G. BENICKE.

MACHINE FOR GRINDING THE TEETH OF MILLING CUTTERS BY MEANS OF ROTATING GRINDING WHEELS IN PARTICULAR OF THE TEETH OF SPIRAL MILLING CUTTERS.

APPLICATION FILED DEC. 3, 1914.

1,233,543.

Patented July 17, 1917.

3 SHEETS—SHEET 1.

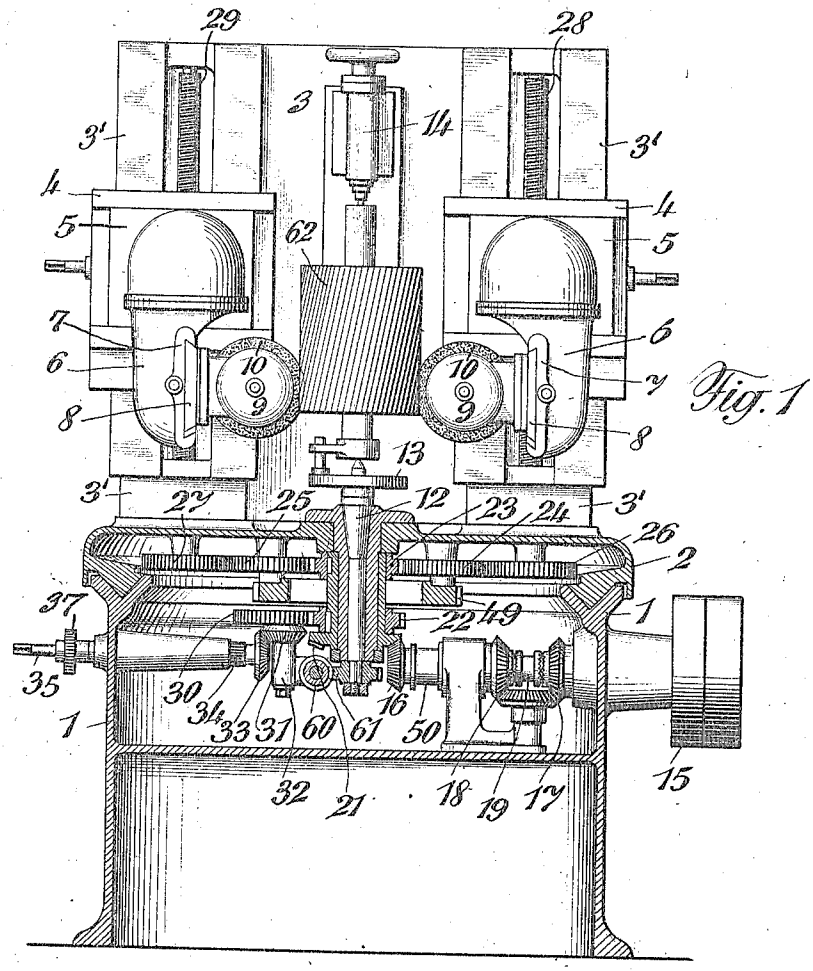


Fig. 1

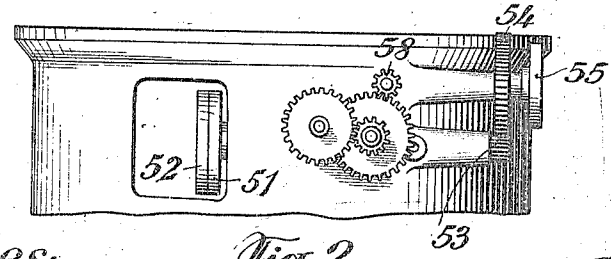


Fig. 2

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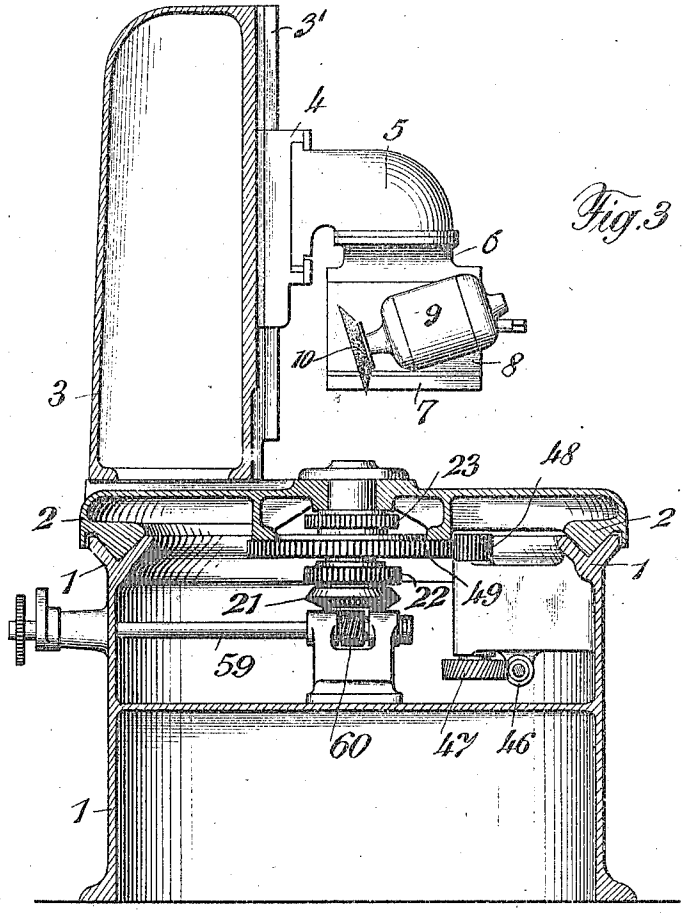


Fig. 3

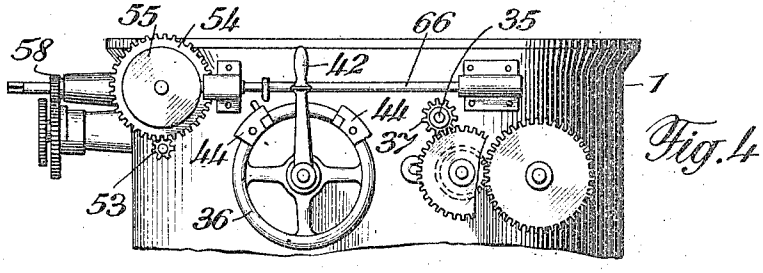


Fig. 4

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3 SHEETS—SHEET 3.

Fig. 5

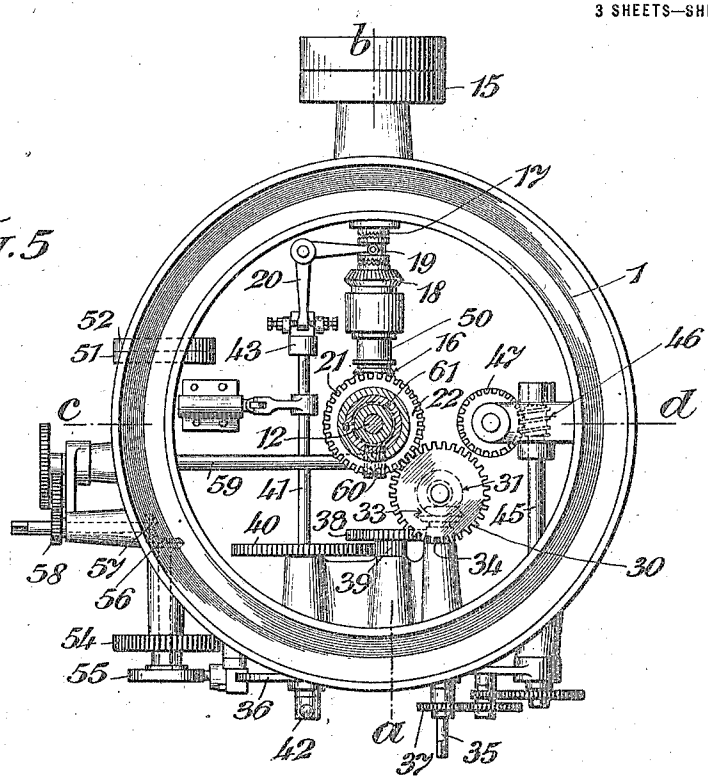
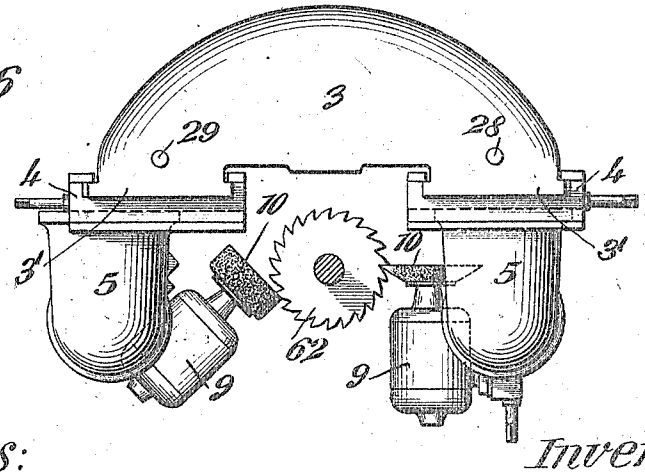


Fig. 6



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Inventor:

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UNITED STATES PATENT OFFICE.

GEORG BENICKE, OF OFFENBACH-ON-THE-MAIN, GERMANY, ASSIGNOR TO THE FIRM OF ERSTE OFFENBACHER SPEZIALFABRIK FÜR SCHMIERGELWARENFABRIKATION MEYER & SCHMIDT, OF OFFENBACH-ON-THE-MAIN, GERMANY.

MACHINE FOR GRINDING THE TEETH OF MILLING-CUTTERS BY MEANS OF ROTATING GRINDING-WHEELS IN PARTICULAR OF THE TEETH OF SPIRAL MILLING-CUTTERS.

1,233,543. Specification of Letters Patent. Patented July 17, 1917.

Application filed December 3, 1914. Serial No. 875,257.

To all whom it may concern:

Be it known that I, GEORG BENICKE, a subject of the Emperor of Germany, residing at Offenbach-on-the-Main, Germany, have invented new and useful improvements in machines for grinding the teeth of milling-cutters by means of rotating grinding-wheels in particular of the teeth of spiral milling-cutters; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

The grinding of milling cutters, especially those having helical teeth, was hitherto done with machines having a differential gear for imparting alternately during the grinding to the work piece a necessary movement for the turning of a single tooth and thereupon a feed motion for the following tooth, without putting the gear out of motion for the first movement. These machines are very expensive due to the differential gear necessary and as they have only had a single grinding support, the grinding requires a considerable long time which makes the grinding very expensive.

With the present invention these disadvantages are avoided. The two movements necessary for the turning of the teeth and for the feed motion of the milling cutter are obtained without a differential gear and in such a manner that the means for producing said movements always remain in gear. By the use of more than one grinding support a higher production is obtained than with machines hitherto known.

In the annexed drawings is shown a form of construction by way of example.

Figure 1 is a vertical section on the line *a—b* of Fig. 5 showing a front view of the grinding supports.

Fig. 2 is a side view of the bed showing the gearing for the feed motion of the work piece.

Fig. 3 is a vertical section on the line *c—d* of Fig. 5 showing a side view of the grinding supports,

Fig. 4 is a front view of the bed showing the gearing for the turning of the work piece,

Fig. 5 is a plan view of the grinding supports.

In an annular groove on the top of the frame 1 is rotatably mounted a base plate 2 carrying a standard 3. Formed on the standard 3 are two vertical, parallel guide ways 3′ on each of which is mounted a vertically movable slide 4, carrying a horizontally movable slide 5. The latter is constructed in the form of a knee having a depending, pivotally connected portion 6 adapted to be rotated in a horizontal plane. This depending portion 6 has a horizontally arranged guide way 7 in which is mounted a slide 8, carrying a motor 9 mounted to swing on a horizontal axis and carrying a grinding disk 10. It will thus be seen that the grinding disks may be adjusted in any inclined position of their axes of rotation and moved laterally of the axis of the work piece 62 in the slides 7; moved toward and from the work piece by the slides 5, and moved longitudinally of said work piece by the slides 4.

The work piece 62 is held by vertical spindles 12 and 14 between dead centers and is driven by the driving plate 13. The upper head stock spindle is adjustable on the standard 3.

Long tools with relative small diameter will by the vertical arrangement not be bent as by the horizontal arrangements; the grinding wheels being arranged opposite each other have the known advantage of compensating the bending stresses.

Work pieces with straight teeth are ground in the usual way by automatically moving the grinding supports up and down and by an automatic feeding of the work piece on to the next tooth at the end positions of the supports if the grinding disks have left the work piece.

If the work piece has spiral wound teeth, of course a turning between the tool and the working piece around its longitudinal axis must take place during the up and down motion of the grinding supports. This is effected by the revolving table 2 with the standard 3 and the up and down moving grinding supports being moved in a circular path around the stationary work

piece according to the pitch of the screw-thread like windings.

The feed motion of the work piece over the distance of one tooth is effected by change wheels at the end of the vertical stroke or path of the supports independent of the turning of the revolving table 2, said change wheels corresponding precisely with the circular pitch.

The workpiece is stationary during the grinding of the screw-thread like windings and is only turned for a single circular pitch during the feed motion on to the next tooth.

The circular movement of the revolving table 2 with the contemporary up and down motion of the grinding supports 4 and 5 is obtained in the following way.

The main driving shaft is driven by a belt pulley 15, on the end of which a bevel gear wheel 16 is keyed. A change gear is provided on the same main shaft, having a coupling box 19 slidable by a crank lever 20, (Fig. 5) on a key between two bevel gear wheels 17 and 18 toward the left or toward the right, thus capable of alternatively being coupled with the wheels 17 or 18 (Fig. 1).

The bevel gear wheel 16 engages with the bevel gear wheel 21 which has a long hub with two spur gear wheels 22 and 23 keyed thereon.

From the spur gear wheel 22 the circular motion of the revolving table 2 for the purpose of grinding the screw thread like windings of milling cutters is derived; the spur gear wheel 23 causes the vertical movement of the grinding supports 4 and 5.

As can be seen from Fig. 1 the wheel 23 drives the spur gear wheels 26 and 27 through the medium of the two idle wheels 24 and 25. These spur gear wheels 26 and 27 are keyed on the vertical screw spindles 28 and 29, respectively causing by their rotation an up or down motion of the compound rests 4 and 5 with the grinding motors 9 according to the engagement of the coupling 19 on the main driving shaft with one of the bevel gear wheels 17 and 18.

Meanwhile the spur gear wheel 22 drives the spur gear wheel 30 keyed on the hub of the bevel gear wheel 31 and loosely mounted on a fixed journal pin within the bearing 32. This bevel gear wheel 31 engages with a bevel gear wheel 33 keyed on a horizontal shaft 35. Furthermore on the shaft 35 are keyed the spur gear wheel 34 for the driving of a self-acting feed that will afterward be described and also the change wheel 37 for the driving of the revolving table (Fig. 5).

As will be seen from the following, the spur gear wheel 34 drives a spur gear wheel 40 by means of a back or countershaft gear 38 and 39 (Fig. 5). At the outside of the frame the controller 36 is keyed on the hollow shaft of the spur gear wheel 40 journaled in the frame 1. In the hollow shaft is loosely mounted the shaft 41 on which the reversing lever 42 (Fig. 4) is keyed on the outside of the frame and the forkshaped lever 43 (Fig. 5) for the swinging of the cranklever 20 is also keyed on the shaft 41 inside of the frame.

Due to the stops 44 (Fig. 4) adjustably fixed to the controlling wheel 36, which is turned by means of the hollow shaft of the wheel 40 the reversing lever 42 on the shaft 41 is swung in a known manner toward the left or toward the right, and with it by means of the forkshaped lever 43 also the cranklever 20, so that the latter alternatively couples the coupling 19 with the wheels 17 and 18, thus driving alternatively the bevel gear wheel 16 clockwise or counterclockwise and effecting the up and down motion. Simultaneously a shaft 45 (Fig. 5) is impelled by the change wheel 37 through the medium of a plurality of change wheels, corresponding to the spiral-like pitch of the work piece. On the shaft 45 is mounted the worm 46 (Fig. 3) being in engagement with the worm wheel 47.

On the shaft of the worm wheel 47, journaled in the frame 1, is mounted the spur gear wheel 48 engaging a larger gear 49 concentrically fixed to the underside of the revolving table 2 and causing a turning to the left or to the right according to the engagement of the coupling 19 with one of the bevel gear wheels 17 or 18.

If no rotation of the revolving table 2 shall take place the wheel 37 (Fig. 5) is taken away, as in the case for work pieces with straight lined or square teeth.

The driving for the feed motion of the teeth is also derived from the main driving shaft in the following way: Next to the bevel gear wheel 18 (Fig. 1) rotating with the main driving shaft on the latter is keyed a belt pulley 50 (Figs. 1 and 5). This pulley 50 drives simultaneously by means of a so-called slipping belt a fixed pulley 51 and a loose pulley 52 next thereto, both carried by a common shaft. A spur gear wheel 53 is keyed on the same shaft (Fig. 2); and a spur gear wheel 54 mounted on a shaft lying above the wheel 53 is in engagement with the latter and is fixed to a dividing plate 55 (Figs. 2 and 4).

Said dividing plate or disk 55 and the spur gear wheel 54 can only rotate, if by the adjustable stop 44 a catching rod 66 (Fig. 4) is brought out of corresponding cavities in the dividing plate, thus leaving the latter free during one revolution. This movement of the rod 66 by the controlling wheel 36 takes place simultaneously with the turning of the lever 42 by the controlling wheel 36, with the reversing of the revolv-

ing table caused thereby and with the vertical motion of the supports 5.

At the other end of the shaft of the dividing disk 55 and of the spur gear wheel 54 is keyed the bevel gear wheel 56 being in engagement with a bevel gear wheel 57. The latter is fixed to one end of a horizontal shaft, the other outer end of which carries a change wheel 58 (Fig. 5) driving another horizontal shaft 59 by the medium of a change gear.

A worm 60 in engagement with a worm wheel 61 on the shaft 12 is fixed to the inner end of the shaft 59, the revolving table 2 forming the bearing of said shaft 12. If now the catching rod 66 is brought out of the dividing disk 55 by the controlling wheel 36, the slipping belt driven by the pulley 50 and guided by the loose pulley 52 will take with the fixed pulley 51 and a single revolution of the dividing disk 55 takes place, whereupon the catching rod 66 again enters into a cavity of the dividing disk by a spiral spring, (not shown).

During this single revolution by the change wheel gear the worm wheel 61 and also the shaft 12 with the driving plate 13 and the work piece is turned over the desired circular pitch, said gear being chosen corresponding to the circular pitch of the work piece.

This operation only takes place if reversed as has already been mentioned, that is if the supports have arrived at the end of their stroke and the grinding disks have left the teeth of the work piece due to their vertical motion.

The motions obtained by the two described drivings to wit 1° the motion of the revolving table 2 with the grinding standards mounted thereon and 2° the up and down motion of the grinding standards enable the grinding of work pieces with screw thread like or helical teeth. A further advantage obtained by the described driving is the almost mutual annulling of the nonavoidable play of the several driving gears of the two driving mechanisms in such a manner, that the grinding disks come uniformly into contact as well during the upward motion as during the downward motion. The total play, that results from the driving means for the driving of the revolving table is composed of the plays of the wheels 22, 30, 31, 33 of the change gear wheels, driven by 37, further of the play of the triple worm 46 within the worm wheel 47 and of the play of the spur gear wheels 48, 49. The play of the driving gear of the vertical up and down motion of the supports is composed of the plays of the wheels 23, 24, 25, 26, 27 of the triple thread spindles 28, 29 with its nuts. Each of these two drivings has a number of toothed wheels and one triple thread spindle, its number of threads and its pitch being entirely equal so that at each reversion the nonavoidable play within the two separate driving gears can almost entirely compensate each other and consequently a uniform grinding can be obtained.

What I wish to claim is:

1. A machine for grinding the teeth of milling cutters having helical teeth, comprising means for vertically supporting the cutter, grinding disks, a support for the latter, driving means for the disks, a table rigidly connected with the support, a movable member, means actuated by the latter to impart to the table and the grinding disks carried by the latter, a revolving movement corresponding to the winding of the cutter-teeth relatively to the cutter, means actuated by said movable member to impart a vertical reciprocating movement to the grinding disks while they are moved around the cutter, means for feeding the latter relatively to the grinding disks to an amount corresponding to the circular pitch of its teeth, and a drive for actuating said member and the feeding means for the cutter, said feeding means being wholly independent of the means effecting a rotation of the table.

2. A machine for grinding the teeth of milling cutters having helical teeth, comprising means for supporting the cutter so that its axis lies in a vertical plane, grinding disks, a support for the latter, driving means for the disks, a table rigidly connected with the support, a sleeve provided with a toothed rim, a driving shaft adapted to rotate the sleeve, two members rigidly connected to said sleeve, means actuated by one of said members for imparting a vertical reciprocating movement to the disks, sets of spur gearings and a worm gearing operatively connected to the second one of said members and adapted to impart to the table and the grinding disks carried by the latter, a revolving movement corresponding to the winding of the cutter-teeth relatively to the stationary cutter, a gearing operatively connected to the means supporting the cutter and adapted to impart to the cutter a feed movement relatively to the grinding disks to an amount corresponding to the circular pitch of its teeth, an operative connection between said gearing and said driving shaft, said connection being wholly independent of the means transmitting the motion of the driving shaft to said sleeve and the means, effecting a revolving movement of the table, means for locking the gearing for feeding the cutter as long as the grinding disks are engaging with the cutter-teeth, and means operatively connected to the means effecting a rotation of the table for throwing out of action said locking means and adapted to change periodically

the direction of rotation of said sleeve arranged concentrically of the cutter.

3. A machine for grinding the teeth of milling cutters having helical teeth, comprising means for supporting the cutter with its axis in a vertical plane, a table, separate grinding means, a drive for each of the grinding means, a support for each of said grinding means, a standard provided with a separate guide-way for each of said supports, the latter being arranged in an eccentric manner relatively to the table and allowing a simultaneous application of the grinding means, means for effecting a feed motion of the cutter, means for turning said table, thus causing a relative movement between the cutter and the grinding means corresponding to the winding of the teeth during the feed movement of the grinding means along the circumference of the cutter while the latter is stationary, a driving member concentric to the axis of the cutter, threaded spindles mounted in said standard and each operatively connected with one of said supports for the grinding means, two sets of toothed gears operated by said member, one of the sets being adapted to rotate said spindles in the standard and the other set being adapted to impart a revolving motion to said table, a worm gear drive for turning the means supporting the cutter to an amount corresponding to the circular pitch of the cutter teeth, said drive being independent of the turning means for said revolving table, a friction drive actuating said worm gear drive, and means for automatically throwing in and out said friction drive.

4. A machine for grinding the teeth of milling cutters having helical teeth, comprising means for supporting the cutter so that its axis lies in a vertical plane, a table, separate grinding means, a drive for each grinding means, horizontally movable slides, each carrying a grinding means together with its drive, each grinding means and its means being adapted to pivot around a horizontal axis, brackets adapted to rotate about a vertical axis, each of said brackets carrying one of said slides, a slide with a horizontal guide-way for each of said brackets, a standard provided with vertical guide-ways for the last mentioned guides, vertically threaded bolts operatively connected to the guides and supported in the standard, the guide-ways for said brackets being arranged in an eccentric manner relatively to the table, means for effecting a feed motion of the cutter, means for turning said table to cause a relative movement between the cutter and the grinding means corresponding to the winding of the teeth during the feed movement of the grinding means along the circumference of the cutter while the latter is stationary, a driving member concentric to the axis of the cutter, two sets of toothed gears operated by said member, one of these sets being adapted to rotate said bolts in the standard and the other set being adapted to impart a revolving motion to said table, a worm gear drive for turning the means supporting the cutter to an amount corresponding to the circular pitch of the cutter teeth, this drive being independent from the turning means of said revolving table, a friction drive actuating said worm gear drive, and means for automatically throwing in and out said friction drive.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

GEORG BENICKE.

Witnesses:
CARL GRUND,
JEAN GRUND.