T. L. R. D'ORVILLE.

LEAF SPRING AND PROCESS OF MAKING THE SAME.

APPLICATION FILED JAN. 20, 1920.

1,381,014. **Patented June 7, 1921.**

3 SHEETS—SHEET 1.

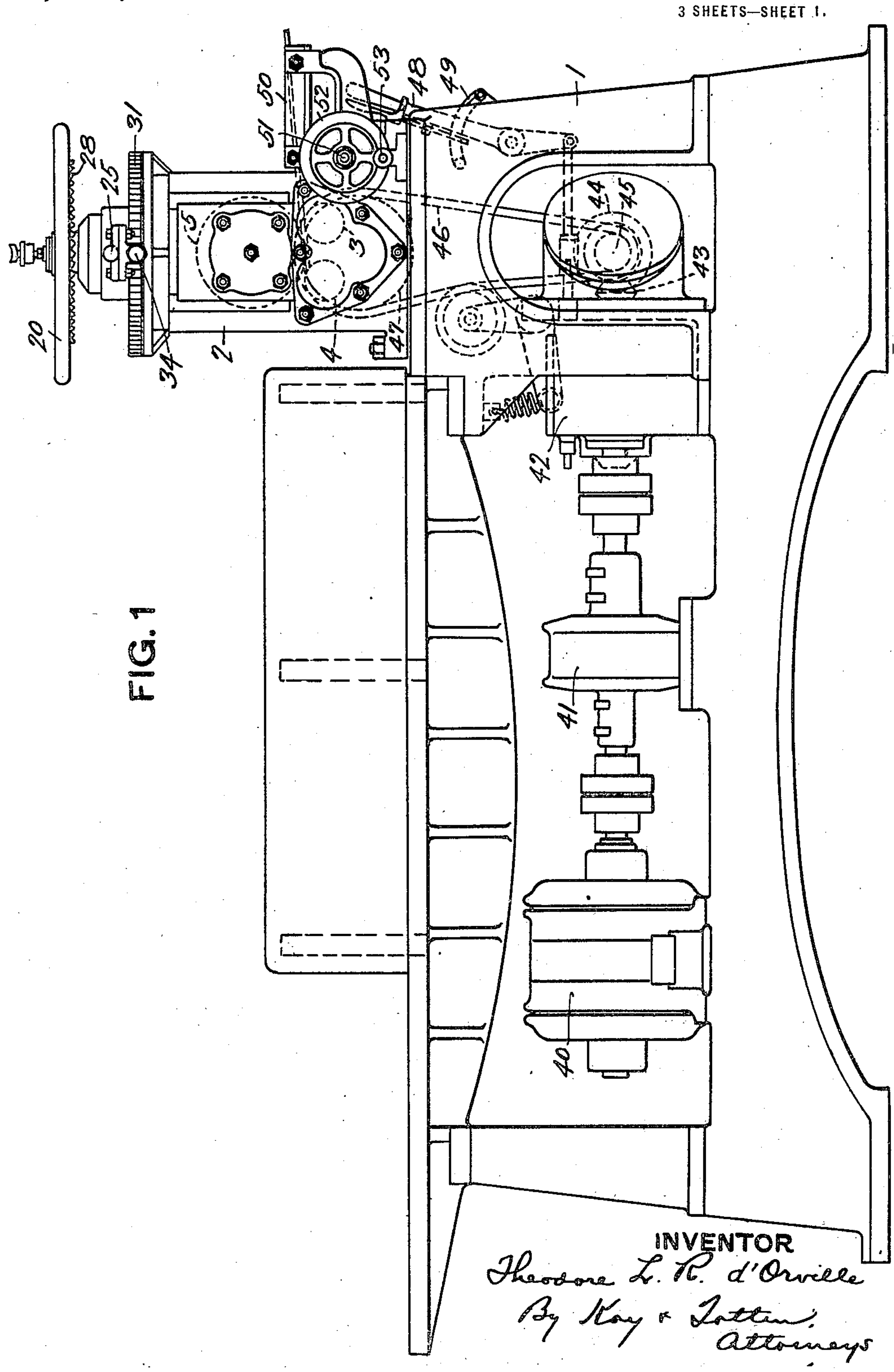

FIG. 1

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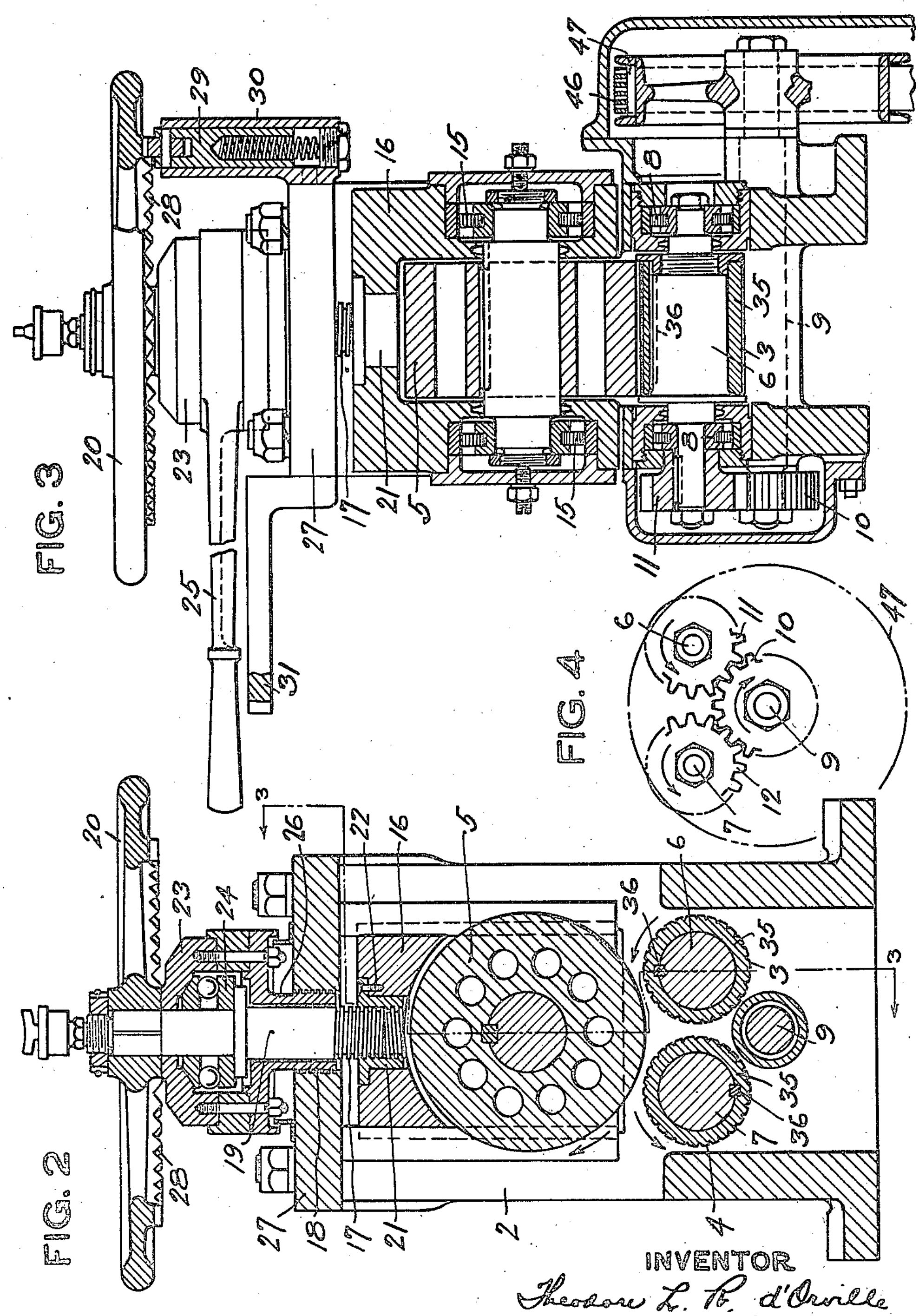

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3 SHEETS—SHEET 3.

FIG. 6

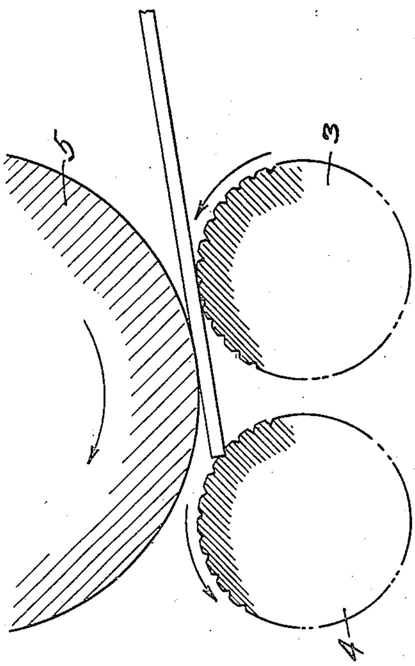
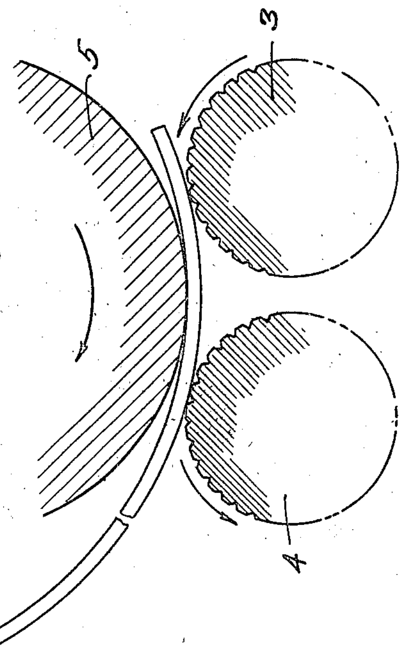


FIG. 7



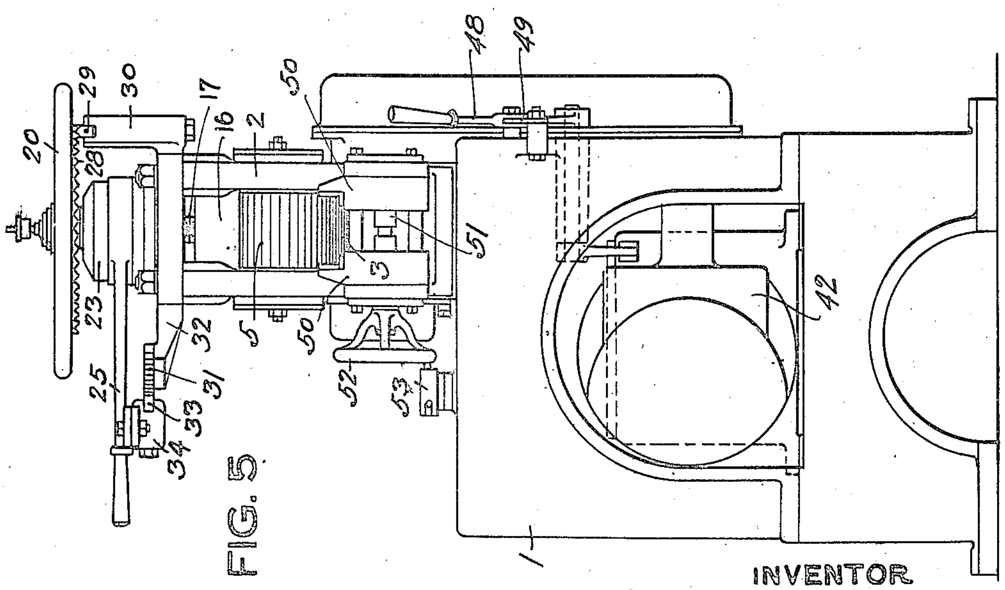


FIG. 5

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UNITED STATES PATENT OFFICE.

THEODORE L. R. D'ORVILLE, OF SEWICKLEY, PENNSYLVANIA, ASSIGNOR TO STANDARD STEEL SPRING COMPANY, OF CORAOPOLIS, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

LEAF-SPRING AND PROCESS OF MAKING THE SAME.

1,381,014. Specification of Letters Patent. Patented June 7, 1921.

Application filed January 20, 1920. Serial No. 352,746.

To all whom it may concern:

Be it known that I, THEODORE L. R. D'ORVILLE, a subject of the Queen of the Netherlands, and resident of Sewickley, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Leaf-Springs and Processes of Making the Same; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the production of steel leaf springs, and it has for its object to provide a rapid and economical process of making such springs without the use of cumbersome and expensive apparatus.

More particularly, the object of my invention is to produce leaf springs of elliptical or other predetermined curvature by rolling the spring blanks in the cold and finishing the shaped blanks by means of a tempering operation.

Broadly stated, my process consists in passing spring blanks having relatively high ductility and low elastic limit through a set of bending rolls, whereby the metal of the blank is distorted and given a permanent set in either a simple or compound curved form. The metal of the blank at this stage is in a condition of strain, and I therefore subject the shaped blanks to sufficient heat to cause the metal to pass its critical flow point and reëstablish a condition of equilibrium within the metal. The heated blanks are then quenched in oil or other quenching medium, whereupon they are found to have a greatly increased elastic limit, decreased ductility and a high degree of uniformity and endurance.

In making springs and other mechanical parts that must undergo bending and similar fatiguing stresses, it has hitherto been thought necessary to avoid any operation which will distort the interior structure of the metal. Cold working methods have therefore been carefully avoided. In making elliptical leaf springs, for example, the universal practice has been to heat the spring blanks until their elasticity is destroyed, to press the blanks between formers or by forming over patterns with tongs and then to quench the blanks with water while thus held. When this process is operated on a large scale, extensive furnace arrangements are necessary for heating the blanks and considerable amounts of time and labor are consumed.

I have discovered the somewhat surprising fact that although cold working strains the structure of steel and therefore produces a material which would be supposed not to withstand fatigue, a proper heat treatment will restore to the cold-worked steel an unstrained structure which is even superior to the structure present in springs produced by ordinary hot-working methods. The springs thus produced are more efficient than springs produced by hot-pressing methods, because the hot-pressing method in which the blank is held in its distorted position and quenched with water produces internal defects in the steel which cannot thereafter be cured by heat treatment.

For a better understanding of my invention, reference may now be had to the accompanying drawings, in which Figure 1 is a side elevational view of a bending machine, by means of which my present invention may be carried out; Fig. 2 is a longitudinal sectional view taken centrally through the bending rolls; Fig. 3 is a transverse vertical sectional view, the section being taken substantially along the line 3—3, Fig. 2; Fig. 4 is a fragmentary side view showing the driving gears for the lower bending rolls; Fig. 5 is a front elevational view of the machine; Fig. 6 is a diagrammatic view showing the relation between a blank and the bending rolls at the beginning of the bending operation; and Fig. 7 is a diagrammatic view similar to Fig. 6 showing the blank at the moment when the rolling is nearly completed.

Referring to Figs. 1 to 5, inclusive, the bending machine consists of a frame 1 which supports near one of its ends a housing 2 in which are mounted two lower bending rolls 3 and 4 preferably having their axes in a common horizontal plane, and an upper bending roll 5, the axis of which is disposed above and midway between the axes of the two lower rollers. The lower rolls 3 and 4 are mounted on shafts 6 and 7 respectively, which are held in bearings that are rigidly carried in the housing 2, roller bearings 8 being suitably provided for both of the rolls 3 and 4. The lower rolls are driven in the same direction from a power shaft 9 disposed below the rolls and connected to drive the rolls by means of a spur gear 10 keyed to the shaft 9 and spur gears 11 and 12 meshing with the gear 10 and keyed to the shafts 6 and 7, respectively. The power shaft 9 is driven in a manner to be described in detail below. The upper roll 5 is loosely mounted for rotation in roller bearings 15 that are supported in a block 16 which is mounted in vertical slides within the housing 2, the purpose of this arrangement being to enable the roll 5 to be vertically adjusted in order to vary the distance or clearance between the upper roll and the two lower rolls in order that the curvature of the blanks fed through the machine may be altered to suit requirements.

The adjustment of the vertically sliding block 16 is effected by means of a coarse adjusting screw 17 and a fine adjusting screw 18. The coarse screw 17 is formed on the lower end of a vertical shaft 19 which carries near its upper end a hand wheel 20 and the screw 17 engages a suitable screw thread which may be formed in the sliding block 16 or, as shown in Fig. 2, in a separate nut 21 that is anchored to the block as by means of a screw 22 for the purpose of cheaper replacement cost when the screw threads become worn.

Surrounding the screw shaft 19 between the screw threads 17 and the hand wheel 20 is a housing 23 which incloses a ball thrust washer 24 for preventing the axial displacement of the shaft 19. The housing 23 is also provided with a hand lever 25 and with a downwardly extending annular portion 26 upon which are formed the fine screw threads 18 which engage corresponding screw threads formed in a steel cap 27 bolted to the top of the housing 3. It will be evident that when the hand lever 25 remains stationary and the hand wheel 20 is turned, the rotation of the screw 17 will cause the steel block 16 to be lowered or raised, thus providing the rough or coarse adjustment of the upper roller. When the hand wheel 20 is prevented from rotating and the lever 25 is turned, it will also be evident that the lever 25 carries with it the housing 23, including the fine screw threads 18, whereby the complete assembly, constituted by the hand wheel 20, the vertical screw 19 with its ball thrust and the housing 23, will be raised or lowered carrying with it the sliding block 16 and the upper roll 5.

In order to prevent the hand wheel 20 from rotating during the fine adjustment of the roller 5, I provide the hand wheel 20 with a toothed quadrant 28 engaged by a spring-pressed plunger 29 inclosed within a tubular housing 30 carried by the cap 27 of the housing 3. The lever 25 is similarly provided with means for preventing it from rotating, such means being best shown in Fig. 5 and consisting of a quadrant 31 carried by a bracket 32 and engaged with a spring-pressed plunger 33 inclosed within a housing 34 attached to the hand lever 25. Since the hand lever 25 controls the fine screw-threads 18, it is obvious that a relatively large angular displacement of the lever will result in a small amount of vertical adjustment of the roll 5. For example, in one machine which I have constructed, each notch on the hand-wheel 20 corresponds to approximately 0.005 inch vertical displacement of the roller, whereas the total swing of the hand lever 25 through an angle of 90° will amount to a displacement of 0.013 inch, so that the total fine adjustment range is equivalent to 2½ notches of the coarse adjustment.

In order that the curvature imparted to the spring blanks may be as accurate as possible, it is desirable to reduce the axial distance between the two lower rolls 3 and 4 to the strictest minimum consistent with structural requirements. Otherwise the ends of the spring blanks will always be left flat for an appreciable distance. As a result of this close arrangement of the lower rolls, the pressures upon the rolls are of considerable magnitude and result in correspondingly high pressures on the bearing surfaces. For this reason it is desirable to make use of heavy-duty roller bearings in order to produce a compact machine and avoid bearing and lubrication difficulties.

It will be observed that the lower rolls, together with their respective shafts, bearings and gears are designed as a unit which may be quickly disassembled in a body for the purpose of rapid replacement. Since the amount of surface wear upon the rolls is comparatively rapid, I provide the lower rolls with replaceable wearing surfaces consisting of sleeves 35 that are slipped over the rolls proper and are secured to the rollers by means of keys 36.

The working sleeves 35, as best shown in Figs. 2, 6 and 7 are provided with longitudinal serrations which constitute an important feature of the machine. These serrations perform two functions. First, by reducing the roller surface in contact with the blank at any one moment, they increase the unit pressure on the surface, thereby squeezing off any oil or greasy film that may exist upon the surface of the blank, the serrations also providing the necessary channels for evacuating grit and scale. Slippage is thus obviated and the drive upon the blank is positive at all times. Secondly, the serrations on the rolls 4 will catch the forward end of each blank when it is fed into the machine, as best shown in Fig. 6, and the serration engaging the end of the blank tends to raise it and carry it up over the top of the roll. If it were not for this action of the serrated roll 4, heavy and tough blanks could not be fed through the machine at all. Thereafter, the blank is supported from below upon substantially two points, as shown in Fig. 7, the drive being continuously transmitted from the same points, and the curvature of the blank is thus kept accurate.

The power shaft 9 which drives the lower bending rolls may be driven in any suitable manner. As shown in Figs. 1 and 5 the driving means comprises an electric motor 40 which delivers its power through an epicyclic speed reduction gear box 41, and a two-speed spur gear box 42 to a bevel pinion 43 which meshes with a bevel wheel 44 that is mounted on a countershaft 45. The countershaft 45 also carries a chain sprocket around which travels a silent chain on link belt 46 which also passes around an upper sprocket 47 that is secured to the power shaft 9.

The two-speed gear box 42 is provided in order that the operator may vary the speed of the bending rolls to increase production, the lower speed being used for bending short plates, while the high speed is more economical when bending long plates. The change-speed mechanism is controlled by a hand lever 48 provided with a notched quadrant 49 and bolted to the side of the frame 1.

It is important that the blanks be fed straight to the bending rolls, as otherwise warping may occur and the blanks may jam against the sides of the housing. In order to properly guide the blanks, I provide movable jaws 50, Fig. 5, which are actuated by means of a right and left hand screw 51 controlled by a small hand wheel 52 provided with a suitable stop device 53. The guides 50 provide for positively centering the blank which not only insures proper bending of the plate itself, but also equalizes the pressure on the roller bearings. Also, as the bending rolls wear, it is evident that the lower roll surface will not be of uniform diameter throughout their length, and it is not desirable to have one side of the blank ride over a larger diameter than the other side. This would be possible if the blank should be fed into the machine otherwise than centrally with respect to the rolls.

The upper roll 5, the surface of which is preferably formed of chilled steel, is made as large as possible in order to increase the available wearing surface and produce a longer life before replacement becomes necessary. The large radius of curvature also has a tendency to allow the blank to wrap itself smoothly around the surface of the roll, thus avoiding the liability of kinks which would impair the quality of the product.

In the operation of the machine which I have shown and described, the blanks are fed through the guides 50 and between the bending rolls. If, as is often the case, it is desired to provide the blanks with a compound curvature, the upper roll is moved vertically during the operation of rolling each blank, this vertical adjustment being produced by turning the hand lever 25 or the hand wheel 20 in accordance with the change in curvature that is desired.

The blanks which I prefer to employ in carrying out my process are composed of steel having an elastic limit of between 40,000 pounds and 90,000 pounds per square inch, though, as in the case of alloy steel blanks, the initial elastic limit may rise as high as 120,000 pounds per square inch. After the blanks are rolled they are heated in a suitable tempering furnace to a temperature suitably between 1480° F. and 1600° F. and are then quenched in oil. This process results in a final elastic limit of the finished product varying between 180,000 pounds and 200,000 pounds.

I am aware that metal-bending machines have been provided in which the bending is effected by means of three rollers arranged in triangular form. This has, however, not been applied to the manufacture of springs, because of the prevailing belief, indicated above, that rolling or other cold working cannot be used to produce a spring which is to be subjected to fatiguing stresses. It is obvious that mechanical means other than those which I have shown and described may be utilized for carrying out the steps of my process and for producing the novel product herein claimed, and I therefore, desire that my invention be not limited to the structural features which I have shown and described, and that no other limitations be imposed upon my invention unless indicated in the appended claims.

What I claim is:

1. As a new article of manufacture, a steel leaf-spring having a curvature or camber produced by cold bending by means of rolls.

2. As a new article of manufacture, a steel leaf-spring having a compound curvature or camber produced by cold bending by means of rolls.

3. The process of making springs that comprises passing a cold steel spring blank between rolls and thereby imparting a camber or curvature thereto.

4. The process of making springs that comprises passing a cold steel spring blank between rolls and thereby imparting a compound camber or curvature thereto.

5. The process of making springs that comprises passing a spring blank between rolls to bend the same, and changing, during the rolling operation, the degree of curvature imparted to the said blank.

6. The process of making springs that

comprises passing a spring blank between bending rolls and altering the relative positions of the said rolls during the bending operation.

7. The process of making springs that comprises passing a cold leaf spring blank between rolls to impart a permanent set thereto, and then tempering the formed blank.

8. The process of making springs that comprises passing a cold spring blank between rolls to impart a compound curvature or camber thereto, and then tempering the formed blank.

9. The process of making springs that comprises passing a cold spring blank between three triangularly arranged rolls, thereby imparting a curvature or camber to the said blank.

10. The process of making springs that comprises passing a cold spring blank between three triangularly arranged rolls, thereby imparting a curvature or camber to the said blank and then tempering the formed blank.

11. The process of making springs that comprises cold-shaping a leaf spring blank having relatively high ductility and relatively low elastic limit and heating and quenching the formed blank, thereby raising the elastic limit of the said blank.

12. The process of making springs that comprises passing between rolls a cold spring blank having relatively high ductility and relatively low elastic limit, thereby imparting a permanent curvature or camber thereto, heating the formed blank to a temperature between 1400° F. and 1600° F. and quenching the heated blank in oil or other quenching medium.

13. The process of making springs that comprises passing between rolls a cold spring-blank of relatively ductile material having an elastic limit between 40,000 and 90,000 pounds, thereby imparting a permanent curvature or camber thereto, heating the formed blank and quenching the heated blank, thereby imparting to the said blank an elastic limit between 90,000 pounds and 200,000 pounds.

In testimony whereof I, the said THEODORE L. R. D'ORVILLE, have hereunto set my hand.

THEODORE L. R. D'ORVILLE.

Witnesses:

WALTER C. EISSLER,

WAYNE R. MOORE.