A. L. STEWART.

GEAR CUTTING MACHINERY.

APPLICATION FILED JAN. 2, 1917.

1,324,475.

Patented Dec. 9, 1919.

2 SHEETS—SHEET 1.

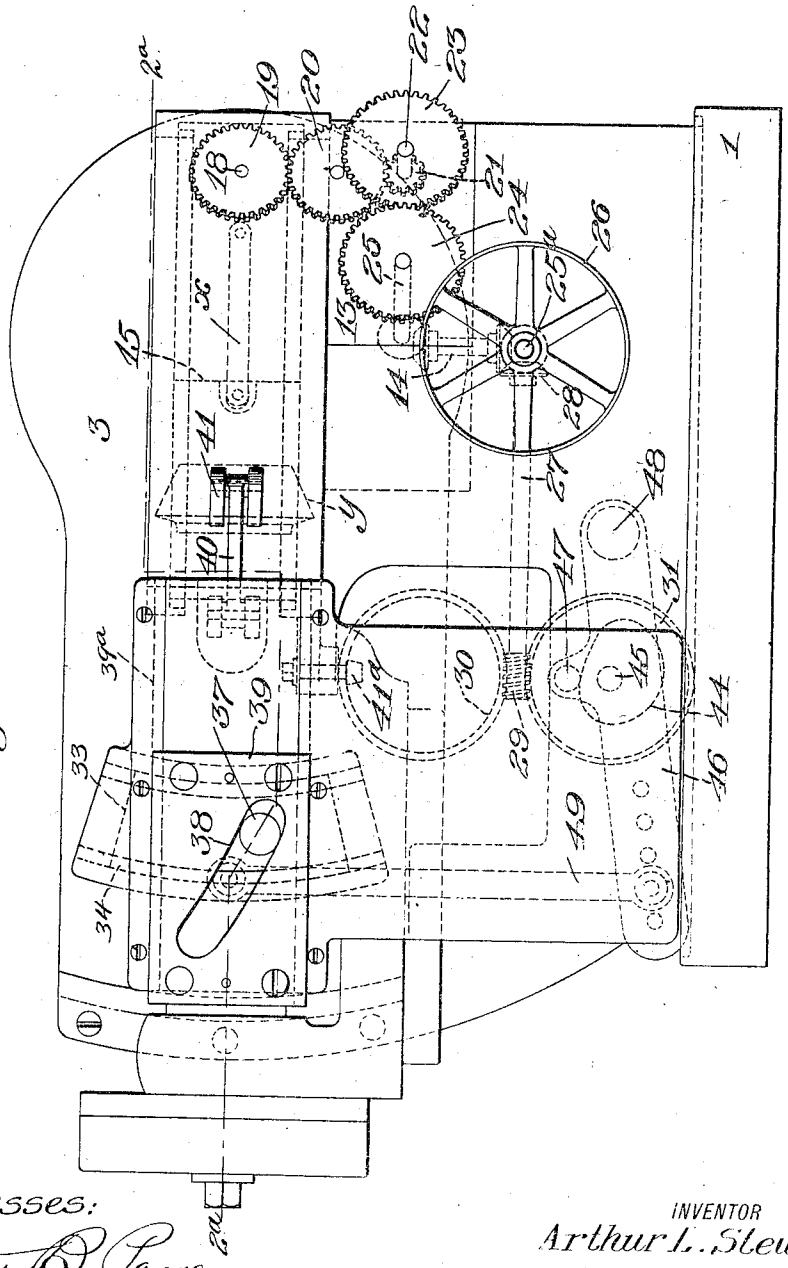


Fig. 1

Witnesses:

Walter D. Payne

H. E. Stonebraker

INVENTOR

Arthur L. Stewart

BY

Munn & Co

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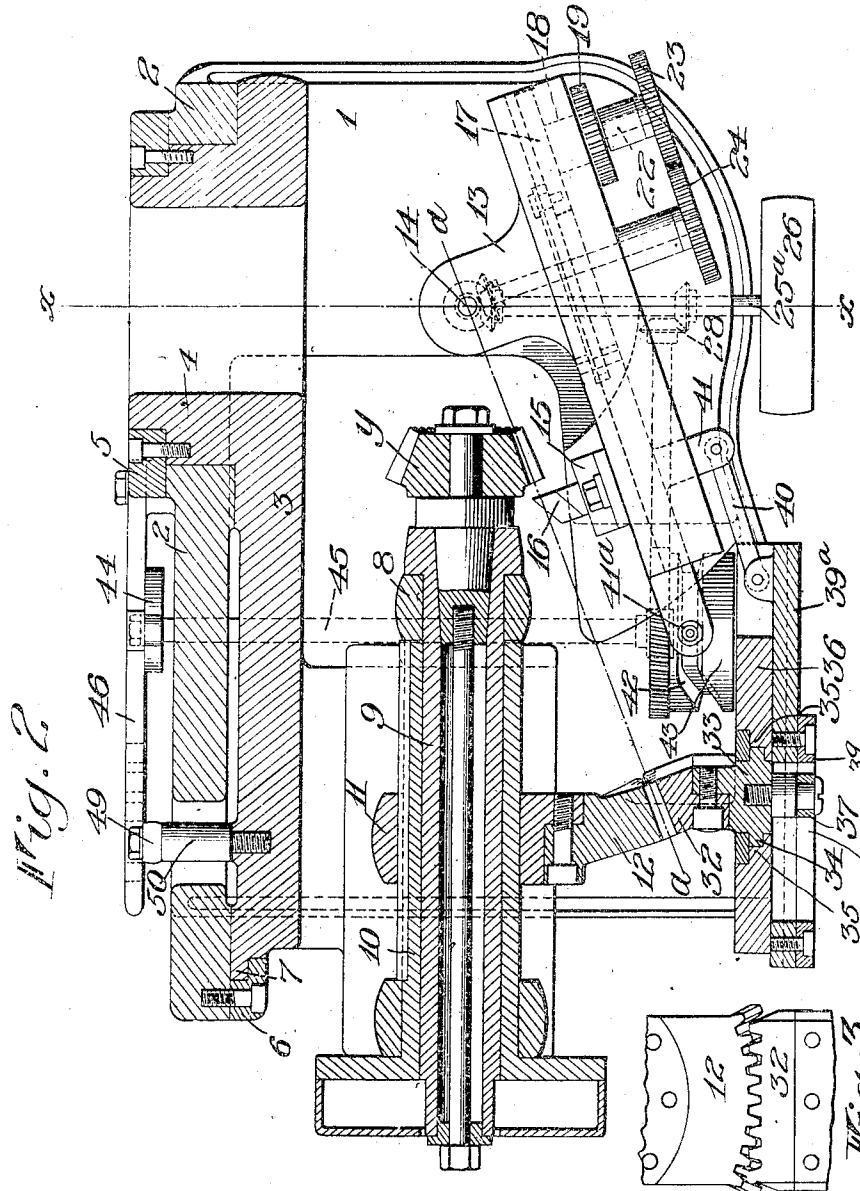


Fig. 2.

Fig 3

Witnesses;

Walter B Payne

H. E. Stonebraker

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UNITED STATES PATENT OFFICE.

ARTHUR L. STEWART, OF ROCHESTER, NEW YORK, ASSIGNOR TO GLEASON WORKS, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

GEAR-CUTTING MACHINERY.

1,324,475. Specification of Letters Patent. Patented Dec. 9, 1919.

Application filed January 2, 1917. Serial No. 140,007.

To all whom it may concern:

Be it known that I, ARTHUR L. STEWART, of Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Gear-Cutting Machinery; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the reference characters marked thereon.

My invention relates to machines for cutting gears and has a general application in the art of bevel and spur gearing, although more particularly designed and intended for the production of generated curved tooth gears, or gears in which each tooth is curved longitudinally or lengthwise and is also characterized by curved theoretically correct profiles according to the well known generating systems in which a relative rolling or generating motion is effected between the tool and gear blank during the cutting operation that corresponds to the movement that the completed gear would have with relation to a mating gear member. In a more specific aspect, the invention has to do with cutting bevel pinions with generated curved teeth and is designed to afford a simple, successful, and commercially practicable machine for this class of work. To these and other ends the invention consists of certain improvements and combinations of parts all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

Figure 1 is a side elevation of a machine embodying my improvements, and

Fig. 2 is a horizontal sectional view on the line 2^a—2^a of Fig. 1 with parts in elevation.

Fig. 3 is a fragmentary detail of the gearing between the tool carrier and blank.

Similar reference characters throughout the several views indicate the same parts.

The present structure is intended merely as an illustrative example of carrying out my invention, which may be embodied in a variety of mechanisms, and the arrangement disclosed herein is designed more particularly for the production of generated curved tooth pinions such as form a part of my gearing system covered in application Serial No. 132,285, filed November 20, 1916.

In the machine shown, 1 designates the bed or base, while 2 is a stationary body or main frame that supports a movable frame 3, the latter having a hub or sleeve 4 mounted in a bearing in the frame 2 so as to be movable swingingly about an axis x—x for effecting generation of the gear teeth as will be more fully described presently. The movable frame 3 has fixed thereon a plate 5 engaging the outer face of the body 2, while 6 designates a curved guide also attached to the body 2 and coöperating with a corresponding extension or flange on the movable frame 3 for properly guiding the latter in its swinging movement. The movable frame 3 has suitably fixed thereon bearings 8 that serve to support the oscillatory blank carrier which includes generally a spindle 9 at the inner end of which is fixed the gear blank y as usual in this class of machinery, and an indexing sleeve 10 which is locked to the spindle 9 during the cutting operation and then forms a part of the blank carrier. The spindle 9 and sleeve 10 are unlocked for indexing in accordance with any of the well known methods involved in gear cutting machine index mechanisms, and which I have not deemed necessary to show or describe fully in this application, inasmuch as the invention and novelty in the present case is entirely independent of any indexing mechanism, and for my purposes, any conventional index mechanism may be employed. The sleeve 10 has keyed or fixed thereon a collar 11 to which is attached securely a gear member comprising a segment of a bevel gear shown at 12 which is in fixed relation to the blank carrier and is moved during the operation of and in synchronism with the tool in the manner which will now be described.

The tool support is designated generally at 13, and is mounted to swing about the vertical axis or spindle 14. Arranged for reciprocatory movement on the tool support 13 is a reciprocating tool carrier 15 to which is attached the straight-sided tool or cutter 16, that is reciprocated or driven back and forth by a crank plate 17 carried by shaft 18. The latter is provided at its outer end with a gear 19 that is driven by gear wheel 20 which in turn is operated by pinion 21

on a shaft 22, as shown in Fig. 1. The shaft 22 carries a gear 23 that is driven by gear 24 mounted on the outer end of the shaft 25 which is driven from the vertical spindle 14 at the center of the machine. Spindle 14 is driven by the main power shaft 25ª, carrying a pulley 26 to which power is applied for operating the various parts of the apparatus. The shaft 25ª also drives a shaft 27 through bevel gears 28 and the shaft 27 carries a worm 29 which operates the worm wheels 30 and 31, respectively, for controlling the generating and tool withdrawing mechanisms as will be more apparent from the following description.

The movement of the tool carrier 15 transmits motion to the bevel gear member 12 so that as the tool 16 makes its cutting movement the gear blank y is turned on its axis a predetermined amount, which results in a curved slot or cut being made, and thus the curvature of each tooth from end to end is automatically determined by the tool carrier operation, while the tool travels in a straight path or line across the face of the blank. The means for thus turning the blank is form-controlled in order to permit varying the amount of turning and consequent degree of curvature by changing the form, and in order to accomplish this I employ a second gear member comprising a segment of a bevel gear 32, which is mounted on a support or slide 33 carrying curved flanges 34 which travel in the correspondingly curved guides 35 of a stationary guide plate 36. The slide 33 carries a roller 37 which engages in a slot 38 of the form 39, the slot being of predetermined suitable shape to effect the desired curvature and angle of cut and is mounted in a reciprocating form carrier 39ª. The form carier 39ª is connected by a link 40 to an extension 41 which is formed on the tool carrier 15. The form 39 having the guide slot 38 consists in the present instance of a plate secured to the form carrier 39ª by bolts as shown in Fig. 2. From this construction, it will be seen that as the tool carrier moves toward the center of the machine or cone center of the gear blank, the form 39 will be moved to the right in Figs. 1 and 2, and through the slot 38 and roller 37 the bevel gear member 32 is elevated, causing a corresponding turning of gear member 12 and consequent turning of the blank y which produces a curved cut longitudinally of the tooth, and during the return stroke of the tool carrier, a reverse movement of the parts takes place and the blank is returned to its initial position. The blank is thus rotated a certain amount, determined by the shape of the slot in the form 39 for each forward or cutting stroke of the tool and the form controlled means, governed by the tool carrier, oscillates the blank carrier in synchronism with the reciprocations of the tool carrier. The tool is arranged for travel in the line of or parallel to the root angle of the gear blank, and in a line with or toward the cone center of the blank, as customary in bevel gearing, and with this arrangement, it is possible to obtain any desired curve for the lengthwise shape of the tooth, by a variation of the form of the slot that governs the movement of the roller 37 and bevel segment 32.

At the completion of each tooth face, the blank is automatically indexed and during this indexing operation it is necessary to withdraw the tool from engagement with the blank. For this purpose I employ on the tool support a roller 41ª that engages a suitable cam way 42 in the cam wheel 43, the latter being connected to and driven by the aforementioned worm wheel 30. The shape of the cam way 42 is such as to cause the tool support to be swung laterally about the central axis 14 when the proper depth of cut has been reached, to move it out of engagement with the gear blank, and after the indexing operation is completed, the tool support is again moved into cutting relation with the blank.

As before stated, the present machine is designed more particularly to cut the pinion employed in connection with the form of gearing disclosed in my co-pending application referred to, in which the teeth on the gear are straight sided and the teeth on the pinion are generated to give a theoretically correct rolling action between the two members of the pair. In order to accomplish this, since the teeth of the gear are straight sided, it is necessary when cutting the pinion to effect such a relative generating or rolling motion between the tool and the pinion as would obtain when the completed pinion is rolled upon the bevel gear. This involves a relative rolling of parts upon a cone or theoretical conical surface, and I accomplish this in the present machine through rolling of the blank and blank carrier by swinging the movable frame 3 about the axis x—x. The result of this is to roll the blank y upon a theoretical conical surface that would be swept out by the line a—a if it were swung bodily around the axis x—x. In other words, the blank y is rolled upon the pitch cone surface of what would be the mating bevel gear, an element of which is represented by the tool, during the cutting operation of the teeth, so as to generate upon the teeth of the pinion curved profiles or side faces that will mesh properly and give a continuous, regular and smooth engagement with the straight sided teeth on the gear. This is accomplished by the tooth profile generating mechanism, which, in the present instance, includes a cam 44 mounted on the shaft 45 carrying the aforementioned worm wheel 31. The cam 44 is preferably of the form shown,

dependent upon the desired speed of generating roll, and controls the movement of a lever 46 which carries a roller 47 engaging the cam 44. The lever 46 is pivoted at 48 and has adjustably connected thereto a link 49 which is pivotally mounted at its upper end upon an extension 50 carried by the movable frame 3. The cam wheel 44 is rotated slowly, causing a continued upward movement of the frame 3 and of the blank carrier about the axis x—x, and this necessarily involves an additional rotation of the gear blank about its axis, owing to the engagement of bevel gear segment 12, fixed to the blank carrier, with gear segment 32. This serves during the cutting operation to give to the blank a bodily movement about the axis x—x and a rotary movement about its own axis, corresponding exactly to the movement of the pitch cone surface of the pinion being cut when rolled upon the pitch cone surface of the mating bevel gear. This results in tooth profiles on the pinion that afford theoretically correct engagement with the straight sided profiles of the teeth on the gear.

I claim as my invention:

1. A gear cutting machine for producing longitudinally curved teeth on gears comprising an oscillatory blank carrier, a reciprocating tool carrier, and form-controlled means governed by the movements of the tool carrier acting to oscillate the blank carrier in synchronism with the reciprocations of the tool carrier.

2. A gear cutting machine for producing longitudinally curved teeth on gears comprising an oscillatory blank carrier, a reciprocating tool carrier, a form operatively connected to the blank carrier and movable to effect oscillation thereof, and connection between the tool carrier and the form whereby the blank carrier is oscillated in synchronism with the movements of the tool carrier.

3. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool carrier supporting a tool the cutting portion of which moves in a line passing through the cone center of the blank, and form-controlled means governed by the movements of the tool carrier acting to oscillate the blank carrier in synchronism with the reciprocation of the tool carrier.

4. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool, the cutting portion of which moves in a line passing through the cone center of the blank carrier supporting a tool, a form operatively connected to the blank carrier and movable to effect oscillation thereof, and connection between the tool carrier and the form whereby the blank carrier is oscillated in synchronism with the movements of the tool carrier.

5. A gear cutting machine for producing longitudinally curved teeth on gears comprising an oscillatory blank carrier, a reciprocating tool carrier, a gear member in fixed relation to the blank carrier, a second gear member in engagement with the first gear member, a support for the latter gear member, and means controlled by the tool carrier for moving the support to effect oscillation of the blank carrier in synchronism with the movements of the tool carrier.

6. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool carrier supporting a tool the cutting portion of which moves in a line passing through the cone center of the blank, a gear member in fixed relation to the blank carrier, a second gear member in engagement with the first gear member, a support for the second gear member, and means controlled by the tool carrier for moving the support to effect oscillation of the blank carrier in synchronism with the movements of the tool carrier.

7. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool carrier supporting a tool, the cutting portion of which moves in a line passing through the cone center of the blank, a bevel gear member in fixed relation to the blank carrier, a second bevel gear member in engagement with the first named gear member, a support for the latter gear member, and means controlled by the tool carrier for moving the support to effect oscillation of the blank carrier in synchronism with the movements of the tool carrier.

8. A gear cutting machine for producing longitudinally curved teeth on gears comprising an oscillatory blank carrier, a reciprocating tool carrier, form-controlled means governed by the tool carrier acting to oscillate the blank carrier in synchronism with the reciprocations of the tool carrier, and tooth profile generating mechanism acting automatically to effect a relative rolling or generating movement between the blank carrier and tool during the cutting operation.

9. A gear cutting machine for producing longitudinally curved teeth on gears comprising an oscillatory blank carrier, a reciprocating tool carrier, a form operatively connected to the blank carrier and movable to effect oscillation thereof, connection between the tool carrier and the form whereby the blank carrier is oscillated in synchronism with the tool carrier, and tooth profile generating mechanism acting automatically to effect a relative rolling or gen-

erating movement between the blank carrier and tool during the cutting operation.

10. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool carrier supporting a tool, the cutting portion of which moves in a line passing through the cone center of the blank, form-controlled means governed by the tool carrier acting to oscillate the blank carrier in synchronism with the reciprocations of the tool carrier, and tooth profile generating mechanism acting automatically to effect a relative rolling or generating movement between the blank carrier and tool during the cutting operation.

11. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool carrier supporting a tool the cutting portion of which moves in a line passing through the cone center of the blank, a form operatively connected to the blank carrier and movable to effect oscillation thereof, connection between the tool carrier and the form whereby the blank carrier is oscillated in synchronism with the movements of the tool carrier, and tooth profile generating mechanism acting automatically to effect a relative rolling or generating movement between the blank carrier and tool during the cutting operation.

12. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool carrier supporting a tool the cutting portion of which moves in a line passing through the cone center of the blank, a bevel gear member in fixed relation to the blank carrier, a second bevel gear member in engagement with the first named gear member, a support for the latter gear member, means controlled by the tool carrier for moving the support to effect oscillation of the blank carrier in synchronism with the movements of the tool carrier, and tooth profile generating means acting automatically to effect a relative rolling or generating movement between the blank carrier and tool during the cutting operation.

13. A bevel gear cutting machine for producing longitudinally curved teeth on bevel gears comprising an oscillatory blank carrier, a reciprocating tool carrier supporting a tool the cutting portion of which moves in a line passing through the cone center of the blank, a bevel gear member fixed to the blank carrier, a second bevel gear member in engagement with the first named gear member, a support for the latter gear member, a form controlled by the tool carrier and operatively connected to said support for moving it in accordance with the shape of the form, and effecting corresponding oscillation of the blank carrier in synchronism with the movements of the tool carrier, and tooth profile generating means acting automatically to effect a relative rolling or generating movement between the blank and tool during the cutting operation by causing the bevel gear member on the blank carrier to have a relative rolling movement upon the mating bevel gear member.

ARTHUR L. STEWART.