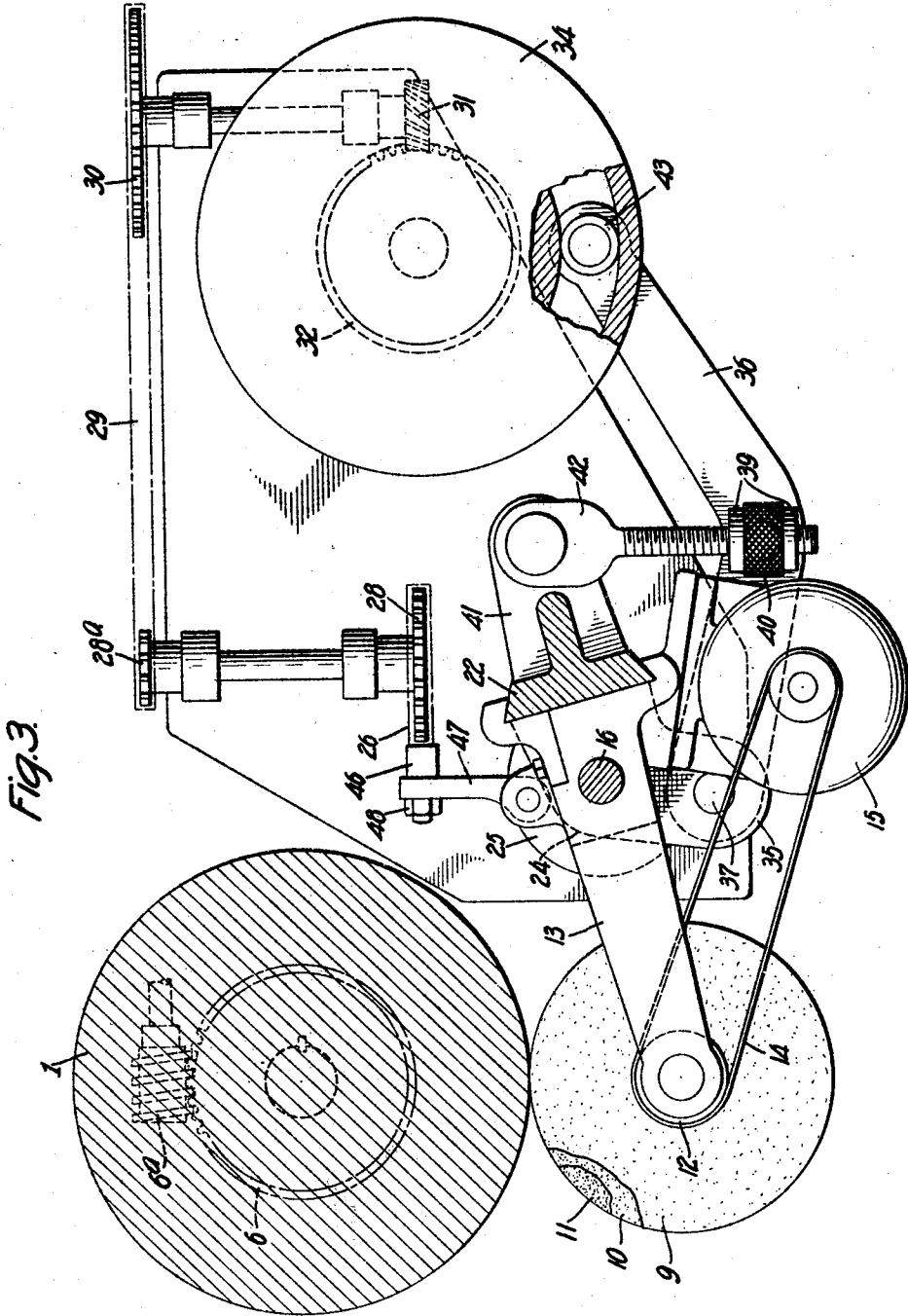
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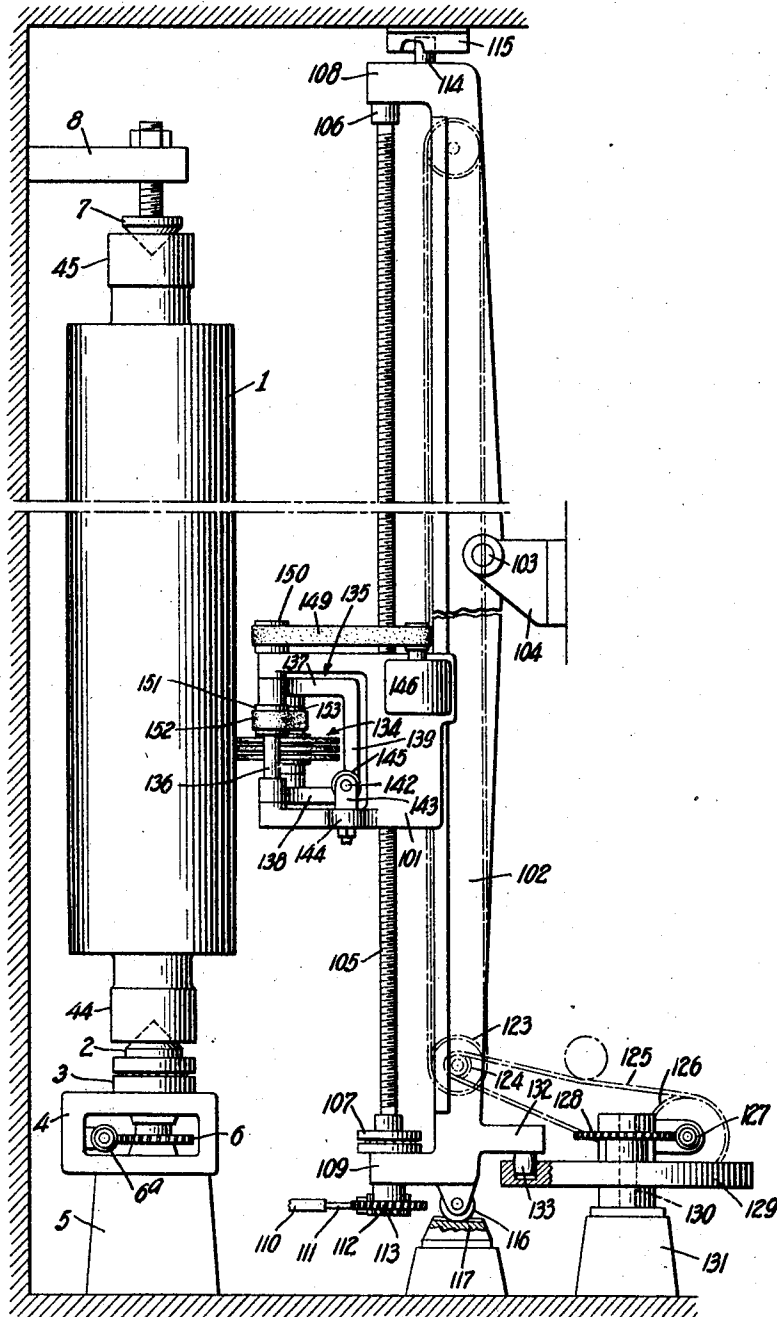
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Fig. 4.



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Fig. 5.

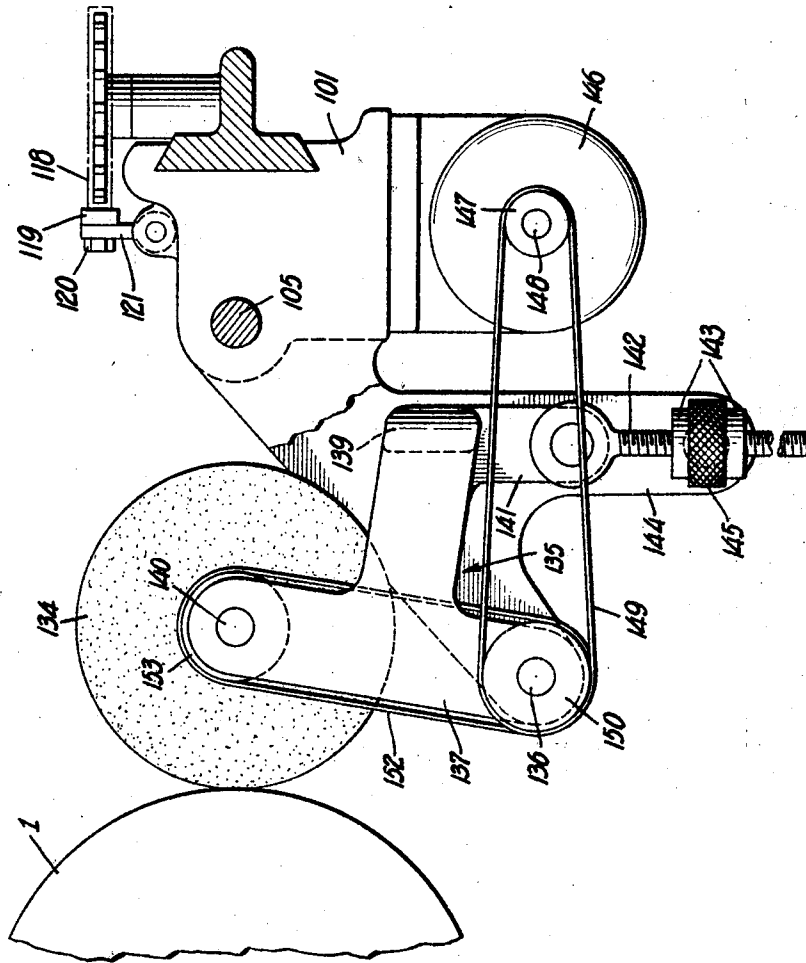
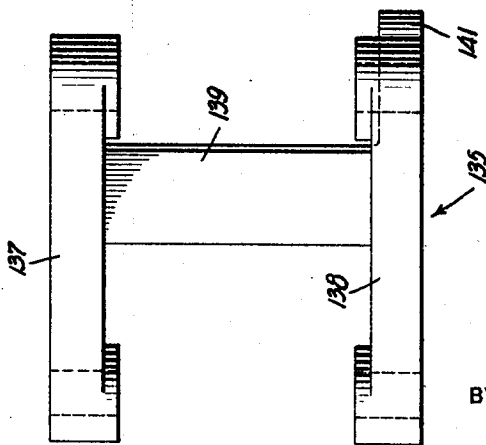


Fig. 6.



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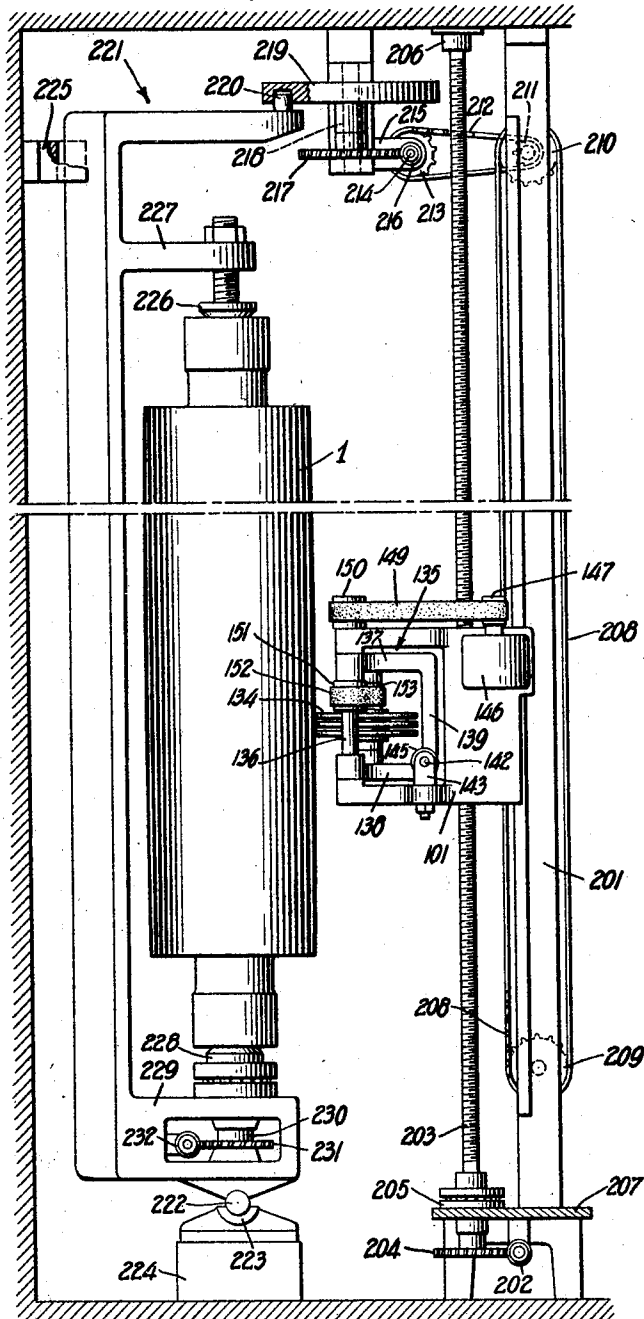
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Fig. 7.



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# UNITED STATES PATENT OFFICE

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## ROLL GRINDING MACHINE

Application filed December 10, 1928. Serial No. 324,836.

This invention relates to the grinding of large rolls, such as calendar rolls, used in paper making machinery to restore such rolls to their proper shape. It will become apparent as the description proceeds that the principle of the invention is applicable to the grinding of truly cylindrical rolls or rolls of any desired longitudinal surface curvature, either concave or convex, but for illustrative purposes the invention will be described in its application to the problem of grinding cambered calendar rolls.

Calendar rolls are required to act upon broad webs of paper, sometimes very thin paper, and in order that they may act uniformly throughout the width of a web passed between them, it is necessary that they be shaped with the utmost precision. The rolls are used in a horizontal position, and as a single roll weighs many tons and is required to span a considerable space, in some instances as much as thirty feet, there is obviously a tendency of the roll to sag in the middle, and this interferes with the accurate and uniform cooperation of the rolls with the thin paper web on which it must act. It is accordingly necessary to grind the lower roll of a couple or battery with a camber just sufficient to neutralize the sagging caused by its own weight and the weight of any rolls resting on it, so that that portion of the surface of the roll which contacts the paper will be caused to stand in a truly horizontal position.

The grinding of calendar rolls to the particular shapes required, with the fine degree of precision required, is attended with substantial difficulty.

According to the practice of the prior art, the roll is ground while in a horizontal position, and hence while it is influenced to sag under its own weight. Long horizontal guideways guide the grinding element in a path to produce the desired longitudinal surface curvature. The maintenance of this relationship of roll and guide in a machine de-

signed to act upon a horizontally arranged roll is extremely difficult to realize. Any settling of the long foundation of the guide or of the roll or any slight warping due to change of temperature throws the grinding mechanism out of proper cooperative relationship with the roll and renders the grinding performed worse than useless.

These difficulties are overcome in a large measure by the present invention by supporting the roll to be ground in a vertical position and supporting the grinding element or elements upon an upright guide. The slight deviation from a true vertical path required of the grinding element in order to produce the desired longitudinal surface curvature is secured by the provision of suitable mechanism, preferably controlled by the grinder feeding means, to move the grinder and the roll axis relatively, to cause them to approach and recede from one another to just the extent required.

The grinding of the roll, while in a vertical position, is a very important feature. The roll has no tendency to sag when in this position, but on the contrary, may be wholly symmetrical with relation to the axes of its rotary supports. The grinder guide is also free from stresses tending to distort it. No recourse is had to an elongated guiding means for producing the camber which would be subject to local distortion tending to produce inaccurate results. On the contrary, a control member may be employed which is so compact and light that it can be replaced conveniently by other like elements designed to produce other surface contours, according to the requirements of the various types of rolls on which the machine may be required to operate.

Other objects and advantages will hereinafter appear.

In the drawings forming part of this specification:

Figure 1 is a fragmentary, front eleva-

tion, cut away intermediate its ends for compactness of illustration, of a roll grinding machine embodying features of the present invention, and showing a calendar roll vertically supported therein for grinding;

Figure 2 is a side elevation similar to Figure 1;

Figure 3 is a detail, sectional, plan view on a larger scale than Figure 1 or 2, showing the mechanism for feeding the grinder carriage and for moving it horizontally;

Figure 4 illustrates a modified form of the invention in which the grinder guide is swung slightly about a horizontal axis to produce the desired curvature;

Figure 5 is a horizontal, sectional view, partly broken away, on a larger scale than Figure 4, showing how the grinder is mounted on its carriage in Figure 4 to provide for adjustment of the grinder toward and from the roll axis;

Figure 6 is a detail elevation of a frame or yoke employed in Figure 5; and

Figure 7 illustrates a further modified form of mechanism in which the grinder guide is stationary and the roll support is rocked slightly to produce the desired longitudinal curvature.

In the embodiment of Figures 1 to 3, inclusive, the roll 1 to be ground with a camber is chucked in a vertical position, being supported at its lower end upon a spindle 2 supported by ball bearing 3 on a frame 4 carried by a base or foundation structure 5. The spindle 2 is driven from a worm 6a by a worm gear 6 fast thereon, and imparts continuous rotary motion to the roll 1. The roll is fixed in a true vertical position with provision for rotation by a bearing 7 at the upper end thereof which is adjustably mounted in a rigid arm 8. Throughout the grinding operation, the roll 1 is continuously rotated.

The grinder desirably consists of several grinding discs, for example, discs 9, 10 and 11. The grinder is carried by a shaft or sleeve 12 which is rotatably mounted on a grinder carriage 13 and is driven through a belt 14 from a motor 15 carried by the grinder carriage 13. The grinder carriage has threaded engagement with a screw 16 which is mounted vertically in parallelism with the axis of the roll supporting spindles 2 and 7. The screw 16 is rotatably supported at its upper end in a bearing 17, and at its lower end in a bearing 18 of a fixed frame 19. The screw 16 is provided at its lower end with a worm gear 20 which is driven by a worm 21 to rotate the screw for feeding the grinder carriage. The grinder carriage embraces a vertical guide 22 having arms 23 and 24 at its upper and lower ends, respectively, which have bearing upon the unthreaded ends of the screw 16. If the guide 22 were held fixed in one position, the mechanism as thus far described would be ef-

fective to feed the grinder carriage, and hence the grinder in a true vertical path.

For the purpose of moving the grinder horizontally to a slight extent to impart the desired camber to the roll being ground, provision is made for rocking the guide in a counter-clockwise direction as the grinder moves from either end to the middle of the roll, and a clockwise direction as the grinder moves from the middle of the roll to either end thereof.

To this end the guide 22 is supported by a ball bearing 25 so that it may rock about the axis of the screw 16. The grinder carriage is made fast to a chain 26 which runs upon sprockets 27 and 28 journaled on fixed bearings adjacent the upper and lower ends of the guide 22. The travel of the carriage causes this chain to drive the pinion 28 and, through a pinion 28a fast thereto, to drive a chain 29 for imparting rotation to a gear 30 journaled in a stationary bearing.

The gear 30 in turn has fast to it a worm 31 which drives a worm wheel 32 fast on a vertical shaft (not shown) which is journaled in a bearing 33 on the fixed frame 19. The shaft 33 carries a track cam 34.

The guide 22 is provided with ears 35 to which a link 36 is pivotally connected by means of a pin 37. The link 36 has an upright post 38 pivotally mounted thereon. This post is bifurcated at its upper ends and receives between the arms 39 thereof a knurled nut 40. A tail portion 41 of the guide 22 has pivotally connected thereon a threaded link 42 which passes through the arms 39 of the post 38 and is threaded through the knurled nut 40. The link 42 and nut 40 constitute means for adjusting and maintaining the link 36 in any desired angular relation to the guide 22.

The link 36 carries at its right hand end, as seen in Figures 1 and 3, a cam follower pin 43 which runs in the track of the cam 34.

The cam track is shaped to swing the grinder toward and from the axis of the roll 1, and since the travel of the cam is controlled by the travel of the grinder carriage, the grinder will always traverse precisely the same path in traveling from one end of the roll to the other. The track of the cam is so formed that precisely the desired camber of the roll is secured by the deviation from a true vertical path produced by this swinging of the grinder carriage guide.

The purpose of the threaded link 42 and the knurled nut 40 is two-fold. As the calendar roll wears in use, its diameter is reduced, and it becomes necessary to set the grinder closer to the axis of the roll at successive grindings. A micrometric adjustment for this purpose is secured by the provision of the threaded link 42 and the nut 40, the adjustment being effective to change

the angular relation of the guide 22 and the link 36.

The second purpose of providing this adjustment is to enable the grinder to be moved substantially nearer to the axis of the roll 1 so that it may be employed also for grinding the bearings 44 and 45 at the ends of the roll 1. When this portion of the grinding operation is in progress, it is not desirable to rotate the cam 34. Provision is accordingly made for disconnecting the grinder carriage from the chain 26 at this time. The connection between the carriage and the chain is therefore made detachable, and consists, as illustrated, of a bolt 46 carried by the chain, an arm or link 47 pivotally carried by the carriage and adapted to receive the threaded portion of the bolt, and a nut 48 adapted to be threaded on the bolt for securing the bolt to the arm 47. Since the link 36 is incapable of rotating the cam 34, the cam remains stationary during the grinding of the bearings, and prevents swinging of the guide 22. The chain 26 also remains stationary, and since it can only be reconnected to the grinder carriage when the arm 47 comes into registry with the bolt 46, there is no danger of losing the precise adjustment of the mechanism by the temporary disconnection described.

The arm 47 is pivoted on the carriage in order to accommodate more readily the relative movement between the guide and the chain occasioned by the automatic swinging of the guide.

In the form of the invention disclosed in Figures 4, 5 and 6 the mounting and driving of the roll is the same as in Figures 1 to 3. The same reference numerals have accordingly been applied to these parts.

The grinder carriage 101, however, runs upon a guide 102 which is not rockable about a vertical axis like the guide of Figures 1 to 3, but is supported on a horizontal shaft 103 carried by a fixed bracket 104 situated about midway of the length of the guide. The guide 102 is rockable to a slight extent about the axis of the shaft 103 to carry the grinder toward and from the axis of the roll 1 as it travels longitudinally of the roll. In this instance a screw 105, which passes through the grinder carriage 101 and has threaded engagement therewith, is mounted in bearings 106 and 107 on forwardly reaching arms 108 and 109 of the guide 102. The screw is driven from a shaft 110 through a train comprising a shaft 111 splined to the shaft 110, but capable of a little longitudinal movement relative thereto. The shaft 111 drives a worm 112, and this worm in turn drives a worm gear 113 fast to the screw 105. The guide 102 carries a pin 114 at its upper end, which runs in a fixed channel guide 115 extending at right angles to the axis of the shaft 103 and in the plane of the axis of the roll 1. The guide 102

carries a roller 116 at the lower end thereof which runs on a fixed guide 117 that extends parallel to the channel of guide 115. The grinder carriage 101 is made fast to a chain 118 by means of a bolt 119 and nut 120 that secure the chain to an arm 121 pivotally mounted on the grinder carriage 101. The chain runs upon sprockets 122 and 123 rotatably carried by the guide 102 at the upper and lower ends thereof. The sprocket 123 is fast to a sprocket 124 which, through a chain 125, drives a sprocket 126. The sprocket 126 is fast to the shaft of a worm 127, which worm drives a worm wheel 128, and through the worm wheel a track cam 129 carried by a vertical shaft 130 on a fixed support 131. A rearwardly extending arm 132 of the guide 102 carries a cam follower 133 which travels in the track of the cam 129.

The described train is made effective by the travel of the carriage to impart rotation to the cam 129 and through the cam to rock the grinder carriage guide 102 about the axis of shaft 103. The track of cam 129 is so shaped that the grinder is caused to recede from the axis of roll 1 as it moves longitudinally of the roll from either end toward the middle of the roll, and to approach the axis of the roll as it moves from the middle of the roll toward either end thereof. The design of the cam track is such that the precise longitudinal curvature desired is imparted to the surface of the roll.

In this form of the invention, since the grinder guide does not rock about a vertical axis and does not, therefore, admit of adjustment of the guide to vary the basic or datum spacial relation between the grinder and the roll axis, provision is made for mounting the grinder 134 in a yoke or frame 135 for swinging movement about the axis of a vertical shaft 136 mounted on the grinder carriage. This yoke comprises upper and lower arms 137 and 138 connected by a web or tie piece 139. The arms 137 and 138 are provided with aligned bearings at their opposite ends for receiving the grinder shaft 140 and the supporting shaft 136. A projecting arm 141 on the web 139 has pivotally connected thereto a threaded link 142 which extends through ears 143 on an extension 144 of the carriage 101. A knurled nut 145 is positioned between the ears 143 and is threaded onto the threaded link 142. Rotation of the knurled nut 145 is effective, therefore, to swing the frame 135 about the axis of the shaft 136 and to change the normal distance between the grinder 134 and the axis of the roll 1.

This adjustment may also be utilized for enabling the bearings to be ground. During the grinding of the bearings, the carriage 101 may be rendered ineffective to rock the guide 102 by disconnecting the bolt 119 from the arm 121.

The grinding motor 146 is fixed on the car-

riage 101, and since the grinder is adjustable with relation to the carriage, the driving train from the motor to the grinder is arranged so that it will not be affected by such adjustment. This is accomplished by effecting the drive of the grinder through a pulley 147 on the motor shaft 148, a belt 149, a pulley 150 on the shaft 136, a second pulley 151 on the shaft 136 and a belt 152 running on the latter pulley and on a pulley 153 fast to the grinder shaft 14. Since the pulleys 150 and 151 are concentric with the axis about which the grinder frame 135 is adjusted, the tension of the belts 149 and 152 is not affected by the adjustment.

In the form of the invention disclosed in Figure 7, the grinder, the grinder carriage, and the grinder driving means are of the same construction as in Figures 4 to 6, and corresponding reference numerals have accordingly been applied. In this form of the invention, however, the grinder travels along a fixed vertical guide 201 in a straight line, and the roll support is tilted slightly to produce the desired longitudinal curvature of the surface of the roll 1. A worm 202 drives a screw 203 through a worm wheel 204 to feed the grinder carriage 101 in the manner already described. The screw 203 in this case is journaled in stationary bearings 205 and 206. The bearing 205 and the guide 201 are mounted upon a fixed support 207. As in the form of the invention illustrated in Figures 4 to 6, the grinder carriage is harnessed to a chain 208 which runs upon sprockets 209 and 210 mounted on the lower and upper ends of the guide 201. The sprocket 210 has fast thereto a small sprocket 211 which, through a chain 212, drives a sprocket 213 fast on a worm shaft 214 that is journaled in a fixed bracket 215. The shaft 214 carries a worm 216 which drives a worm wheel 217 fast on a vertical shaft 218. The shaft 218 has fast thereon a track cam 219 in which runs a cam follower 220 fixed on the roll support 221. The roll support 221 is provided with an arcuate bearing 222 at the lower end thereof which rests in a complementary bearing 223 carried by a fixed support 224. The bearings 222 and 223 extend at right angles to the guide 201, and hence to the path of movement of the grinder, so that the rotation of the cam 219 is effective to rock the roll support directly toward and from the grinder. For the purpose of further assuring movement of the roll support 221 in exactly the right direction, provision is made of a fixed guide yoke 225 which embraces a portion of the support 221 near the upper end thereof, and constrains it to move in the desired direction only.

The roll is mounted between an upper adjustable bearing 226 carried by an arm 227 of the support 221 and a spindle 228 carried by a lower angle portion 229 of the support

221. The spindle 228 is fast to a shaft 230 which carries a worm wheel 231 arranged to be driven by a worm 232.

The track of cam 219 is so designed that the roll axis is caused to recede from the grinder as the grinder travels from either extremity of the roll toward the middle thereof and to approach the grinder as the grinder recedes from the middle of the roll toward either extremity thereof. The design of the cam is such that the desired longitudinal curvature of the roll surface is secured with precision.

Although I have herein shown and described only certain specific forms of embodiment of the invention, it will be understood that the same is not limited thereto, but that various changes and modifications may be made therein within the scope of the accompanying claims, without departing from the spirit and scope of the invention.

I claim:

1. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, means guiding the grinder for substantially vertical movement, and means for causing the roll axis and the grinder to relatively approach and recede from one another to impart a predetermined lengthwise curvature to the surface of the roll.

2. In a machine for grinding long heavy rolls in combination, means for supporting and rotating a roll in substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, and means controlled by the travel of the grinder to cause the grinder and the roll axis to relatively approach and recede from one another to impart a predetermined lengthwise curvature to the surface of the roll.

3. In a machine for operating on the surface of a long heavy roll having a longitudinal surface curvature, in combination, means for supporting and rotating a roll in a substantially upright position, an operating element, a guide therefor extending longitudinally of the roll, means for feeding the operating element along the guide, and means for causing the roll axis and the operating element to relatively approach and recede from one another to describe a relative path of the desired curvature.

4. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in substantially upright position, a grinder, means for feeding the grinder longitudinally of the roll, and means for causing the grinder and the roll axis to relatively approach and recede from one another to describe a relative path of the necessary curvature to impart a predetermined

longitudinal curvature to the surface of the roll.

5. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, and a grinder guide extending parallel to the axis of rotation of the roll.

6. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, means guiding the grinder for movement lengthwise of the roll, and means controlled by the travel of the grinder for moving the grinder toward and from the axis of the roll to impart a desired lengthwise curvature to the surface of the roll.

7. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, and means for imparting a relatively minute rocking movement to the grinder to move it toward and from the roll axis to impart a slight longitudinal curvature to the roll surface.

8. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, and means operated by the grinder feeding means for rocking the guide to carry the grinder toward and from the roll axis.

9. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, and means operated by the grinder feeding means for rocking the guide about a vertical axis to swing the grinder horizontally toward and from the axis of the roll.

10. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, and means operated by the grinder feeding means for rocking the grinder toward and from the roll axis, comprising a cam, a driving train therefor harnessed to the grinder carriage, and a cam follower angularly fixed with reference to the grinder.

11. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, means operated by the grinder feeding means for caus-

ing the grinder and the roll axis to relatively approach and recede from one another to impart a desired longitudinal curvature to the roll surface, and manually operable means for adjusting the normal spacial relation of the grinder and the roll axis.

12. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, means operated by the grinder feeding means for automatically causing the grinder and the roll axis to relatively approach and recede from one another to impart a desired longitudinal curvature to the roll surface, adjusting means for changing the distance between the grinder and the roll axis to enable the roll bearings to be ground, and means manipulatable to render the automatic means referred to ineffective while the bearings are being ground.

13. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in a substantially upright position, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, means for rocking the guide to cause the grinder to approach and recede from the roll axis, and means for adjusting the grinder horizontally with reference to the guide.

14. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in substantially upright position, a grinder, a frame on which the grinder is mounted, a grinder carriage supporting the frame, a guide for the grinder carriage extending longitudinally of the roll, means for feeding the grinder carriage along the roll, and means for relatively adjusting the grinder frame and carriage to vary the distance of the grinder from the axis of the roll.

15. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll, a grinder, a grinder carriage, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, and means operated by the grinder feeding means for rocking the grinder toward and from the roll axis, comprising a cam, a driving train therefor harnessed to the grinder carriage, and a cam follower angularly fixed with reference to the grinder.

16. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, means operated by the grinder feeding means for automatically causing the grinder and the roll axis to relatively approach and recede from one another in phase with the travel of the grinder along the roll to impart

a desired longitudinal curvature to the roll surface, adjusting means for changing the distance between the grinder and the roll axis to enable the roll bearings to be ground, and means manipulatable to render the automatic means referred to ineffective while the bearings are being ground.

17. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll, a grinder, a grinder guide extending longitudinally of the roll, means for feeding the grinder along the guide, means for rocking the guide in phase with the travel of the grinder to cause the grinder to approach and recede from the roll axis to impart a predetermined longitudinal curvature to the roll surface, and means for adjusting the grinder horizontally with reference to the guide.

18. In a machine for grinding long heavy rolls, in combination, means for supporting and rotating a roll in an upright position, a grinder, a substantially vertical guide for the grinder, means for feeding the grinder along the guide, and means for rocking the guide slightly about a horizontal axis to cause the grinder and the roll axis to approach and recede from one another as the grinder travels along the roll to impart a predetermined longitudinal curvature to the roll surface.

19. A method of cambering long heavy rolls, comprising the steps of supporting the roll in a substantially upright position, rotating said roll about its longitudinal axis, and machining the roll to impart a lengthwise curvature to the face of the roll.

20. A method of grinding long heavy rolls comprising the steps of supporting the roll in a substantially upright position, rotating said roll about its longitudinal axis, rotating a grinding wheel and moving the same in a substantially vertical path, and varying the distance between said grinder and said roll axis during the grinding operation to impart lengthwise curvature to the surface of the roll.

In testimony whereof I have affixed my signature to this specification.

HARRISON R. WILLIAMS.

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