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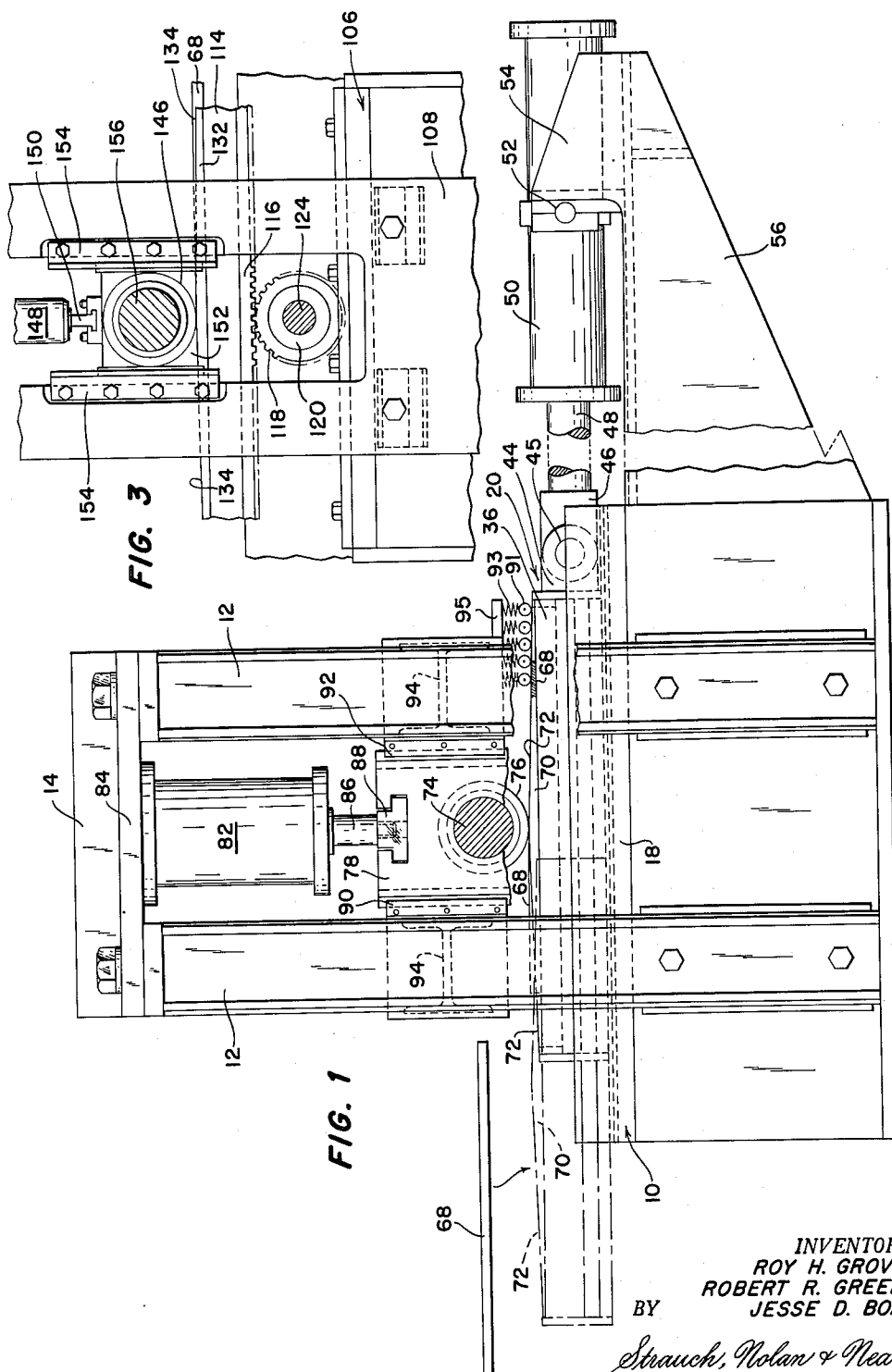
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3,233,444

TAPER ROLL MACHINE AND METHOD

Filed June 26, 1962

3 Sheets-Sheet 1



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3 Sheets-Sheet 3

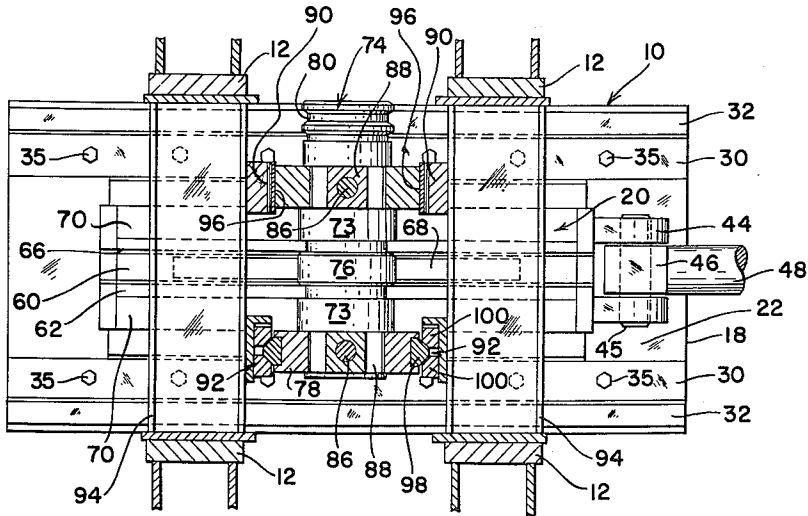


FIG. 5

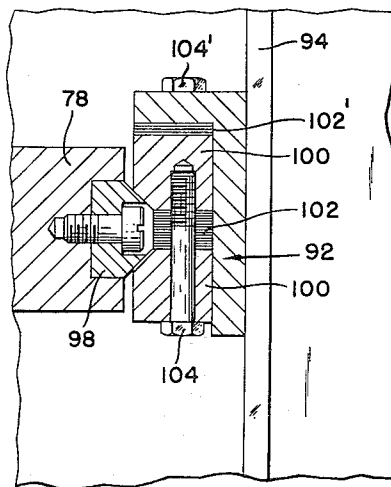


FIG. 6

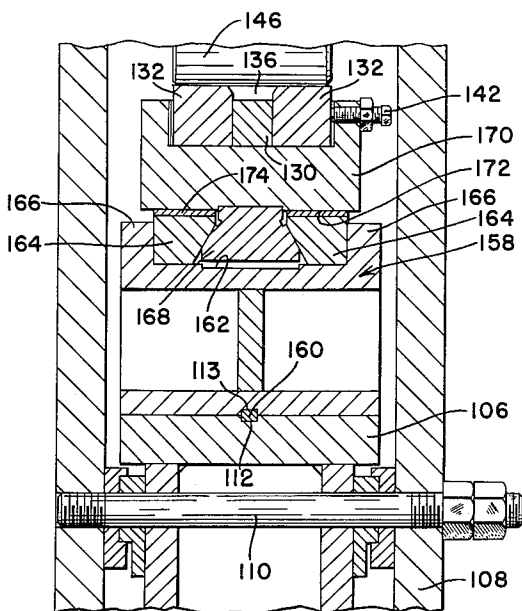


FIG. 7

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TAPER ROLL MACHINE AND METHOD

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11 Claims. (Cl. 72-207)

This invention relates to metal working machines and methods and more particularly to rolling machines adapted to specially reduce metal blanks. More specifically it relates to roll tapering machines to accurately taper members of solid cross section such as spring leaves.

It is common practice in industry to end-taper the individual spring leaves used in vehicle spring assemblies to obtain a uniform stress distribution throughout the assembled unit. The tapers thus provided on the end sections of the individual leaves have been of necessity relatively short since each spring assembly is composed of a number of individual leaves stacked one over the other and usually diminishing in length from top to bottom, and the taper section on each leaf extended only from the end inwardly longitudinally to a region just short of the end of the next adjacent longer leaf. Simple and relatively inexpensive rolling machines are available, either single or dual ended, as for instance that disclosed in United States Patent No. 2,775,152 issued to F. R. Krause. It was furthermore not necessary to control the taper to extremely close tolerances since a number of such end-tapered leaves which make up a spring assembly act together as a unit and the load stresses are distributed among the several individual leaves.

With the development and advance of the single taper leaf spring as a vehicle suspension the problem of providing a sufficiently long accurate taper formation on the leaf arose. In contrast to the known leaves of a multi-leaf assembly wherein each leaf has only a relatively short tapered section at each end the taper formation in a single leaf spring is longer and in fact extends from both its ends towards its midsection which is usually the portion at which the spring leaf is attached to the spring seat on the axle.

Several machines and methods have been devised in the past to attempt to reliably form a satisfactory taper formation on the single spring leaf. One method comprised running a continuous strip of metal through a rolling mill that incorporates rolls of varying diameters so that continuous and reversely positioned taper formations are produced on the moving strip which is then cut between reverse taper sections to provide spring leaves of desired length. This method does not provide a satisfactory taper leaf spring because the taper can not be controlled accurately and undesirable spreading and elongation of the metal fibers occurs. Other methods and machines employed an overhead longitudinally movable single forming roll and reciprocating carriage, or a stationary carriage and reciprocating cam support with or without anvil roller support of any combination of the above. Those machines are usually expensive and of excessive size in relation to the workpiece and usually only one end of the blank can be roll tapered before reheating. The blank usually has to be taken out, reheated and again placed in the machine to roll taper the other end.

In order to have a perfectly tapered leaf the movement of the roll and support and cam carriage as well as the pressure on the blank all should preferably be interrelated and accurately controlled which could not be satisfactorily achieved hitherto with the known methods and machines. Since proper roll tapering of a spring leaf is

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essentially a forging operation, to prevent spreading of the metal and to densify the metal fibers rather than elongate them retaining dies are preferred to be incorporated to prevent excessive spreading of the metal and, consequently, conventional reducing mills can not be employed.

The inherent advantages of single tapered leaf springs have now become well known and recognized in the vehicle industry, and it is an object of the present invention to further advance the development of a machine and method for producing a satisfactory single tapered leaf spring.

Another object of the present invention is to provide a simplified but more efficient taper rolling machine and method in which a blank to be formed is moved longitudinally underneath a longitudinally stationary positively rotated forming roll which exerts pressure downward on the blank.

Still another object of the invention is to provide a machine comprising novel means to effectively and accurately taper roll a metal blank by reduction forging the blank lengthwise in such a way as to prevent excessive elongation and side spreading of the metal.

A further object of the invention is the provision in a taper rolling machine of a work piece supporting and retaining die adapted to be moved longitudinally underneath a downwardly pressurized rotating forming roll, with cam paths provided along side the retaining die to determine the vertical position of the roll as it rotates to accurately control the taper contour impressed on the work piece.

A still further object of the invention resides in the provision of a novel taper rolling machine having a roll actuated for rotation and a blank-supporting die carriage actuated for movement underneath the roll and in which the rotation of the roll and movement of the carriage are synchronized to prevent slipping of the roll on the blank and providing means for controlled pressure of the roll downward on the blank so as to accurately control the degree of metal deformation during rolling of the blank.

Another object of the present invention is to provide a novel taper rolling machine in which both ends of the blank can be taper-rolled in one pass without the necessity of removing the blank after the first taper operation and having to reheat and return the blank to the machine for the second taper operation.

Still another object is to provide a novel method of taper rolling a spring leaf blank which consists of heating the blank to forging temperature, placing the blank in a supporting and retaining die having cam paths along both sides thereof and moving the die and blank lengthwise underneath a pressurized rotatively actuated roll going "up-hill" and "down-hill" to impart opposite taper contours on the blank extending from approximate the center of the blank towards both its ends in one pass through the machine.

In previously known taper rolling machines, the forming roll or rolls were not mechanically actuated because it was thought that the pressure of the roll on the blank would cause the roll to properly rotate, but the inventors have discovered that this was not always the case, so that the operation was unreliable. If the blank carrying carriage moved too fast or too slow or if pressure on the roll was insufficient, the forming roll might not even rotate, thus causing the roll to slide along the blank instead of rolling and damaging the surface fibers of the metal of the blank and causing other improper metal deformations which resulted in a finished spring of inferior quality. The present invention particularly contemplates the provision of positively rotating the blank forming roll in synchronism with the carriage movement so that

the roll will be positively driven at all times during the rolling operation.

Other objects and novel features will become evident from the specification and claims and the appended drawings wherein:

FIGURE 1 is a side elevation partially broken away and in section of a rolling machine according to a preferred embodiment of the invention;

FIGURE 2 is a front view of the machine of FIGURE 1 with the table and die carriage shown in section;

FIGURE 3 is a partial side elevation partly in section showing the working parts of a rolling machine according to another embodiment of the invention;

FIGURE 4 is an enlarged cross section through the embodiment of FIGURE 3 showing lower support details;

FIGURE 5 is a top plan view in horizontal cross section through the roller guide mechanism in FIGURE 1;

FIGURE 6 is an enlarged detail view in section showing the adjustable roller guide mechanism in the machine of FIGURES 1, 2 and 5; and

FIGURE 7 shows in vertical and cross section still another embodiment having a related roller, die carriage and table arrangement.

FIGURES 1 and 2 show a rolling machine comprising a stationary table 10 to which are rigidly attached two pairs of vertical standards 12. Standards 12 are rigidly connected at their upper ends well above table 10 by side frame members 14 (FIGURE 1) and transverse frame members 16 (FIGURE 2). Table 10 is rigidly supported from beneath on frame members 11 uprising rigidly from a floor mounted base 13. Standards 12 are preferably secured to the outer members 11.

The rigid bed 18 of table 10 supports a reciprocating slide mechanism 20 in a centrally located longitudinal rectangular channel 22 (FIGURE 2). A number of flat upstanding ridges 24 are formed in the bottom of channel 22 and provided with smooth flat horizontal bearing liners 26 of suitable material. The upper part of channel 22 is widened at 28 to provide horizontal longitudinal ledges 29 mounting inwardly extending longitudinal dovetail type clamps 30 secured to the marginal longitudinal outer side flanges 32 of bed 18 as by lateral screws 34 and held down on ledges 29 by screws 35.

Clamps 30 provide upwardly converging smooth surfaces 31 engaging similar inclined slide guide surfaces 33 on a slide carriage 36. Carriage 36 is slidable longitudinally in channel 22 and its bottom is provided with a number of longitudinal ridges 38 opposite the ridges 24 of channel 22 and surfaced with bearing liners 39 adapted to slide on the bearing liners 26.

Thus, the slide carriage 36 is mounted for smooth horizontal reciprocation on bed 18, the engaged slide guide surfaces at 26, 39 and 31, 33 cooperating to prevent either lateral or vertical displacement of the carriage without interfering with its freedom of reciprocation.

The slide bearing arrangement between carriage 36 and the table 10 provides reduced area multiple point bearing contact of the slide and surfaces and more equally distributes the load. The inclined guide faces 33 of carriage 36 may be relatively laterally located as by a suitable number of shims 42 inserted between the adjacent flange 32 and the dovetail clamps 30. By changing the thickness or number of shims 42, the fit with the slide 36 may be varied or different sizes of slide carriages may be accommodated.

Slide carriage 36 is forwardly provided with a bifurcated shackle 44 which is pivoted at 45 to joint 46 of a piston rod 48 extending into a hydraulic cylinder 50. Cylinder 50 is centrally pivotally supported at 52 in a yoke 54 upstanding from the end of a support bracket 56 attached to the rear end of table 10. Hydraulic cylinder 50 is provided to impart reciprocating motion to the slide carriage 36 as will be understood.

Slide carriage 36 (FIGURE 2) is provided with an upwardly open rectangular longitudinal channel 58 to re-

ceive a die block 60 flanked by a pair of parallel side confining members 62 having sloping edges 64 to provide the necessary draft angle to enable a workpiece confined on die 60 to be removed after rolling. Members 62 extend a certain distance upwardly beyond the upper surface of die block 60 to provide a cavity 66 between them (FIGURE 2) and above the blocks 60 and adapted to receive a workpiece 68. The die block 60 and side confining members 62 could be made in one piece or rigidly connected, if desired, as a U-shaped structure, but the separate arrangement shown permits easily changing the sizes of the die block and side confining members to accommodate workpieces of different dimensions or the change of the rolled thickness or width of the workpiece.

Adjacent the side members 62 and abutting the carriage side flanges 59, channel 58 contains a pair of identical longitudinal cam blocks 70 each of which has its upper surface 72 taper contoured from the middle section longitudinally towards both ends so as to provide a cam path for the roller cam followers 73 to be described. Cam blocks 70 are preferably separate, as shown, to permit interchangeability thereof with cam blocks having different taper contours or for re-working the cam surface when wear occurs or for replacement when they are otherwise damaged. The entire anvil assembly consisting of die block 60, side members 62 and cam blocks 70 may be press fitted tightly into the carriage channel 58 as in FIGURE 2, or they may be adjustably secured by means of shims and adjusting screws as illustrated in FIGURES 4 and 7 to prevent any movement thereof relative to carriage 36.

Cam followers 73 are cylindrical and rigidly part of a horizontal roll shaft assembly 74 suspended above carriage 36. Shaft assembly 74 has a cylindrical forming or working roll 76 positioned laterally between cam followers 73 and of a width corresponding to the width of the cavity 66 and adapted to be brought into engagement with the top surface of the workpiece 68 disposed in cavity 66.

As shown in FIGURE 2, the rolls 73 and 76 are all of the exact same diameter. Also the oppositely extending tapered cam surfaces 72 are identical in lateral alignment at the same height above table 10 so that rolls 73 will engage both uniformly along opposite sides of channel 58. The forming roll 76 will engage the workpiece 68 in channel 66 and eventually shape it in conformity with the surfaces 72 as will appear. In the embodiments of FIGURES 4 and 7, the forming rolls are of larger width and different form than roll 76 as will be later described.

The roll shaft assembly 74 is rotatively supported adjacent and above cam blocks 70 in bearing assemblies 78, and one end is extended outwardly to mount a drive wheel 80 such as a V-belt pulley or a chain sprocket. Shaft 74 may be further extended as at 81 to be directly connected by means of a universal joint (not shown) to a drive motor (not shown) to positively drive the roll 76 from any convenient power source in substantial synchronism with the reciprocation of carriage 36.

The roll shaft assembly 74 is vertically adjustably suspended from the center of the framework of the machine (FIGURES 1 and 2) by a pair of hydraulic cylinders 82 attached to a center cross member 84 which is secured to a transverse member 16 and supported by standards 12 of the frame and whose vertical piston rods 86 are suitably attached to the roll shaft bearing assemblies 78, preferably by easily detachable bayonet type interlocking blocks 88 (FIGURE 2) to facilitate assembly and removal of the entire roll shaft and bearing assembly. Suspension of the roll shaft assembly 74 by the vertically disposed hydraulic cylinders 82 enables the roll 76 to be accurately brought into contact with the workpiece 68 under predetermined controlled and adjustable pressure exerted downwardly by actuating cylinders 82 from a suitable hydraulic control (not shown) by which the roll shaft assembly 74 may be moved up or down, and forced.

continuously toward the table 10 during roll tapering of workpiece 68.

Bearing assemblies 73 are vertically slidably supported in opposite pairs of slide guides 90 and 92 (FIGURES 1 and 5) attached to transverse horizontal stationary frame rails 94 extending rigidly between columns 12. As shown in FIGURES 5 and 6, one of the slide pairs 90 may have hard smooth antifriction lining material 96 placed between the slide and the bearing assembly 73.

The other slide 92 may be adjustable transversely of shaft 74 by means of a wedge block 98 attached to opposite sides of the bearing assembly 78 and mating pressure blocks 100 attached to the slides. The distance between the pressure blocks 100 may be varied by changing shims 102 (FIGURE 6) inserted between them, and changing shims 102' between upper block 100 and the fixed support and tightening adjusting screw 104 and 104', so as to align and interfit the related inclined guide surfaces on blocks 100 and the wedge block 98 and thus take any wear and initial looseness in the slide assembly.

It will be seen that variation in the vertical distance between blocks 100 in FIGURE 6 will vary the location of bearing assembly 78 in a lateral direction at right angles to the shaft 74 axis. This adjustment enables forming roll 76 and cam rolls 73 to be exactly positioned in the assembly.

Referring to FIGURE 1, depending from the underside of the rear transverse rail 94 of the frame at the longitudinal center of the frame and centered with the length of recess 65 are a number of small pressure rolls 91 which are mounted on spring loaded rod assemblies 93 carried by a bracket 95 fixed to rail 94. Pressure rolls 91 are thus positioned in linear position above the longitudinal center line of the carriage 36 and operate to resiliently engage and hold the end of the workpiece 68 already rolled down in the die when the other end is being rolled. Since pressure rolls 91 are spring loaded downwardly they follow easily the contour of the formed tapered workpiece without in any way inducing too much friction or otherwise hindering normal rolling operation. Rolls 91 move only vertically and they have free rotative engagement with workpiece 68.

With reference to FIGURES 3 and 4, this embodiment employs a slightly different machine table or base 106 which are attached standards 108 by screw rods 110. Table 106 has a longitudinal key way 112 for a purpose to appear. The slide carriage in this embodiment comprises a longitudinal member 114 to the underside of which is fixed a pair of toothed racks 116 meshed with a pair of gears 118 fixed on a shaft 120 immediately above the table 106. Shaft 120 is rotatively supported in bearing blocks 122 adjacent and outwardly of gears 118 and extends outwardly at one side as at 124 to be connected to a motor (not shown) or any other driving means. Rotation of gears 118 will thus horizontally reciprocate carriage 114.

Intermediate the spaced gears 118, shaft 120 has fixed thereon a cylindrical back up roll 126 (FIGURE 4) on which the carriage 114 is supported for rolling movement. Carriage 114 has a longitudinal channel 128 which receives a die block 130 positioned laterally between a pair of identical cam blocks 132 which have upper surfaces 134 of dual taper configuration as shown in FIGURE 3 and extend beyond the upper surface of the die block 130 so as to provide a cavity 136 between them which is adapted to receive the workpiece 68. The cavity side edges 138 of the cam blocks 132 are inclined to provide the necessary draft angles. The die and cam block assembly is securely held in the channel 128 by suitable shims 140 and may be adjustably held by an adjusting and locking screw 142 extending through one of the side flanges 144. The die and cam blocks in this embodiment are likewise replaceable and interchangeable as in the embodiment of FIGURE 2 to accommodate different size workpieces and/or different taper formations.

A relatively large cylindrical forming working roll 146 is suspended above the carriage member 114 and is of such length axially as to bridge and roll along the cam surfaces 134 of both cam blocks 132, thus deforming the metal of a workpiece 68 in the die cavity 136. The horizontal axis of roll 146 is parallel to that of roll 126.

It will be noted that in the foregoing embodiments the finished thickness of the workpiece, in this instance a spring leaf, is determined by the depth and width of the cavities 66 or 136 and the diameter of rolls 76 or 146 respectively.

Roll 146 is vertically adjustably suspended by a pair of hydraulic cylinders 148 whose piston rods 150 are attached to a pair of bearing assemblies 152 vertically slidably within sliding arrangements 154 (FIGURE 3), similarly to the arrangement shown in FIGURES 5 and 6. Thus the downward pressure of roll 146 may be vertically adjusted by suitable hydraulic control means provided for cylinders 148. Roll 146 is attached to a shaft 156 which is rotatively supported in the bearing assemblies 152 and may extend outwardly at one side as at 153 to provide suitable power so as to be positively driven in substantial synchronism with the working speed of the carriage 114. The rack and gear drive arrangement of FIGURES 3 and 4 corresponds to the hydraulic cylinder 50 drive of the embodiment of FIGURE 1 and provides a backup roll 126 arrangement instead of a flat table bed of FIGURE 1 to absorb the downward pressure and rigidly support the carriage 114.

In the embodiment of FIGURE 7, the same frame and table structure is used as in FIGURE 4, but instead of the rack and gear and rotatable backup roll arrangement, a fixed slide support member 158 is rigidly attached to stationary table 106 by a key 160 inserted in keyway 112 and a coating keyway 113 in the bottom of support 158. The slide support 158 has a longitudinal channel 162 mounting a pair of opposite dovetail slide guide members 164 secured to the flanges 166 in any suitable manner.

Mounted slidably between the dovetail members 164 is the conformably shaped dovetail section 168 of a slide carriage 170. The bottom surface 172 of slide carriage 170 adjacent is slidably supported on bearing liners 174 attached to the upper surfaces of dovetail members 164 for smooth essentially frictionless reciprocation. The dovetail carriage section 168 fits smoothly slidably between the outer dovetail members 164 so as to be in linear sliding engagement therewith and the position of the outer dovetail members 164 may be adjusted inwardly so as to vary the pressure on the dovetail section 168 and preventing any irregular side movement of the slide. The carriage 170 in this instance is likewise hydraulically actuated as in FIGURE 1 and it is apparent that, with the frame and table arrangement in FIGURES 4 and 7, either the rack and pinion or hydraulic reciprocating mechanism may be employed. The die, cam block and forming roll arrangement may be similar to that in FIGURE 4.

In all embodiments of the invention the workpiece 68 to be rolled to shape is disposed on a reciprocable carriage having an upwardly open horizontal rectangular recess or cavity along opposite sides of which extend dual tapered cam bars, that is cam bars which have their upper surfaces tapered from the middle down toward opposite ends. The recess has a flat horizontal bottom on which rests the workpiece blank to be rolled, and the tapered cam surfaces are identical and represent the contour to be imparted to the rolled upper surface of the workpiece disposed in the recess. In the disclosed embodiments the sides of the blank receiving recess are disposed to restrain lateral spread of the blank during rolling, but that is not essential for all purposes and some apparatus made under the invention does not use these restraining means. The carriage is solidly supported from below either on slide or rolling surfaces.

The cam surfaces support bridging cam follower roller surfaces on opposite sides of the cavity, and these follower surfaces may be independent and spaced from the forming roll as in FIGURE 2, or continuation of the forming roll surfaces as in FIGURE 4. In any event the forming and cam roll surfaces are of the same diameter.

Forming of the workpiece is effected by hydraulically pressing downward on the forming roll which bears upon and rolls along the length of the workpiece as the carriage on which the workpiece is mounted is longitudinally moved. Downward movement of the forming roll as permitted by deformation of the workpiece is controlled by the taper of the cams. These cams are so hard that deformation by the exerted rolling pressure is held to a minimum, so that as a result of the rolling operation the workpiece thickness is contoured exactly to the cam shape with great accuracy. The forming roll is positively rotated by a power drive attached at 80 or 81 to shaft 74 during the rolling operation.

The peripheral speed of the forming roll surface in contact with the workpiece 68 is in all embodiments the same as the linear speed of the carriage carrying the workpiece, so that there is only pure rolling of the forming roll along the surface of the workpiece. This is effected by synchronized drive of the carriage and the forming roll.

The parallel sides of the cavities 66 and 136 confine the blank against undesired spreading during rolling and may be straight or likewise tapered.

The rolling operation and method of the invention as carried out in FIGURE 1 is as follows:

A metal blank 68, in this instance a flat strip of steel for shaping into a spring leaf, which has been heated as by induction heating to a suitable hot rolling temperature, is placed in the die cavity 66, with the forming roll 76 raised by the hydraulic cylinders 82 and the carriage 36 in maximum extended forward position which is at the left as shown in broken lines in FIGURE 1.

Then carriage 36 is linearly moved towards the right to the forming position shown in solid lines in FIGURE 1, and the roll shaft assembly 74 is lowered to bring forming roll 76 into contact with the center of blank 68 and dispose the cam follower rolls 73 over and against the centers of the cam blocks 70 with predetermined downward pressure exerted by cylinders 82.

Then carriage 36 is moved in a working stroke in one direction by hydraulic cylinder 50 with the forming roll remaining under pressure and being simultaneously positively rotated starting with the beginning of the working stroke, by which the desired taper contour is impressed onto the blank 68 as determined by the contour of the cam faces 72 extending from the approximate center of the blank towards one end in a "down-hill" motion. After completion of the stroke in that direction, for example a working stroke to the right in FIGURE 1, the forming roll 76 is raised clear of the blank and the carriage 36 returned to centered position. Then the forming roll is again lowered under pressure to engage the center of the blank 68 and a similar working stroke in the opposite direction is effected for the outer half of the blank, starting again at the center. During this second working stroke, pressure rolls 91 bear down on the workpiece 68 continuously and prevent the rear end of the workpiece from being lifted from the bed while the other end is being rolled.

If a cantilever leaf spring is roll tapered, only one stroke in one direction will be necessary.

Instead of rolling from the center towards the end, that is "down-hill," the blank may be roll tapered from the end towards the center ("up-hill") because of the controlled hydraulic pressure of the roll which may be so predetermined as to assure the desired compression of the blank at the low starting end of the taper formation. This method may be advantageous where it is desired to have a materially increased section of metal

at the supporting center of the leaf, which is desirable in many single leaf spring applications to counteract the high stresses at the spring seat attaching section of the leaf. Another feasible rolling method for taper leaves would be combination of "up-hill" and "down-hill" rolling; that is, rolling may be started at one low end going up to the center and down again to the other end in one long stroke. Any of the above methods may be employed depending on operational facilities and type of spring leaf desired. During all operations the forming roll is positively rotated in synchronism with the carriage so as to prevent sliding or slipping of the roll on the blank surface which would result in an inferior surface finish of the spring leaf and poor quality and wear characteristics.

Thus the present invention provides a taper rolling machine embodying novel means to improve and facilitate the accurate taper rolling of spring leaves. This comprises hydraulic or mechanical carriage actuation as desired, hydraulic roll pressure and positive forming roll rotation, all of which can be accurately controlled in relation to each other.

The linear speed of the carriage, surface speed of the forming roll and pressure on the forming roll are all so interrelated as to prevent creep of the workpiece metal during rolling, thus providing a tapered leaf of superior quality. Excessive side spread and elongation are prevented to achieve a spring leaf having a smooth running grain flow line structure. By incorporation of these novel rolling methods the section thickness or density of the metal along the spring leaf may be accurately controlled so as to have sections of greater strength at points of high stresses. The separate die and cam blocks of the carriage may be easily assembled and disassembled for replacement or interchange to accommodate workpieces of different sizes or shapes.

The present invention may be embodied in other specific forms without departing from the essential characteristics and spirit thereof, and therefore the present embodiment is considered in all respects as illustrative only and not restrictive, with the scope of the invention being indicated by the appended claims rather than by the foregoing description.

What is claimed and desired to be secured by Letters Patent is:

1. Apparatus for roll tapering a blank to form a spring leaf of desired longitudinal contour comprising means for supporting and positively horizontally moving a metal blank to be rolled, a forming roll positively driven about a horizontal axis of rotation that extends at right angles to the direction of movement of said blank, means mounting said forming roll for vertical displacement during the roll tapering operation, means for constantly urging said forming roll under pressure downward against said blank, and means including said last named means for automatically controllably changing the vertical position of said forming roll while maintaining said pressure sufficient as the blank moves in rolling contact with said forming roller to form said blank to said desired contour comprising cam means of predetermined taper positioned to oppose downward movement of said forming roll.

2. In the apparatus defined in claim 1, said means for supporting the blank comprising means extending along opposite sides of said blank restraining spreading of said blank during rolling.

3. In a machine for roll tapering spring leaves and the like, a support, a carriage mounted for generally horizontal reciprocable movement on said support, means on said carriage adapted to support a blank to be rolled, a forming roll mounted above said carriage for rotation on a horizontal axis substantially at right angles to the direction of movement of said blank and for substantially vertical displacement toward and from said blank, means constantly urging said forming roll downward under

pressure against said blank in said recess, means for automatically controllably varying the vertical position of said downwardly urged forming roll while maintaining said pressure as said carriage is moved therebeneath with said forming roll engaging said blank whereby a desired contour is imparted to said blank comprising cam means of predetermined taper positioned to oppose downward movement of said forming roll, and means operated concomitantly with said carriage moving means for positively rotating said forming roll as said carriage moves the blank therebeneath with the peripheral speed of the forming roll surface engaged with said blank being substantially the same as the linear speed of said moving blank.

4. In a machine for roll tapering spring leaves and and the like, a support, a carriage mounted for generally horizontal reciprocable movement on said support, means on said carriage adapted to support a blank to be rolled, a forming roll mounted above said carriage for rotation on a horizontal axis substantially at right angles to the direction of movement of said blank, slide guide means mounting said forming roll for vertical displacement toward and from said blank, means constantly urging said forming roll downward under pressure against said blank, cam means of predetermined longitudinal contour extending alongside said blank on said carriage and cooperating with follower means associated with said forming roll to oppose downward of said forming roll for automatically controllably varying the vertical position of said downwardly urged forming roll while maintaining said pressure as said carriage is moved therebeneath with said forming roll engaging said blank whereby a desired contour is imparted to said blank, and means for positively rotating said forming roll as said carriage moves the blank therebeneath with the peripheral speed of the forming roll surface engaged with the blank being substantially the same as the linear speed of the moving blank.

5. In a machine for roll tapering spring leaves and the like, a support, a carriage mounted for generally horizontal reciprocable movement on said support, means on said carriage providing an upwardly open longitudinal recess adapted to support a blank to be rolled, a forming roll mounted above said carriage for rotation on a horizontal axis substantially at right angles to the direction of movement of said blank, guide means mounting said forming roll for substantially vertical displacement toward and from the blank in said recess, hydraulic cylinder means operably connected to and constantly urging said forming roll downward under pressure against the blank in said recess, means comprising spaced identical cams of predetermined taper extending longitudinally parallel at opposite sides of said recess and cam follower roll surfaces of the same diameter as and movable with said forming roll adapted to engage said cams for controllably varying the vertical position of said downwardly urged forming roll while maintaining said pressure as said carriage is moved therebeneath with said forming roll engaging the blank in said recess whereby a desired contour is imparted to the blank, and means for positively rotating said forming roll as said carriage moves the blank therebeneath.

6. In the machine defined in claim 5, said cams being laterally spaced from said recess and said follower rolls

being spaced rolls non-rotatably connected to said forming roll.

7. In the machine defined in claim 5, said cams defining the opposite sides of said recess and defining means for restraining lateral spread of the blank during rolling, and said forming roll surface being laterally extended to bridge said cams and provide said cam follower surfaces.

8. In the machine defined in claim 5, a die block on said carriage defining the bottom of said recess and adapted to underlie the blank to be rolled.

9. In the machine defined in claim 8, said die block and cams being disposed laterally immovably in a longitudinal recess in the upper part of said reciprocable carriage.

10. In a machine for roll tapering spring leaves and the like, a support, a carriage mounted for generally horizontal reciprocable movement on said support, means on said carriage providing an upwardly open longitudinal recess adapted to support a blank to be rolled, a forming roll mounted above said carriage for rotation on a horizontal axis substantially at right angles to the direction of movement of said blank, slide guide means for mounting said forming roll for vertical displacement toward and from the blank in said recess, a shaft assembly on which said roll is non-rotatably mounted and vertically slidably mounted end bearing supports for said shaft assembly, disposed in said guide means, means constantly urging said forming roll downward under pressure against the blank in said recess comprising hydraulic means operably connected to said bearing supports, and cooperating cam and follower means on said shaft assembly and carriage for opposing downward movement of said forming roll and automatically controllably varying the vertical position of said downwardly urged forming roll as said carriage is moved therebeneath with said forming roll engaging the blank in said recess whereby a desired contour is imparted to the blank, and means for positively rotating said forming roll as said carriage moves the blank therebeneath with the peripheral speed of the forming roll surface engaged with the blank being substantially the same as the linear speed of the moving blank.

11. In the machine defined in claim 10, means for linearly moving said carriage during rolling of the blank comprising a reversible motor adapted to move said blank at substantially the same speed as the driven peripheral surface of said forming roll.

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CHARLES W. LANHAM, *Primary Examiner.*

MICHAEL V. BRINDISI, *Examiner.*

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,233,444

February 8, 1966

Roy H. Groves et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 59, for "roller" read -- roll --; column 9, line 1, strike out "in said recess"; line 15, strike out "and"; line 28, after "downward" insert -- movement --.

Signed and sealed this 7th day of February 1967.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents