Aug. 1, 1939. C. HERFURTH ET AL 2,167,948

CAMBERING MECHANISM FOR GRINDING MACHINES

Filed April 25, 1938 4 Sheets-Sheet 1

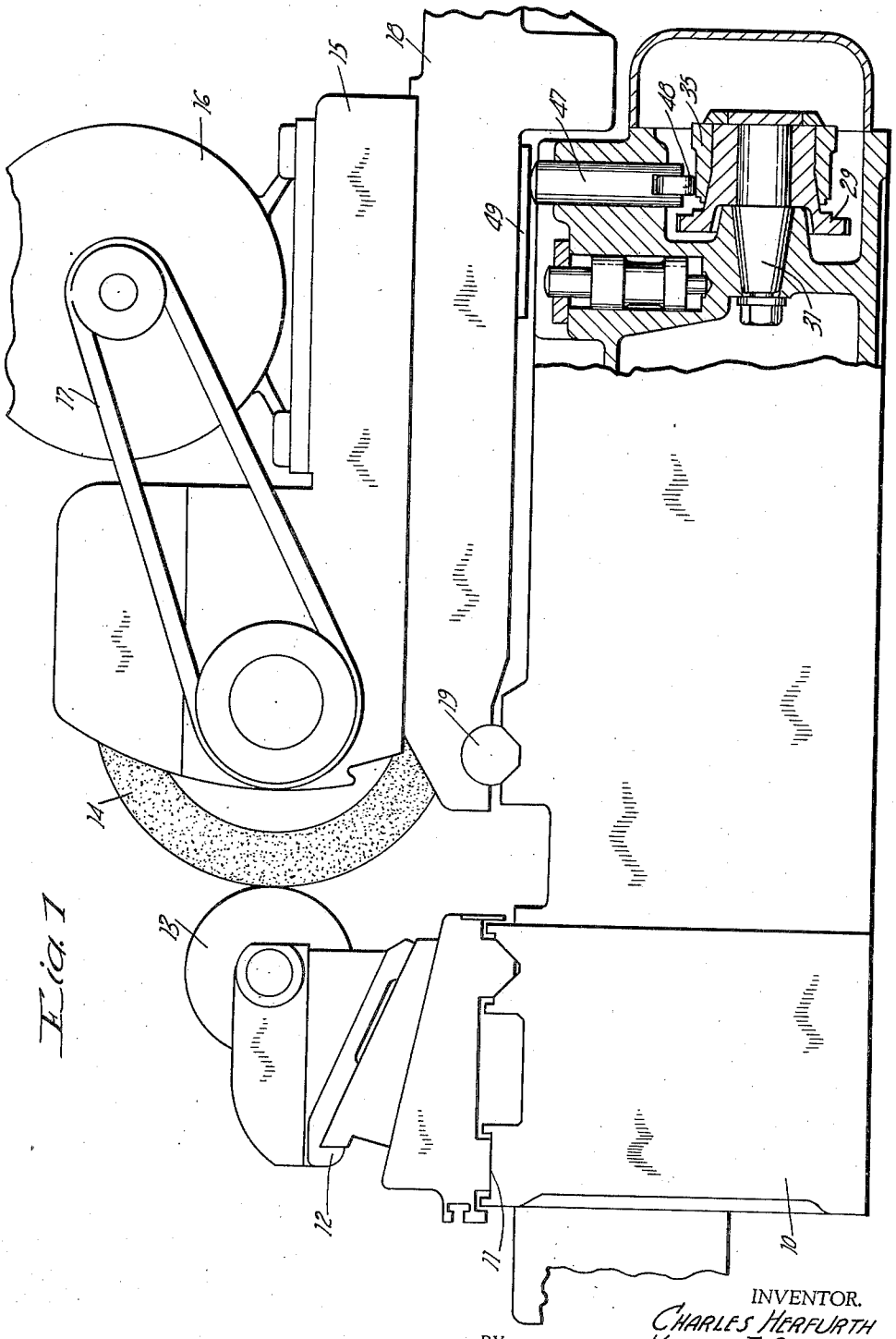


Fig. 1

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CAMBERING MECHANISM FOR GRINDING MACHINES

Filed April 25, 1938 4 Sheets-Sheet 2

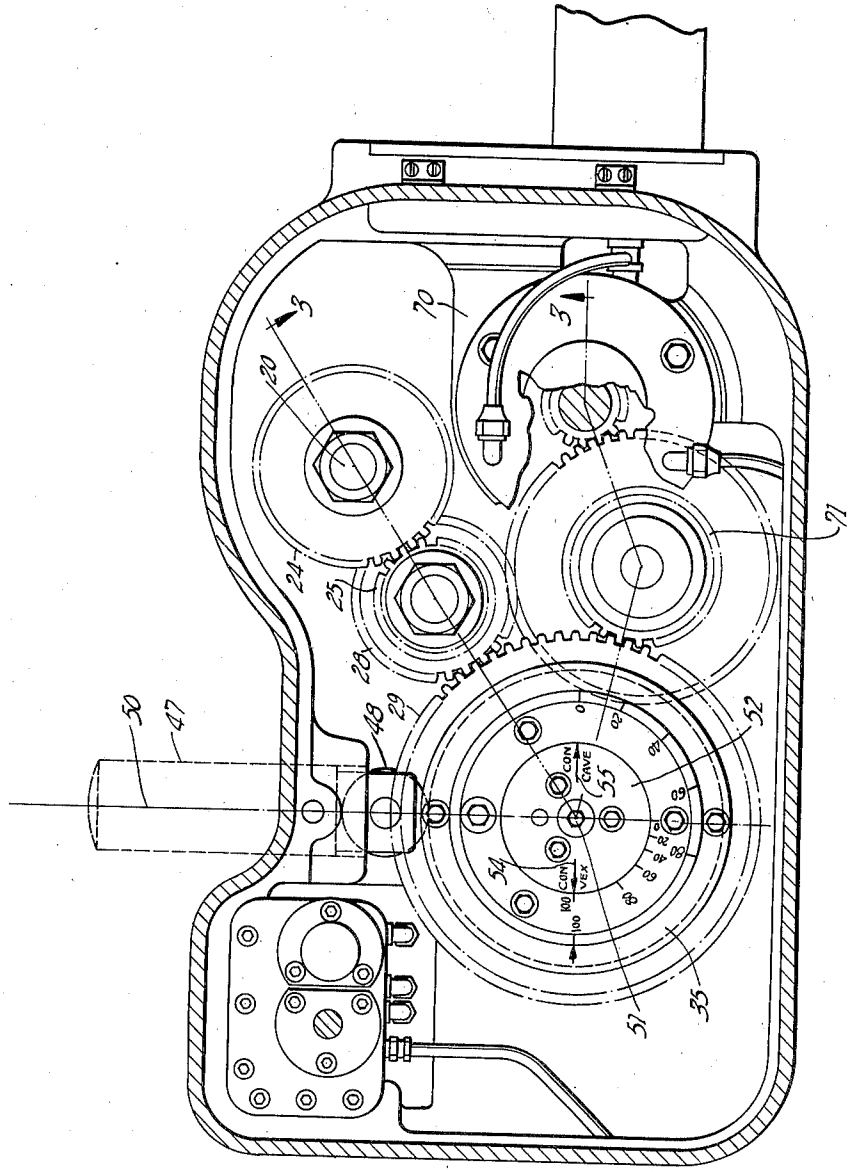


Fig. 2

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CAMBERING MECHANISM FOR GRINDING MACHINES

Filed April 25, 1938 4 Sheets-Sheet 3

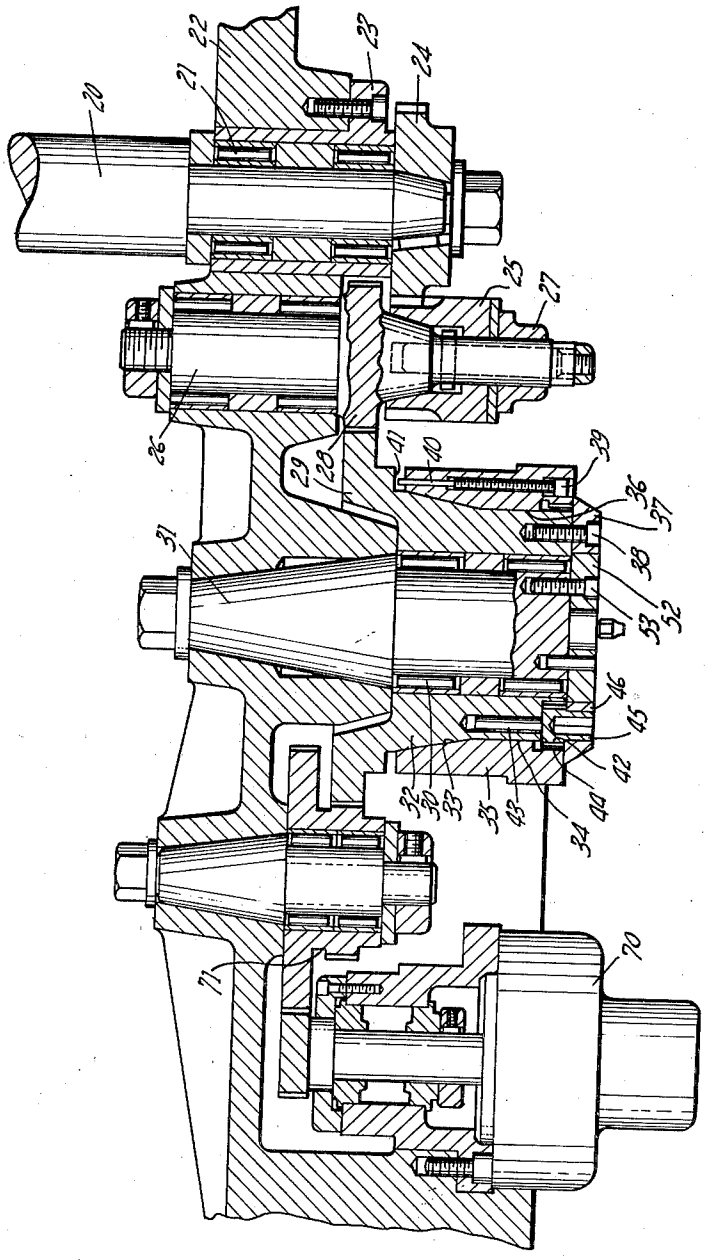


Fig. 3

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CAMBERING MECHANISM FOR GRINDING MACHINES

Filed April 25, 1938 4 Sheets-Sheet 4

Fig. 4

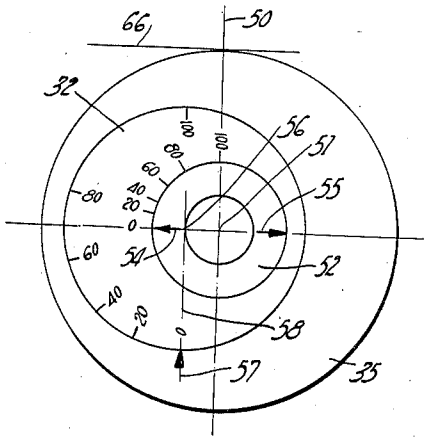


Fig. 5

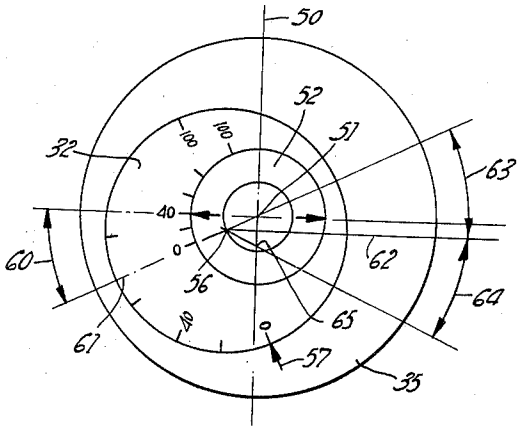


Fig. 6

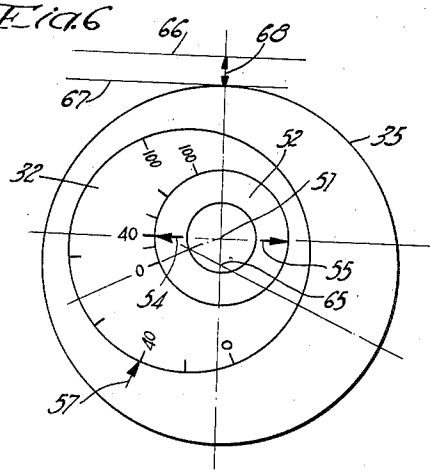


Fig. 7

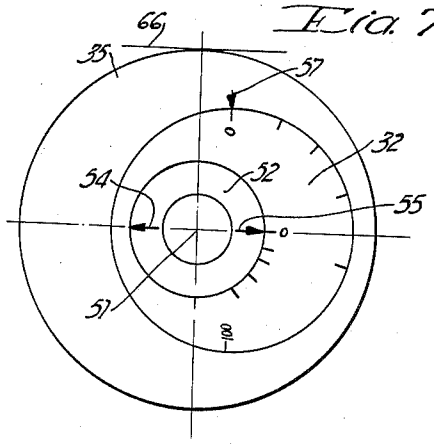


Fig. 8

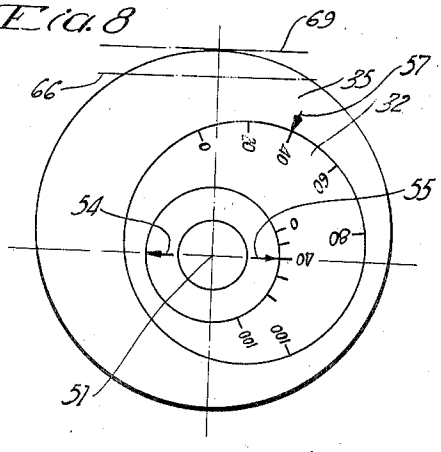
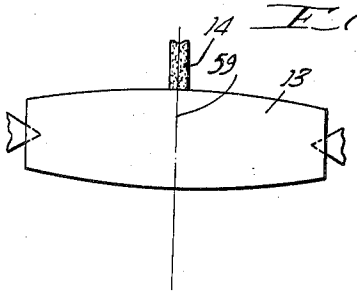


Fig. 9



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UNITED STATES PATENT OFFICE

2,167,948

CAMBERING MECHANISM FOR GRINDING MACHINES

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Application April 25, 1938, Serial No. 204,082

11 Claims. (Cl. 51—33)

This invention relates to grinding machines, and more particularly to improvements in camber control mechanisms therefor.

One of the objects of this invention is to provide an improved and simplified camber control mechanism for a roll grinding machine.

Another object of this invention is to provide a camber control mechanism which has a wide range of adjustment and a high degree of accuracy for any setting.

A further object of this invention is to provide a camber control mechanism which is composed of a relatively few number of parts which are easy and inexpensive to manufacture.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification considered in conjunction with the accompanying drawings illustrative of one embodiment thereof, but it will be understood that any modifications may be made in the specific structural details within the scope of the appended claims without departing from or exceeding the spirit of the invention.

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

Figure 1 is a side elevation of a roll grinding machine.

Figure 2 is a section on the line 2—2 of Figure 1.

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

Figures 4, 5, 6, 7, and 8 are diagrammatic views showing different settings of the camber control mechanism for obtaining convex and concave surfaces.

Figure 9 is a diagrammatic view showing the set-up relationship between grinding wheel and work.

In Figure 1 of the drawings there are shown the general features of a roll grinding machine comprising a bed 10 upon the top of which are formed guideways 11 for receiving and supporting a reciprocable work supporting table 12. This table is adapted to support a work piece, such as a roll 13, in opposition to a grinding wheel 14. The grinding wheel is rotatably mounted on a subslide 15 which also carries a motor 16 for rotating the grinding wheel by means of a driving belt or chain 17.

The slide 15 is longitudinally adjustable relative to a support 18 for effecting major adjustments between the wheel and the work. The support 18 is supported for oscillation about a pivot 19 whereby during camber grinding operations the wheel may be oscillated toward and from the work in timed relation to the longitudinal travel of the work.

This invention deals more particularly to an improved adjustable mechanism which may be preset so that upon actuation in synchronous relation to the travel of the work table, various desirable cambers may be obtained. This mechanism comprises an eccentric cam, and a follower which engages the oscillatable support together with means for shifting the axis of eccentricity along the axis of movement of the follower. The following mechanism is provided for effecting rotation of the cam, and this mechanism may be actuated in synchronized relation to the table travel by means of the transmission shown and described in copending application Serial Number 294,083 filed on the 25th day of April, 1938. The camber control mechanism is mounted on the rear of the bed, and there is a shaft 20 which is antifrictionally supported by bearings 21 in the wall 22 of the cambering mechanism gear box indicated generally by the reference number 23. The shaft 20 has a spur gear 24 keyed to the end thereof and intermeshing with a gear 25 keyed to a stub shaft 26.

The gear 25 is held in position on the end of shaft 26 by a nut 27 threaded on the end of the shaft. The gears 24 and 25 are removable and gears of different sizes may be substituted therefor, whereby they constitute rate change gears for varying the rate of actuation of the remainder of the gear train. The shaft 26 also has a gear 28 which intermeshes with a large gear 29. The gear 29 is supported by antifriction bearings 30 on a fixed shaft 31. The gear 29 has an elongated eccentric hub 32 on which are formed a tapered portion 33 and a straight portion 34. A circular cam member 35 having an eccentric bore 36 is mounted on the hub of gear 29. This eccentric bore has a straight portion and a tapered portion corresponding to the straight and tapered portions on the hub of gear 29 whereby the cam may be forced on the tapered portion and frictionally held for rotation with the gear.

The cam is clamped to the gear 29 by means of a clamping ring 37 which overlaps the end of the cam and is secured to the gear 29 by bolts 38. When these bolts are tightened, the cam is forced upon the tapered portion 33. When adjustment is to be made, the clamping bolts 38 are loosened and the cam is forced off the tapered portion by means of a pair of screws 39 which are threaded in the cam and have reduced ends 40 which engage the face 41 of the gear 29 whereby the reaction on the screw threads will force the cam off

the taper 33. When the cam has been loosened in this manner, a small pinion 42 which is journaled in the gear member 29 by means of an integral stud 43 is rotated and through interengagement with internal gear teeth 44 carried by the cam member, the same may be rotated relative to the gear 29.

It will be noted that the pinion 42 has a reduced portion 45 which passes through a hole 46 formed in the clamping ring 37 and since the pinion 42 is fixed with the gear 29, the clamping ring 37 will also be held with the gear whereby the cam 35 may be rotated relative to both of these parts.

As shown in Figure 1, a cam follower 47 is supported for vertical reciprocating in the bed 10 and one end of this follower is provided with a roller 48 which engages the periphery of the cam 35 and the other end engages a wear plate 49 mounted on the under side of the pivoted support 18. It will be noted from Figure 2, that the vertical axis 50 defines a vertical plane in which the follower reciprocates, and that this axis passes through the axis of rotation of the gear 29 and cam 35. Since the peripheral surface of the cam 35 is a true circle, it should be evident that if the eccentricities of the hub 32 and the bore 36 are equal and positioned opposite to one another, that the eccentricities will cancel whereby the true center of the circular surface of the cam may be made to lie on the center of rotation 51, whereby no movement of the follower will result upon rotation of the cam.

In order that the operator may know the relative positions of the eccentrics for set-up purposes, a plate 52 is attached to the end of the fixed shaft 31 by means of screws 53, and provided with two diametrically opposite index marks 54 and 55 that lie in a plane at right angles to the vertical axis 50. Referring to Figure 5 in which the eccentricities are exaggerated for explanatory purposes, the point 56 indicates the true center of the hub 32, and the distance between the axis of rotation 51 and the point 56 represents the effective radius or eccentricity of the hub. When the cam 35 is rotated relative to the hub 32, the point 56 becomes the axis of rotation about which the cam moves. When the cam is in the position shown in Figure 4, the true center of the cam lies on the axis of rotation 51 because its eccentricity, which may be measured to the right of the point 56, is equal to and cancels the eccentricity of the hub 32 which is measured to the left of the axis of rotation 51. The result is that the true center of the cam lies on the axis of rotation and the resultant eccentricity is equal to zero. Therefore, with the parts in a zero eccentric position, the end face of the hub 32 is graduated beginning with a "0" mark opposite the arrow 54 and other marks extending throughout the 90° arc clockwise to the axis 50.

Since the cam 35 moves about the center 56 when it is adjusted relative to the hub 32, it is provided with an arrow 57 which is located in the plane of the radius 58 passing through the center 56 and parallel to the vertical axis 50. The end face of the hub 32 is graduated from this point through an arc of 180° in a clockwise direction, the graduations being equal in number to the first named graduations but having twice the angular extent. The graduations shown indicate percentages of the maximum camber which can be obtained. This maximum camber will be equal to twice the radius 51—56.

To set the machine up for obtaining a convex camber on the work, the table 12 is traversed until the longitudinal center of the work, as represented by the axis 59, Figure 9, is opposite the center of the grinding wheel 14, and then the gear 25 is withdrawn from mesh with the gear 24 so that the gear 29 may be rotated in a counterclockwise direction, as viewed in Figure 4, until the desired camber percentage is opposite the arrow 54.

The gear 25 is then replaced in mesh with the gear 24, and the cam 35 loosened and rotated relative to the gear 29 until the arrow 57 is opposite a graduation mark having a value equal to the value of the graduation mark opposite the arrow 54. The effect of this is to shift the true center of the cam circle 35 along the axis 50 and in this case downward or below the center 51 which will thereby cause the grinding wheel support 18 to move clockwise, as viewed in Figure 1, thus determining the maximum diameter or crown on the work at its longitudinal center. It will now be evident that after the cam 35 is reclamped to the gear 29, rotation of the cam in either direction will cause the effective radius to increase. This will cause counterclockwise movement of the support 18 whereby the grinding wheel will move toward the work and thus reduce its diameter.

In Figure 6, the parts are shown in a position to yield a camber which is 40% of the maximum camber obtainable. To obtain this set-up, the gear and cam are rotated about the axis 51 in a counterclockwise direction through an angle indicated by the reference numeral 60 until the graduation mark 40 is opposite the arrow 54. The parts will then be in the position indicated in Figure 5. It will be noted that the true center of the cam 35 still remains in juxtaposition to the center 51. The center 56 of the eccentric hub 32 has moved and lies on the radial line 61. The cam 35 is now rotated about the center 56 and through an angle equal to twice the angle 60 so that the true center of the cam 35 will still lie on the vertical axis 50.

It is desirable that the maximum offset or eccentricity of the cam be measurable along the axis 50 during set-up, because this position of the cam corresponds to the central position of the work with respect to the grinding wheel, as shown in Figure 9, and whatever maximum displacement the cam can effect should be effected at the moment that the center of the work is central of the grinding wheel. If a radial line 62 is drawn from the center 56 in Figure 5, parallel to the diameter through the arrows 54 and 55, the angle 63 between this line and the prolongation of radial line 61 will be equal to the angle 60.

If a second angle 64 is laid off equal to the angle 63, and the cam rotated through the angle 63 and the angle 64, it will be apparent that the cam will be rotated through an angle which is twice as great as the angle 60, and this will position the arrow 57 opposite the graduation mark 40 on the outer periphery of the hub 32, and in so doing the true center 65 of the circle 35 will be caused to move downward, but will still lie on the axis 50 so that the effective eccentricity of the cam is the distance between the line 66, which was tangent to the cam 35 in Figure 4, and the new tangent 67, shown in Figure 6 and indicated by the reference numeral 68.

Thus, in Figures 4, 5, and 6, there is shown a method of adjusting the camber control mechanism to produce a convex camber on the work piece which is 40% of the maximum. The same

mechanism may be utilized to produce a concave camber on the work. To accomplish this, and assuming the parts in the position shown in Figure 4 in which the true center of the cam **35** is concentric with the center of rotation **51**, it will be apparent that the entire assembly shown in Figure 4 may be rotated through an angle of 180°, or in other words, to the position shown in Figure 7, without causing relative displacement of these centers.

Since the shaft **31** is fixed, the plate **52** remains fixed, whereby the arrows **54** and **55** will remain in the same position, so that the "0" mark on the hub **32** will now be opposite the arrow **55**. The cam **35** is 180° out of angular phase with its position shown in Figure 4. It will now be apparent that if the hub and cam are rotatively adjusted in the same direction as before, that the follower contact point on the cam will be moved up instead of down.

Thus the same graduation marks may be used to effect concave camber adjustments, and in Figure 8, the parts are shown in an adjusted position to yield a 40% concave camber. This is accomplished by rotating the hub **32** in a counterclockwise direction until the graduation mark **40** coincides with the arrow **55**, and then by rotating the cam **35** in a clockwise direction until the arrow **57** coincides with the graduation mark **40** located on the outer periphery of the hub **32**. This raises the tangent point of the cam from the line **66** to the line **69**. It will now be apparent that upon rotation of the cam **35** in either direction from the position shown, that the effective radius of the cam with respect to the center of rotation **51** will decrease whereby the grinding wheel will recede from the work with the result that the work will be ground to the smallest diameter at its longitudinal center, and this diameter will increase in either direction therefrom, thus producing a concave surface on the work.

After the necessary adjustment has been made in accordance with the desired camber, synchronism between rotation of the cam and travel of the work table is maintained by providing a backlash eliminating motor **70**, and connecting it to gear **29** through intermediate gearing **71**, whereby the motor will act to retard the drive in one direction of table travel, and act as a driver in the other direction of table travel. The manner of hydraulically connecting this motor to the table control circuit to accomplish these results automatically does not constitute part of the present invention, being described and claimed in the copending application supra.

There has thus been provided an improved camber control mechanism which is adjustable to provide either convex or concave cambers, and although composed of a relatively few number of parts, it has a wide range of adjustment.

What is claimed is:

1. In a grinding machine having a work support and a grinding wheel, the combination of a pivoted support for effecting radial movement of the grinding wheel toward and from the rotational axis of the work, means for relatively positioning the work and the grinding wheel with its central plane intersecting the longitudinal center of said rotational axis, a cam follower carried by said pivoted support and movable in a fixed plane, a shaft lying in said plane, a circular cam surrounding said shaft with its periphery in contact with said follower, and eccentricity adjusting means in the form of an eccentric between said shaft and said cam supported for relative rotation with respect to both of said parts for adjustably positioning the effective center of said cam with respect to the shaft and along said fixed plane for determining the diameter of the work at its longitudinal center, and means to cause synchronized movement of the cam and of the work relative to the wheel to produce a cambered surface on the work.

2. In a cambering attachment for an oscillatable wheel head of a grinding machine, the combination of a rotatable gear having an eccentric hub, a circular cam having an eccentric bore mounted on said hub, a follower engaging said cam for movement in a radial plane with respect to the axis of rotation of said gear, a fixed shaft for supporting said gear having two index marks on the end thereof, graduation marks carried on the end of said gear member and adjustable relative to the first two marks for indicating the percentage of convexity or concavity of the camber to be produced by a selective relative positioning of the shaft and gear, an index mark carried by the cam for movement relative to a series of index marks carried by said gear for indicating the necessary relative rotation of the cam with respect to said gear to produce the percentage of camber indicated by the first named index marks, and a power operated gear train for rotating said gear in synchronism with the traverse of a work piece relative to said wheel head.

3. In a cambering attachment for an oscillatable wheel head of a grinding machine, the combination of a rotatable gear having an eccentric hub, a circular cam having an eccentric bore mounted on said hub, a follower engaging said cam for movement in a radial plane with respect to the axis of rotation of said gear, a fixed shaft rotatably supporting said gear having two index marks on the end thereof, graduation marks carried on the end of said gear member and adjustable relative to the first two marks for indicating the percentage of convexity or concavity of the camber to be produced, an index mark carried by the cam for movement relative to a series of index marks carried by said gear for indicating the necessary relative rotation of the cam with respect to said gear to produce the percentage of camber indicated by the first named index marks, a power operated gear train for rotating said gear in synchronism with the traverse of a work piece, and change gears in said gear train for varying the rate of movement of the cam with respect to the rate of said traverse movement.

4. In a cambering attachment for an oscillatable tool head of a machine tool, the combination of a rotatable gear having an eccentric hub, a circular cam having an eccentric bore mounted on said hub, a follower engaging said cam for movement in a radial plane with respect to the axis of rotation of said gear, a fixed shaft rotatably supporting said gear having two index marks on the end thereof, graduation marks carried on the end of said gear member and adjustable relative to the first two marks by relative rotation of the parts for indicating the percentage of convexity or concavity of the camber to be produced, an index mark carried by the cam adjustable by relative rotation of the cam and hub as respects the index marks carried by said gear for indicating the relative position of the cam with respect to said gear to produce the percentage of camber indicated for the first named index marks, a power operated gear train for rotating

said gear, and means to clamp the cam to the gear for rotation thereby.

5. In cambering means for a grinding machine having a bed, a work support reciprocably mounted on the bed, and a grinding wheel support pivotally mounted on the bed for moving the axis of the grinding wheel in substantially a radial plane toward and from the rotational axis of the work, the combination of a gear box mounted on the rear of said bed having a gear train therein, motion transmitting means for driving said train from the work support, one of said gears having an eccentric hub, a circular cam eccentrically mounted on said hub, a follower engaging the periphery of said cam and movable in a radial plane with respect to the axis of rotation of said gear for oscillating the grinding wheel support, and a fixed shaft for supporting said gear, said gear and said cam being rotatably adjustable with respect to one another and with respect to said shaft for varying the effective eccentricity of said cam.

6. In a cambering mechanism for a grinding machine having a grinding wheel support mounted for oscillation toward and from a translatable work support, the combination of a rotatable member having an eccentric circular hub, a cam member having a circular periphery and a circular bore eccentric to said periphery, the eccentricities of said hub and said bore being equal whereby the cam may be mounted on the rotatable member in such a position that the eccentricities cancel and the true center of the cam periphery is concentric with the axis of rotation of the circular member, and means to relatively angularly adjust the cam relative to the rotatable member to shift the periphery of said cam eccentric to the axis of rotation, and means to transmit motion from said cam to said oscillatable support.

7. In a cambering mechanism for a grinding machine having an oscillatable grinding wheel support and a work table translatable relative thereto in a direction parallel to the axis of oscillation, the combination of a rotatable member having a fixed axis of rotation, said member having an eccentric periphery consisting of cylindrical and conical portions, a circular cam having an eccentric bore comprising cylindrical and conical portions adapted to fit the corresponding portions of said member, means to effect relative angular adjustment between said parts to change the eccentricity of said cam, and additional means for effecting relative axial movement between said parts to effect frictional engagement between the conical surfaces and thereby clamping of the cam with the member for rotation therewith.

8. In a cambering mechanism for effecting relative oscillation between a grinding wheel support and a work support, the combination of a rotatable member having a fixed axis of rotation, a cam mounted on the periphery of said member, the inner engaging surfaces having a straight portion and a conical portion, said surfaces being eccentric to the axis of rotation, said cam having a circular periphery eccentric to the bore therein, means to effect relative angular adjustment between the cam and member to change the eccentricity of the cam periphery with respect to the axis of rotation, a clamping plate supported on the end of said member and overlapping the end of said cam, and means to clamp said plate and thereby cause axial movement of the cam in a direction to effect frictional engagement of the conical surfaces whereby the cam will rotate with said member after adjustment thereof.

9. In a cambering mechanism for effecting relative oscillation between a grinding wheel support and a work support, the combination of a rotatable member having a fixed axis of rotation, a cam mounted on the periphery of said member, the interengaging surfaces having a straight portion and a conical portion, said surfaces being eccentric to the axis of rotation, said cam having a circular periphery eccentric to the bore therein, means to effect relative angular adjustment between the cam and member to change the eccentricity of the cam periphery with respect to the axis of rotation, a clamping plate supported on the end of said member and overlapping the end of said cam, means to clamp said plate and thereby cause axial movement of the cam in a direction to effect frictional engagement of the conical surfaces whereby the cam will rotate with said member after adjustment thereof, and means carried by the cam for effecting opposite axial relative movement between the cam and said member for loosening the cam to permit subsequent adjustment thereof.

10. In a grinding machine having a translatable work support and a grinding wheel support oscillatable relative thereto, the combination of a cambering mechanism for effecting relative oscillation of said grinding wheel support during translation of the work support including a rotatable member having a fixed axis of rotation and a circular periphery eccentric thereto, a cam having a circular periphery and a bore eccentric thereto, said cam being mounted on the rotatable member, means to effect relative rotation between the cam and said member to vary the eccentricity of the periphery of the cam with respect to said fixed axis of rotation and includiing internal gear teeth formed on the cam and a pinion supported for rotation on said member and interengaging said gear teeth, and means to frictionally clamp the cam to said member after relative adjustment therebetween.

11. In cambering means for a grinding machine having a grinding wheel oscillatable toward and from the rotational axis of the work piece, a member rotatable about a fixed axis, driving means for effecting rotation of said member, said member having a hub portion eccentrically disposed as respects the axis of rotation of the member, a cam member having a circular outer periphery and a central eccentric bore interfitting said hub, means for effecting a presetting of the member in accordance with the selected center and amount of camber to be formed on a work piece, means for effecting a compensatory rotary adjustment of the outer cam member with respect to the hub whereby the desired location and extent of camber will be effectible upon rotation of the rotatable member, and means for transmitting the effect of rotation of the cam member in is selected positioning to the grinding wheel for oscillation of the latter.

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