July 15, 1952 H. E. MULLER, JR 2,603,131

ROLL GROOVING METHOD AND APPARATUS

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FIG. 1.

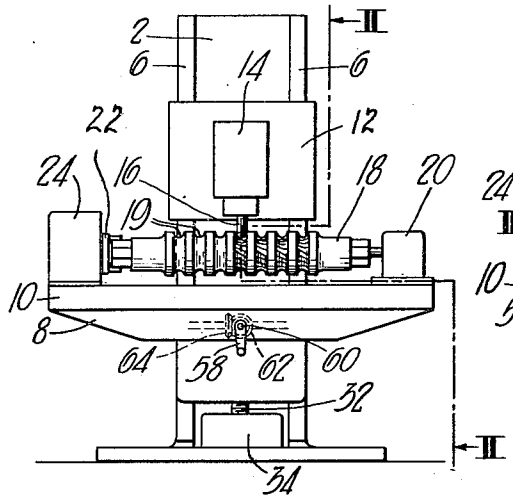



FIG. 2.

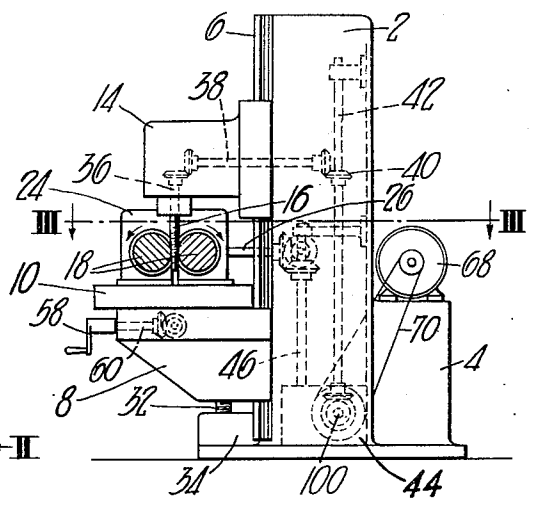



FIG. 3.

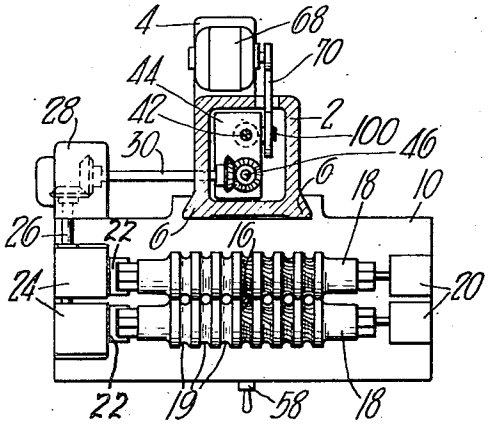



FIG. 4.

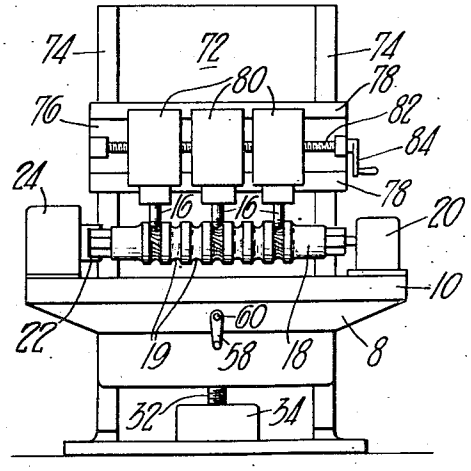



FIG. 5.

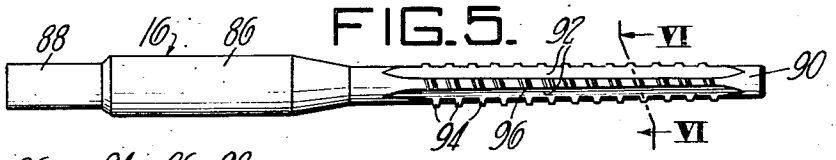
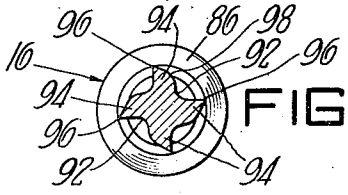



FIG. 6.




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ROLL GROOVING METHOD AND APPARATUS

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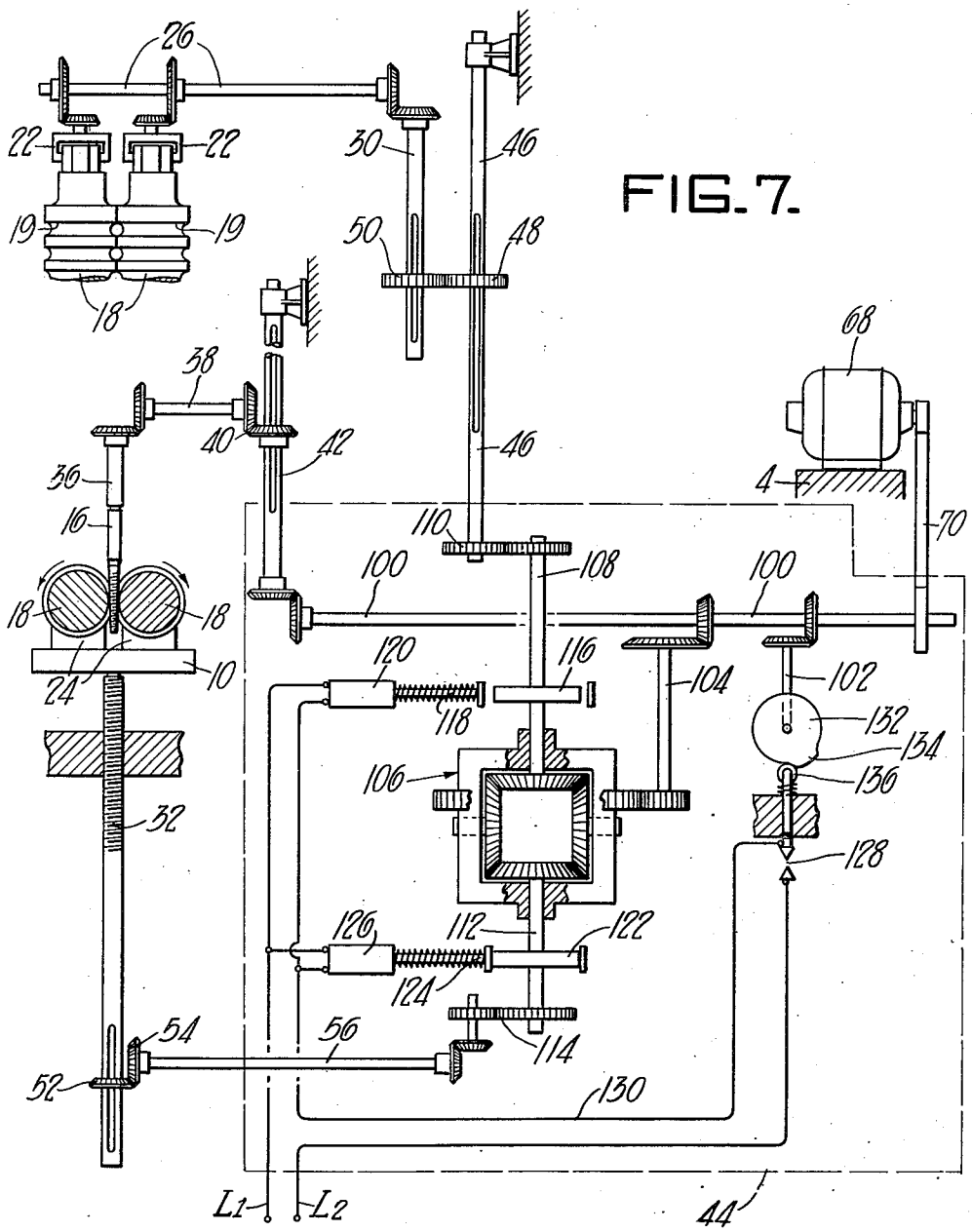



FIG. 7.

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ROLL GROOVING METHOD AND APPARATUS

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FIG. 8.

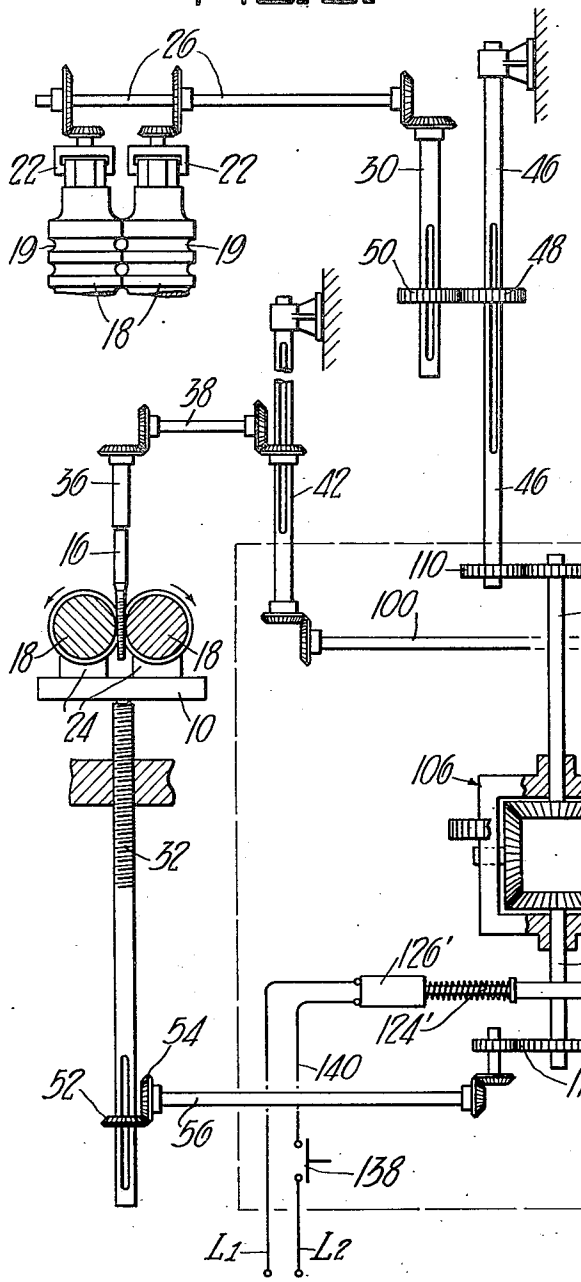
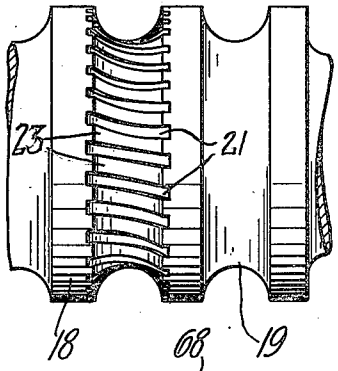
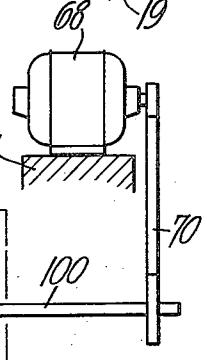



FIG. 9.




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# UNITED STATES PATENT OFFICE

2,603,131

## ROLL GROOVING METHOD AND APPARATUS

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Application December 14, 1945, Serial No. 635,025

9 Claims. (Cl. 90—20)

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This invention relates to a method and an apparatus for cutting spiral grooves in the peripheral surfaces of solids of revolution, for example rolling mill rolls.

The invention has among its objects the provision of a novel method for the grooving of the peripheral surfaces of solids of revolution, such as rolls, whereby two such rolls are grooved at once by the same tool whereby accurate matching of the grooves in such rolls is assured.

A further object of the invention is the provision of a simple easily operated apparatus for grooving two rolls at once by the operation of a single tool.

Still another object of the invention is the provision in such roll grooving apparatus of means for feeding the rolls and the tool relative to each other in such manner that the speed of such feed is positively correlated to the relative speeds of tool and rolls so that the desired relationship between tool and rolls is maintained at all times.

These and other objects of the invention will be more fully apparent in the following description of preferred embodiments of the roll grooving method and apparatus of the present invention.

In the rolling of spirally ribbed rods and bars, such as concrete reinforcing bars of a type generally similar to those disclosed in the patent to Mueser, No. 815,619, it is necessary that at least the final set of rolls be spirally grooved so as to present a roll pass having a shape complementary to that desired in the rod or bar. Such mill rolls are thus grooved circumferentially, such circumferential grooves in turn having spiral grooves formed therein, such spiral grooves lying on a helix whose axis is perpendicular to the axis of each roll. The spiral grooves, which must be formed quite accurately to insure their matching on the mating rolls of the roll pass, have hitherto been difficult and expensive to form. Use of the method and apparatus of the present invention permits the fast accurate forming of such grooves in two mating rolls at one time, thereby greatly speeding up the machining operation and at the same time insuring accurate matching of the spiral grooves on the mating rolls.

Briefly, the method consists in placing two previously peripherally grooved rolls together in the relationship they will have in the rolling mill and rotating them in opposite directions at a given speed. An elongated cutting tool with spirally arranged teeth is then fed centrally into a groove on the in-feed side at right angles to the

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plane containing the roll axes. The cutter is rotated at a speed such that the pitch of its teeth multiplied by its angular velocity equals the in-feed velocity plus the peripheral velocity of the rolls at the pitch circumference of the groove, that is, on a circle having a diameter equal to the pitch diameter of the groove. Feeding of the cutter relative to the rolls to progressively deepen the spiral grooves is accomplished either by making the cutter teeth of increasing height along the length of the cutter or, when using a cylindrical cutter, by utilizing solely the generally V-shape gap between the rolls at the in-feed side of the pass to provide such feed as the tool is fed into the pass. The tool is fed axially in such manner so that during the period of feeding as well as at all other times the condition—pitch of cutter times angular velocity equals peripheral speed of the rolls at the pitch circumference of the groove—is maintained. Such condition is assured by the apparatus of the present invention by the provision of a differential driving means by which the rolls are driven and by which the rolls and tool are fed relatively to each other.

The invention will be more readily understood by the reference to the accompanying drawings, in which:

Figure 1 is a view in front elevation of an apparatus for spiral grooving one roll pass of a set of rolls;

Figure 2 is a view in side elevation partly in section of such roll grooving apparatus, the section being taken along the line II—II in Figure 1;

Figure 3 is a view in horizontal section of the roll grooving apparatus shown in Figures 1 and 2, the section being taken along the line III—III in Figure 2;

Figure 4 is a view in front elevation of an alternative construction of the apparatus, such modification employing a plurality of cutting tools for grooving a plurality of roll passes at once;

Figure 5 is a view in side elevation of a typical cutting tool employed in the apparatus;

Figure 6 is a view in cross section through such tool, the view being taken along the line VI—VI in Figure 5;

Figure 7 is a diagrammatic view of the driving means and controls for the various parts of the apparatus in that modification in which the feed of the tool relative to the rolls is accomplished automatically;

Figure 8 is a similar diagrammatic view of a modification of the roll grooving apparatus in

which the feed of the tool relative to the rolls is accomplished manually; and

Figure 9 is a view in elevation of a broken portion of a roll having one peripheral pass forming groove spiral grooved by the apparatus of the present invention.

The roll grooving apparatus of the present invention may conveniently take a form similar to that of a milling machine having a vertically adjustable table upon which the rolls are mounted and an adjustable head above the table upon which the tool is carried and driven. In the modification shown in Figures 1, 2, and 3 the apparatus has a vertical column **2** mounted upon a base as shown, the rear portion of the machine providing a support **4** for the motor driving the tool and rolls. Column **2** is provided with vertical ways **6** on the lower portion on which is mounted the vertically adjustable knee **8** on which in turn is mounted the horizontally adjustable table **10**. On the upper part of ways **6** is mounted a vertically movable tool slide **12** which carries on its outer face the tool carrying head **14**, from the bottom of which projects a quill carrying the vertically positioned rotatable grooving tool **16**.

The rolling mill rolls **18**, previously grooved circumferentially as at **19**, are mounted horizontally upon the table between the dead centers **20** and the driven chucks **22** which engage the wobbler ends of the rolls so as to hold them accurately in fixed angular position with respect thereto. The chucks **22** are driven through the medium of the gear box **24**, which in turn is driven by the horizontal shaft **26**, shown in Figure 3. Shaft **26** is driven by horizontal shaft **30** extending from the column of the machine, through the medium of bevel gears in gear box **28**.

Vertical adjustment of the roll carrying table with respect to the tool is accomplished by means of worm **32** which supports the knee **8** and has screw threaded engagement with the portion **34** of the base of the machine. The tool carrying quill or spindle **36** is rotated by means of horizontal shaft **38** within the head **14** through the bevel gears shown in Figure 7, shaft **38** in turn being driven from vertical shaft **42** by the interposed gears **40**, shaft **42** being within the column **2** of the machine and stationarily positioned with respect thereto, the upper portion of such shaft being splined as shown in Figure 7 to allow the horizontal bevel gear of the gearing **40** to move freely vertically thereon. Thus tool **16** is driven at all times, while freedom of vertical adjustment of slide **12** is preserved.

The means whereby shaft **42** driving the tool, shaft **30** driving the rolls, and screw **32** adjusting the table, are driven in the desired relationship may conveniently be assembled in one unit **44**, shown at the base of the column **2** and indicated within the dotted lines in Figure 7. From such unit there project the two vertical shafts, shaft **42** previously mentioned, and the vertical shaft **46**, to the latter of which is connected the horizontal shaft **30** by means of the gears **48** and **50** shown in Figure 7, gear **50** being splined to shaft **30** and gear **48** being splined to shaft **46**. It will be understood that although shafts **30** and **46** are shown parallel to each other in the diagrammatic view in Figure 7 they actually have the relationship indicated in Figures 2 and 3. The gears are so mounted that gears **48** and **50** move vertically with the knee, and that the shaft **30** moves horizontally with the table, thereby preserving the drive while allowing vertical and horizontal adjustment of the table. Shaft **56** projecting from drive unit **44** drives the knee adjusting worm **32** by means of bevel gears **52** and **54**, as shown, gear **52** being splined to the lower unthreaded cylindrical end of the worm shaft as shown to allow vertical movement of the worm with respect thereto. Table **10** is adjusted horizontally by the means shown in Figures 1 and 2, which comprises a crank **58** on the knee driving horizontal shaft **60** on the inner end of which is carried gear **62** which meshes with the bevel gear **64** keyed to the horizontal adjusting screw **66** for the table. By means of such adjustment of the table the rolls may be positioned with the particular pass thereof to be machined in line with the axis of the tool, which is raised during such adjustment. The motive power for driving unit **44** is provided by motor **68** through belt **70**, shown in Figures 2 and 3.

A modification of the apparatus above described is shown in Figure 4. This modification provides a plurality of tools for grooving a plurality of circumferential grooves of a roll set simultaneously. The arrangement of parts in such alternative structure is generally similar to that shown in Figures 1, 2, and 3, and similar parts in the two modifications are labeled with the same reference characters. In such latter modification, however, a wider column **72** is employed having ways **74** thereon, upon which is mounted the vertically adjustable slide **76**. Such slide is provided with the horizontal ways **78** upon which are mounted a plurality of tool carrying heads **80** driven from a common horizontal drive shaft, but having splined connections therewith to allow their horizontal adjustment. The horizontal adjustment of heads **80** to bring the axis of each tool in line with a pass of the rolls may be accomplished manually, after which the heads may be locked in position by means not shown. In Figure 4 however, there is indicated a horizontal adjusting screw **82** provided with a crank **84** mounted on the end of slide **76**. A retractable split nut, not shown, may be provided on the rear of each head **80** selectively to engage the feed screw **82** so that one or all of the heads may be adjusted by the turning of screw **82**, following which the heads are locked in position as described.

A typical tool for use in the present roll grooving method and apparatus is shown in Figures 5 and 6. The tool, which is somewhat similar to a tap, is of elongated shape having a shank **86**, a rear portion of reduced diameter **88** for engagement by the tool holding chuck on the quill, and a forward cutting end having spirally arranged cutting teeth thereon. The forward end **90** of the cutting portion is in the form of a smooth right circular cylinder which is somewhat smaller in diameter than the pass formed of the peripheral grooves on the rolls. Portion **90** thus functions to guide the cutting portion into the pass and to center it with respect thereto. In the modification of the tool shown, the central core or body of the cutting portion rearwardly of guide **90** is gradually tapered so that it increases in diameter uniformly in a direction toward the shank until it reaches a diameter adjacent the tool shank, which is only slightly smaller than the diameter of the roll pass prior to being grooved spirally. The tool is provided in its cutting portion with a plurality of longitudinally extending flutes **92** providing spaces for the reception of chips and the introduction of coolant and lubricant. The lands between the flutes are

provided with a series of spaced teeth 94 of a height from the tool body gradually increasing toward the shank, consecutive teeth being so located that they lie on a single helix of constant pitch or lead. The teeth have the cross sectional shape shown in Figure 6, with a forward substantially radial cutting edge 96, and a curved rear edge 98 merging into the side of the adjacent rearwardly located flute. The gradual taper of the cutting section of the tool allows the grooves cut by teeth 94 to be deepened gradually as the tool is fed axially relative to the rolls. It is to be understood, however, that the tool body of the cutting section of the tool may be made cylindrical, with the teeth all of the same height, if desired, the generally V formation of the entering portion of the roll pass being relied upon to provide such increasing depth of cut as the tool and rolls are fed toward each other. It should also be understood that whereas the teeth in the cutter shown while on a single helix, they may, if desired, lie on two or more parallel helices in the manner of a plural thread. Figure 9 shows a spirally grooved roll cut by the tool shown in Figures 5 and 6. As there shown, the tool cuts a series of parallel grooves 21 corresponding roughly to half a helix leaving parallel spiral lands 23 between each adjacent path of grooves.

The manner in which the rolls and the tool are driven, and the manner in which the relative feed between rolls and tool is effected, so that the relationship—lead of the cutter times angular velocity of the cutter equals peripheral speed of the rolls at the pitch circumference at the location of contact between them and the cutter—is maintained at all times will be more readily apparent by consideration of Figure 7. As there shown, motor 68 drives the main drive shaft 100 of unit 44 through the belt 70. Driven in turn by shaft 100 in fixed relationship thereto is the driving shaft 102 of the timing switch, subsequently to be described, and the shaft 104 driving the cage 106 of a differential. One of the differential branch shafts 108 is connected to the roll driving shaft 46 through the medium of change speed gears 110, the other branch shaft 112 of the differential driving knee adjusting shaft 56 through the medium of change speed gears 114. The tool driving shaft 42 is driven directly off shaft 100, as shown. Shaft 108 is provided with a brake drum 116 cooperating with which is the brake 118 actuated by solenoid 120. In the normal operation of the device, except during feeding of the rolls relative to the tool, the brake 118 is held in released position allowing shaft 108 to rotate freely.

Shaft 112 is provided with a similar brake drum 122, cooperating with which is a brake 124 actuated by solenoid 126. During normal operation of the device, except during feed of the rolls relative to the tool, brake 124 engages drum 122 holding shaft 112 from rotation. During those intervals, however, at which the tool and rolls are fed toward each other the position of the brakes is reversed, that is, brake 118 engages drum 116 and brake 124 is released from drum 122, thereby stopping rotation of the rolls and turning the feed screw 32 the desired amount to provide an increment of feed of the tool relative to the rolls.

In the modification shown in Figure 7, such relative feed of rolls and tool is accomplished automatically, at regular intervals, by means of a timing switch 128 actuated by shaft 102. Switch 128, which is normally open, when closed closes the circuit from electrical mains $L_1$ and $L_2$ to the solenoids 120 and 126, which are connected in parallel. Switch 128 is closed whenever the cam 132, driven by shaft 102, is brought to such angular position that the raised portion 134 engages the cam follower 136, thereby closing the switch. When such condition occurs solenoid 120 is energized to apply brake 118 and solenoid 126 is energized to release brake 124. The duration of the feeding period may readily be changed by the substitution of a cam 132 having a raised portion 134 of different length.

The mechanism shown in Figure 7 therefore permits the spiral grooving of a peripherally grooved roll pass to be carried out automatically, once the proper change speed gears 110 and 114 are chosen from a consideration of the pitch of the cutter, the pitch diameter of the rolls at the peripheral groove, and the pitch of the knee feeding screw 32. The properties of the differential drive are such that although the rolls are momentarily halted from rotation during the feeding period, the feed of the rolls relative to the tool by screw 32 is such as to compensate for such stoppage of the rolls. The differential also allows the exact correlation of peripheral speed of the rolls at the pitch circumference at the point of contact of the tool with the value of the pitch of the cutter times its angle of velocity during those periods in which the roll driving shaft 108 is being decelerated by brake 118 and the knee adjusting shaft 112 is being accelerated by release of brake 124, and during which shaft 108 is accelerated by release of brake 118 and shaft 112 is being decelerated by operation of brake 124.

Such results follow from the fact that the sum of the angular velocities of shafts 108 and 112 is always twice that of shaft 104, a fundamental characteristic of a differential. Thus, when shaft 112 is held against rotation the velocity of shaft 108 is twice that of shaft 104, and when shaft 108 is held and shaft 112 rotates, the angular velocity of shaft 112 is twice that of shaft 104. Accordingly, by a proper choice of the pitch of the knee adjusting screw 32 and of change speed gears 110 and 114 the upward feed of the rolls will compensate at any time during the feeding of the rolls relative to the tool for the deceleration, stoppage, and acceleration of the rolls 18, thereby allowing the cutter to rotate continuously in operative cutting engagement with the rolls without harm to the rolls or to the cutter.

In Figure 8 there is shown a modification of the device shown in Figure 7, similar parts in Figure 8 being designated in the same manner as in Figure 7. In this modification, feed of the rolls relative to the cutter is effected manually and so the shaft 102 and the timing switch driven thereby are omitted. The brake drum, brake, and brake operating solenoid employed on shaft 108 of the first modification are likewise omitted, there being employed, however, within driving unit 44' a brake drum 122' on shaft 112, a brake 124', and a solenoid 126' which allows the brake to engage the drum when deenergized, but which retracts it from the drum and allows shaft 112 to rotate when it is energized. Energization of solenoid 126' from source $L_1$ and $L_2$ is effected when manually operated switch 138 is closed, thereby connecting wire 140 from the solenoid to the main $L_2$. In this modification the rolls are not stopped during feed of the rolls relative to the cutter, but instead, due to the inherent properties of the differential drive, as above explained, will be slowed in rotation at all times in amounts exactly sufficient to compensate for the upward

feed of the rolls by the knee screw 32, thereby maintaining the desired relationship between rolls and cutter.

Having thus fully described preferred modifications of the roll grooving method and apparatus of the present invention I desire to claim as new the following.

I claim:

1. Apparatus for spirally grooving the peripherally grooved surfaces of two rolling mill rolls simultaneously, which comprises means for positioning the two rolls with their axes in a common plane and the peripheral grooves mating to form a pass, means for positioning a spirally toothed cutting tool with its axis centrally of the pass and at right angles to the plane of the roll axes, means for rotating the rolls in opposite directions, means for rotating the cutting tool, means for feeding the cutting tool and the rolls relatively toward each other in a direction along a line coinciding with the axis of the tool, a differential device having a cage and two differentially driven branch shafts, means for driving the cage thereof in fixed speed relationship to the speed of rotation of one of the two elements consisting of the cutting tool and the rolls, means connecting one branch shaft of the differential to the other of the two elements consisting of the cutting tool and the rolls, and means connecting the other branch shaft of the differential to the means for feeding the cutting tool and rolls relatively toward each other.

2. Apparatus for spirally grooving the peripherally grooved surfaces of two rolling mill rolls simultaneously, which comprises means for positioning the two rolls with their axes in a common plane and the peripheral grooves mating to form a pass, means for positioning a spirally toothed cutting tool with its axis centrally of the pass and at right angles to the plane of the roll axes, means for rotating the rolls in opposite directions, means for rotating the cutting tool, means for feeding the cutting tool and the rolls relatively toward each other in a direction along a line coinciding with the axis of the tool, and a differential device having a cage and two differentially driven branch shafts, means for driving the cage thereof in fixed speed relationship to the speed of rotation of one of the two elements consisting of the cutting tool and the rolls, means connecting one branch shaft of the differential to the other of the two elements consisting of the cutting tool and the rolls, means connecting the other branch shaft of the differential to the means for feeding the cutting tool and the rolls relatively toward each other, means to brake the feeding means to hold the rolls and cutting tool in fixed relation to each other along the axis of the cutting tool, and means to release said brake to feed the rolls and cutting tool relatively toward each other.

3. Apparatus for spirally grooving the peripherally grooved surfaces of two rolling mill rolls simultaneously, which comprises means for positioning the two rolls with their axes in a common plane and the peripheral grooves mating to form a pass, means for positioning a spirally toothed cutting tool with its axis centrally of the pass and at right angles to the plane of the roll axes, means for rotating the rolls in opposite directions, means for rotating the cutting tool, means for feeding the cutting tool and the rolls relatively toward each other in a direction along a line coinciding with the axis of the tool, and a differential device having a cage and two differentially driven branch shafts, means for driving the cage thereof in fixed speed relationship to the speed of rotation of one of the two elements consisting of the cutting tool and the rolls, means connecting one branch shaft of the differential to the other of the two elements consisting of the cutting tool and the rolls, means connecting the other branch shaft of the differential to the means for feeding the cutting tool and rolls relatively toward each other, means to brake the feeding means to hold the rolls and cutting tool in fixed relation to each other along the axis of the cutting tool, said braking means comprising a normally operative brake and a solenoid for releasing the braking means, and a switch operable to close the solenoid energizing circuit to release the braking means to allow the rolls and cutting tool to feed relatively toward each other.

4. Apparatus for spirally grooving the peripherally grooved surfaces of two rolling mill rolls simultaneously, which comprises means for positioning the two rolls with their axes in a common plane and the peripheral grooves mating to form a pass, means for positioning a spirally toothed cutting tool with its axes centrally of the pass and at right angles to the plane of the roll axes, means for rotating the rolls in opposite directions, means for rotating the cutting tool, means for feeding the cutting tool and the rolls relatively toward each other in a direction along a line coinciding with the axis of the tool, and a differential device having a cage and two differentially driven branch shafts, means for driving the cage thereof in fixed speed relationship to the speed of rotation of one of the two elements consisting of the cutting tool and the rolls, means connecting one branch shaft of the differential to the other of the two elements consisting of the cutting tool and the rolls, means connecting the other branch shaft of the differential to the means for feeding the cutting tool and rolls relative toward each other, normally operative means to brake the feeding means to hold the rolls and cutting tool in fixed relation to each other along the axis of the cutting tool, normally inoperative means to brake the means connected to the other branch shaft of the differential, and means for simultaneously releasing the first braking means and for applying the second braking means, whereby the rolls and cutting tool are fed relatively toward each other.

5. Apparatus for spirally grooving the peripherally grooved surfaces of two rolling mill rolls simultaneously, which comprises means for positioning the two rolls with their axes in a common plane and the peripheral grooves mating to form a pass, means for positioning a spirally toothed cutting tool with its axes centrally of the pass and at right angles to the plane of the roll axes, means for rotating the rolls in opposite directions, means for rotating the cutting tool, means for feeding the cutting tool and the rolls relatively toward each other in a direction along a line coinciding with the axis of the tool, and a differential device having a cage and two differentially driven branch shafts, means for driving the cage thereof in fixed speed relationship to the speed of rotation of one of the two elements consisting of the cutting tool and the rolls, means connecting one branch shaft of the differential to the other of the two elements consisting of the cutting tool and the rolls, means connecting the other branch shaft of the differential to the means for feeding the cutting tool and rolls relatively toward each other, normally operative means to brake the feeding means to hold the

rolls and cutting tool in fixed relation to each other along the axis of the cutting tool, normally inoperative means to brake the means connected to the other branch shaft of the differential, control means driven in timed relationship with the cutting tool, and means responsive to the control means for periodically simultaneously releasing the first braking means and for applying the second braking means, whereby the rolls and cutting tool are fed relatively toward each other.

6. Apparatus for spirally grooving the peripherally grooved surfaces of two rolling mill rolls simultaneously, which comprises means for positioning the two rolls with their axes in a common plane and the peripheral grooves mating to form a pass, means for positioning a spirally toothed cutting tool with its axes centrally of the pass and at right angles to the plane of the roll axes, means for rotating the rolls in opposite directions, means for rotating the cutting tool, means for feeding the cutting tool and the rolls relatively toward each other in a direction along a line coinciding with the axis of the tool, and a differential device having a cage and two differentially driven branch shafts, means for driving the cage thereof in fixed speed relationship to the speed of rotation of one of the two elements consisting of the cutting tool and the rolls, means connecting one branch shaft of the differential to the other of the two elements consisting of the cutting tool and the rolls, means connecting the other branch shaft of the differential to the means for feeding the cutting tool and rolls relatively toward each other, normally operative means to brake the feeding means to hold the rolls and cutting tool in fixed relation to each other along the axis of the cutting tool, normally inoperative means to brake the means connected to the other branch shaft of the differential, solenoids for operating the first and second recited braking means, a circuit for energizing the solenoids, and a switching means in the circuit driven in timed relationship with the cutting tool periodically to operate the solenoids to release the first braking means and to apply the second braking means, whereby the rolls and cutting tool are fed relatively toward each other.

7. The method of spirally grooving a cylindrical body whose outer surface contains a peripheral groove, which comprises rotating a helically toothed tapered cutting tool in the peripheral groove so as to contact the surface thereof, rotating the body on its axis, the axis of rotation of said tool being parallel to a tangent of the body at the point of contact, intermittently relatively feeding said body and said tool toward each other in a direction parallel to the tool axis while maintaining continuity of cutting and while the tool axis remains fixed, and slowing the rate of rotation of said body to compensate for said intermittent relative feeding, thereby maintaining constant the relative velocity component of the tool teeth in the direction of the tool axis with respect to the body surface at its pitch circumference, said relative velocity component being a summation of velocities which are derived from the helix lead of the rotating cutting tool, rotation of the body about its axis at a varying rate, and relative feeding between the tool and the body at a varying rate.



8. The method of spirally grooving a cylindrical body whose outer surface contains a peripheral groove, which comprises rotating a helically toothed tapered cutting tool in the peripheral groove at a substantially constant rate so as to contact the surface thereof, rotating the body on its axis, the axis of rotation of said tool being parallel to a tangent of the body at the point of contact, periodically relatively feeding said body and said tool toward each other in a direction parallel to the tool axis while maintaining continuity of cutting and while the tool axis remains fixed, and decreasing the rate of rotation of said body during periods of relative feeding to compensate for the relative movement between the tool and the body caused by such feeding, thereby maintaining constant the relative velocity component of the tool teeth in the direction of the tool axis with respect to the body surface at its pitch circumference, said relative velocity component being a summation of velocities which are derived from the helix lead of the rotating cutting tool, rotation of the body about its axis at a varying rate, and periodic relative feeding between the tool and the body.

9. Apparatus for spirally grooving a cylindrical body whose outer surface contains a peripheral groove, which comprises means for rotatably mounting the body, a helically toothed rotatably mounted tapered cutting tool adapted to contact the body within the peripheral grooves with the tool axis centrally of the groove and parallel to a tangent of the body at its point of contact, a drive mechanism connected to said tool for rotating the latter, a differential connecting said drive mechanism and the mounting means for the body for transmitting rotary motion to the body, feed means operatively connected to said differential and one of the elements consisting of said tool and the mounting means for the body, means normally holding said feed means stationary and thus preventing feeding, and means for intermittently releasing said feed means and thereby intermittently relatively feeding said tool toward the body while maintaining continuity of cutting, said differential slowing the rate of rotation of the body during each intermittent feed step to compensate for this realtive feeding movement, thereby maintaining constant the relative velocity component of the tool teeth in the direction of the tool axis with respect to the body surface at its pitch circumference.

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