W. F. ZIMMERMANN.

GEAR CUTTING MACHINE.

APPLICATION FILED JAN. 16, 1909.

973,399. Patented Oct. 18, 1910.

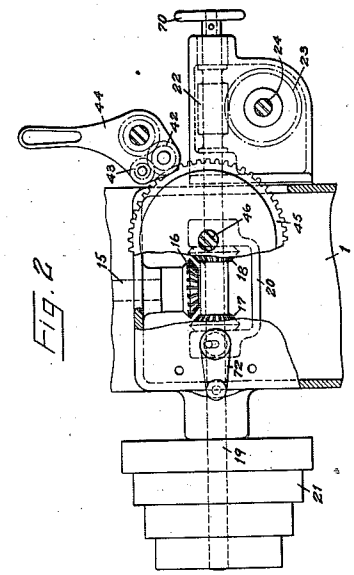

Fig. 2

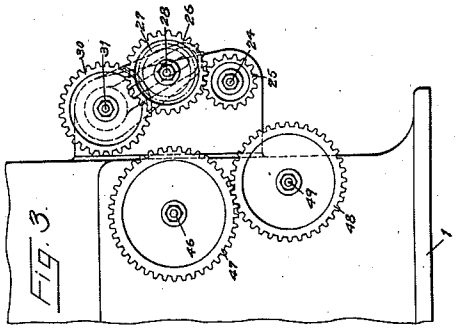

Fig. 3

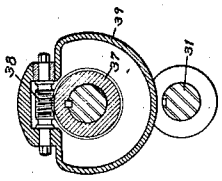

Fig. 4

Fig. 1

WITNESSES:

Benjamin Pettinger.

Edwin C. Thurston

INVENTOR

William F. Zimmermann

UNITED STATES PATENT OFFICE.

WILLIAM F. ZIMMERMANN, OF NEWARK, NEW JERSEY, ASSIGNOR TO GOULD & EBERHARDT, OF NEWARK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

GEAR-CUTTING MACHINE.

973,399. Specification of Letters Patent. Patented Oct. 18, 1910.

Application filed January 16, 1909. Serial No. 472,592.

To all whom it may concern:

Be it known that I, WILLIAM F. ZIMMERMANN, a citizen of the United States, residing at Newark, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Gear-Cutting Machines; and I do hereby declare the following specification, taken in connection with the drawings forming part of the same, to be a full, clear, and exact description of the principle of said invention and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

The invention relates primarily to machines for cutting helical gear wheels with a helical or hob cutter, especially to machines as shown and described in the pending applications filed Feb. 24th, 1907 and Oct. 24th, 1907, Serial Numbers 357,782 and 399,033 respectively, in which the feed of the helical cutter has a specific ratio to either the rotations of the helical cutter or the gear blank being cut.

The object of this invention is to provide, in a machine for cutting helical gears, devices whereby the original rotative relations existing between the cutter and the gear wheel being cut, and the feeding means for said cutter, may at all times be reset for the purpose of taking a recut without disturbing said existing relations.

The invention comprises means to relatively position the cutter to the helical gear blank being cut, with means for adjusting and positioning the rotative relations of said cutter and blank, said positioning means comprising a series of zero marks, adjustable and stationary, arranged upon suitable parts of the machine.

The annexed drawings which illustrate the invention in its preferred form and the following description set forth in detail, certain mechanism embodying means constituting, however, but one of the various mechanical forms in which the principle of the invention may be used.

The novelty of the invention is more particularly pointed out in the claims and will be readily understood from the drawings and description.

Referring to the drawings, Figure 1 represents a side elevation of a helical gear cutting machine, employing a helical or hob cutter, embodying the invention in its preferred form. Fig. 2 is a section at x_1 x_2 of Fig. 1, showing the cutter and feed reversing mechanism. Fig. 3 is a rear end elevation, illustrating the change gear arrangement, and Fig. 4 is a section at z_1 z_2 of Fig. 1, showing clearly the gear blank adjusting device.

Referring particularly to Fig. 1, upon the base 1 and preferably in one piece therewith, is a stanchion or upright 2, upon which is mounted a cutter carriage 3, vertically adjustable thereon. The swivel slide 4, is mounted angularly adjustable upon the carriage 3 and secured thereto in its various angular positions by the bolts 5. Upon the swivel slide 4 is mounted a cutter support 6, longitudinally adjustable thereon, and having a cutter spindle 7 rotatably mounted therein. The helical cutter can be secured to and rotated by said spindle 7, to which is also keyed a spindle gear 8 meshing with and driven by the pinion and shaft 9. A bevel gear 10 is secured to said pinion and shaft 9, and driven by the bevel gear 11, secured to the central shaft 12, passing through the slide 3, about which the swivel slide 4 revolves as a center. To the other end of said shaft 12 is secured another bevel gear 13, driven by the sleeve bevel gear 14, slidably keyed to the vertical cutter driving shaft 15, and carried by the slide 3. To the lower end of the vertical shaft 15, is secured a bevel gear 16 (see Fig. 2) which can be alternately engaged with the reversing bevel gears 17 and 18, slidably keyed to the main driving shaft 19, and carried by the yoke 20. The eccentric lever 72 is arranged to operate the yoke 20, whereby either of the bevel gears 17 or 18 can be engaged with the bevel gear 16.

The function of the structure, as above explained, is to rotate the cutter, and operates as follows: The cone 21, connected with any suitable source of power is secured to the main driving shaft 19, and rotates same with the bevel gears 17 and 18 thereon, either of which transmits motion to the vertical shaft

15, through the gear 16, secured to said shaft 15. The sliding bevel gear 14, rotates with said shaft 15 and drives the center shaft 12, through the gear 13, which in turn transmits motion to the pinion 9, through the bevel gears 10 and 11. The pinion 9 engages with the spindle gear 8, and rotates the spindle 7 and the helical cutter. Keyed to the other end of the main driving shaft 19, is a worm 22, driving a worm wheel 23, keyed to the index driving shaft 24 and rotating therewith. A change gear 25 is keyed to the end of the index driving shaft 24, and engages the compound gear 26, rotating in unison with the gear 27; both gears 26 and 27 are loosely mounted upon the compound stud 28 carried by the swinging shoe 29. The compound gear 27, engages with, and rotates the change gear 30, keyed to the end of the index shaft 31.

The index shaft 31 extends along the side of the machine and has a bearing in the adjustable work carriage 32 mounted upon the horizontal ways of the frame 1. Rotatably mounted within the work carriage 32 is the index worm wheel 33, preferably in one piece with the face plate 34 and carries the work spindle 35 upon which the wheel to be cut is secured.

The index worm wheel 33 is driven by the worm 36, journaled in suitable bearings on the work carriage 32. Keyed to one end of said worm 36 (see Fig. 4) is a worm wheel 37, connected to the gear 39 by the worm 38. The gear 39 is loosely mounted upon the hub of the worm wheel 37 and has the worm 38 journaled therein, thereby forming a positive connection between the worm 36 and the gear 39.

Slidably keyed to the index shaft 31 is a sleeve gear 40 carried by the work carriage 32, and engaging with the gear 39, whereby motion is transmitted to the index wheel 33. The worm 38 and wheel 37 are employed to alter the relation between the index wheel 33, and index shaft 31 when desired, without affecting the relation between the remainder of the parts.

The mechanism between the main driving shaft 19 and the index wheel 33, is such as to give the proper number of rotations to the gear blank being cut in relation to the rotations of the cutter, also in relation to the advance or feed of the cutter, parallel to the axis of the gear blank.

The feeding mechanism for the cutter is driven from the index shaft 31, thus establishing a relation between the rotations of the gear blank to be cut and the advance of the cutter. It consists of a spur gear 41, secured to, and rotatable with said index shaft 31, and a tumbler lever 44, loosely mounted concentric with said index shaft 31, carrying two tumbler gears 42 and 43. The gear 41 engages with the tumbler gear 42, which in turn meshes with the other tumbler gear 43. These gears are used to alter the direction of the feed to the cutter, by alternately engaging the spur gear 45. The tumbler lever 44 is secured in either of the engaged positions by the bolt 71. The spur gear 45 is secured to a short shaft 46, the other end of which is arranged to receive the change wheel 47, meshing with the change wheel 48, keyed to the feed worm shaft 49. The feed worm 50 is preferably in one piece with the shaft 49, and engages with the feed worm wheel 51, loosely mounted upon the feed screw 52, which engages a nut portion in the slide 3. The face of said worm wheel 51 is provided with clutch teeth, which are engaged by the clutch 53, slidably keyed to the feed screw 52, rotating therewith and deriving its motion from the feed worm wheel 51. The feed clutch 53 is operated manually by the clutch lever 54 to engage or disengage said worm wheel 51.

The structure thus far disclosed adds nothing material to the existing state of the art, since the applications previously filed embody the novel features thus disclosed.

The mechanism now to be explained embodies the essence of this invention, and consists of devices to facilitate the resetting of the machine when taking a recut through helical gears, and is fully shown in Figs. 1 and 4. Fastened to the slide 3 is a strap 55 having projections 56 thereon, to which is secured a guide rail 57. A sliding piece 58 is adjustably mounted upon the guide rail 57, being secured thereto by a screw 61, and carrying a zero mark thereon, to match with a similar but stationary zero mark 59, secured in the main frame 1. These zero marks are to enable the operator to return the cutter slide 3 to its original position after each cut through the teeth.

The slide 3 is returned manually by means of the hand wheel 60, secured to the feed screw 52. Other zero marks are provided to bring the cutting teeth of the helical cutter in the same relation to the teeth of the helical gear that they occupied at the beginning of the cutting and are arranged upon the index driving shaft 24. One zero mark is arranged upon a collar 62 which is loosely mounted upon the index driving shaft 24, but can be secured thereto in position by a screw 63, the other zero mark 64 is stationary upon the index driving shaft bearing 65.

The zero marks 66 and 67 are arranged upon the face plate 34 and work carriage 32 respectively. The zero mark 67 is a stationary mark, while the mark 66 revolves with the face plate, 34. The two zero marks can at any time be brought to correspond by

means of the micrometer adjusting device, comprising the worm 38 and wheel 37, see Fig. 4.

The machine is arranged for cutting helical gears in a similar manner as described in the pending applications. The feed of the helical cutter in a path substantially at right angles to the axis, is controlled by the rotations of the wheel blank being cut, as in the application filed Oct. 24th, 1907, Serial Number 399,033. The devices for resetting the machine are shown in their preferred form when the feed is controlled by the rotations of the wheel blank being cut, but can readily be arranged in a machine where the feed is controlled by the rotations of the helical cutter as in the application filed Feb. 18th, 1907, Serial Number 357,782.

The operation of the machine when cutting helical gears is as follows: The helical cutter is set at the proper angle, depending upon the angle of the helices with their axis, by revolving the slide 4 about its axis to the correct angle and is secured in position by the bolts 5. The change gears 25, 26 and 27 and 30 are then placed in position according to the formula

$$\frac{CC'P^{nc}}{C'NP^{nc} \mp V \sin. X}$$

fully deduced and explained in application, Series Number 399,033. The work slide 32 is adjusted to the proper depth of tooth by means of the hand wheel 68 and screw 69. The feed is engaged by operating the handle 54, whereby the clutch 53 is engaged with the worm wheel 51. After taking up all the backlash in the gearing by rotating the cone 21 a few times, the zero marks are adjusted. The face plate 34 is rotated by means of the cone 21 until the zero mark 66 thereon, corresponds with the mark 67 on the work slide 32. The zero mark on the dial 62 is then adjusted to correspond with the mark 64. The dial 62 is secured to the shaft 24 by means of the clamp screw 63. The sliding piece 58 carrying a zero mark is adjusted upon, and clamped to the guide rail 57 to correspond with the stationary mark 59. The machine can now be placed in operation; it merely being necessary to return all the zero marks to their respective positions, when a recut through the helices is to be made, without affecting the lead in any way. To return the parts to their original positions, the following method is employed. The machine is stopped; the blank is disengaged from the cutter by the hand wheel 68, and the shaft 24 is rotated by means of the cone 21 or the hand wheel 70, preferably the latter, until the zero mark on the dial 62 corresponds with the mark 64, the feed is then disconnected by the handle 54, and the cutter slide is raised by means of the hand wheel 60 until the zero mark on the slide 58 corresponds with the mark 59. It will then be found that the zero marks 66 and 67 do not quite correspond, depending upon the angularity of the helices being cut. The zero mark 66 is then adjusted by rotating the face plate 34, independent of the remainder of the mechanism; this is accomplished by rotating the worm 38 of the micrometer adjusting device with a suitable key wrench, thereby rotating the worm wheel 37, secured to, and rotating the index worm 36, which in turn rotates the index wheel 33, and the face plate 34 to which it is cast. After readjusting the work slide 32 to the proper depth, plus the additional depth, the machine can again commence cutting upon the helices.

The resetting of the various parts takes considerably less time than it takes to explain the *modus operandi*. The device is found to be simple and effective, replacing the quick return mechanisms with their high speed shafts and other defects, in this particular style of machine. The devices as shown, are very cheap to produce since they are nearly all parts of the regular machine.

Having described my invention and its mode of operation, I claim as new, and desire to secure by Letters Patent, the following:

1. In a helical gear cutting machine, the combination with a helical cutter, of means to feed said cutter substantially parallel to the axis of the wheel blank being cut, a blank spindle, gearing to synchronize the movements of said feeding means, cutter and spindle, producing substantially a motion in a helical line, passing around the axis of said blank, devices to indicate the original relative positions of said spindle, cutter and feeding means, comprising a cooperating series of stationary and adjustable zero marks, arranged upon intermediate mechanism between said spindle, cutter and feeding means.

2. In a helical gear cutting machine, the combination with a helical cutter, of means to feed said cutter substantially parallel to the axis of the wheel blank being cut, a blank spindle, gearing to synchronize the movements of said feeding means, cutter and spindle, producing substantially a motion in a helical line passing around the axis of said blank, devices to indicate the original relative positions of said spindle, cutter and feeding means, comprising a cooperating series of stationary and adjustable zero marks, arranged upon intermediate mechanism between said spindle, cutter and feeding means, with means to adjust said spindle, cutter or feeding means

relatively to each other, without destroying the synchronism.

3. In a helical gear cutting machine, the combination with a helical cutter, of means to feed said cutter substantially parallel to the axis of the wheel blank being cut, a blank spindle, gearing to synchronize the movements of said feeding means, cutter and spindle, producing substantially a motion in a helical line, passing around the axis of the wheel blank, devices to indicate the original relative positions of said spindle, cutter and feeding means, comprising a coöperating series of stationary and adjustable zero marks, arranged upon intermediate mechanism between said spindle, cutter and feeding means, with means to adjust said spindle, relatively to said cutter and feeding means, without destroying the synchronism.

4. A helical gear cutting machine, comprising a helical cutter, with feeding means therefor, a work spindle, devices to indicate the original relative positions of said spindle, cutter and feeding means, with means to adjust said spindle, cutter and feeding means, relatively to each other, without destroying the synchronism.

5. A helical gear cutting machine comprising a helical cutter, with feeding means therefor, a work spindle, gearing to synchronize the movements of said spindle, cutter and feeding means, devices to indicate the original positions of said spindle, cutter and feeding means comprising a coöperating series of stationary and adjustable zero marks, arranged upon intermediate mechanism between said spindle, cutter and feeding means, with means to adjust said spindle, relatively to said cutter and feeding means without destroying the synchronism.

6. In a helical gear cutting machine, the combination with a frame, of a cutter carriage mounted, to reciprocate thereon, a cutter rotatably mounted therein, feeding means for said carriage, a work carriage, adjustably upon said frame, a work spindle, rotatably mounted therein and connected to an index wheel, gearing to synchronize the movements of said spindle, cutter and feeding means, comprising a shaft rotating in accordance with said cutter, devices to indicate the original positions of said spindle, cutter and feeding means, comprising a zero mark on said frame, a corresponding zero mark adjustably mounted upon said cutter carriage, to indicate the original position of said feeding means, an adjustable zero mark arranged upon said shaft to correspond with a stationary zero mark provided upon the bearing therefor, to indicate the original rotary position of said cutter, and corresponding zero marks arranged upon said index wheel and work carriage, to indicate the original relative position of said work spindle.

7. In a helical gear cutting machine, the combination with a frame of a cutter carriage, mounted to reciprocate, thereon, a cutter rotatably mounted therein, feeding means for said carriage a work carriage, adjustably mounted upon said frame, a work spindle rotatably mounted therein and connected to an index wheel, gearing to synchronize the movements of said spindle, cutter and feeding means, comprising a shaft rotating in accordance with said cutter devices to indicate the original positions of said spindle, cutter and feeding means, comprising a zero mark on said frame, a corresponding zero mark adjustably mounted upon said cutter carriage, to indicate the original position of said feeding means, an adjustable zero mark arranged upon said shaft to correspond with a stationary zero mark provided upon the bearing therefor, to indicate the original rotary position of said cutter, and corresponding zero marks arranged upon said index wheel and work carriage, to indicate the original relative position of said work spindle, and means to adjust said index wheel relatively to said cutter and feeding means without destroying the synchronism.

8. A helical gear cutting machine, comprising a helical cutter with feeding means therefor, a work spindle, connected to an index wheel, a worm therefor, an index shaft, devices to indicate the original relative positions of said spindle, cutter and feeding means, with means to adjust said spindle relatively to said cutter and feeding means without destroying the synchronism comprising a gear secured to said index shaft, an adjustable worm wheel secured to said index worm, a gear loosely mounted thereon, having a worm in one end at right angles thereto and engaging therewith and said gear arranged to mesh with said index shaft gear.

9. In a helical gear cutting machine, the combination with a frame, of a cutter carriage mounted, to reciprocate, thereon, feeding means therefor, a cutter rotatably mounted therein, a work carriage adjustably mounted upon said frame, a work spindle, rotatably mounted therein and connected to an index wheel, a worm therefor, and index shaft, gearing to synchronize the movements of said spindle, cutter and feeding means, comprising a shaft rotating in accordance with said cutter, devices to indicate the original positions of said spindle, cutter and feeding means, comprising a zero mark adjustably mounted upon said cutter carriage to indicate the original position of

said feeding means, an adjustable zero mark arranged upon said shaft to correspond with a stationary mark provided upon the bearing therefor, to indicate the original rotary position of said cutter, corresponding zero marks arranged upon said index wheel and work carriage to indicate the original relative position of said spindle, and means to adjust said index wheel relatively to said cutter and feeding means without destroying the synchronism, comprising a gear secured to said index shaft, an adjustable worm wheel secured to said index worm, a gear loosely mounted thereon, having a worm in one end at right angles thereto, and engaging therewith, and said gear arranged to mesh with said index shaft gear.

WILLIAM F. ZIMMERMANN.

Witnesses:
EDWIN C. THURSTON,
BENJAMIN HITTINGER.