Nov. 6, 1951 S. J. KOPEC 2,574,112

GRINDING MACHINE ATTACHMENT

Filed May 10, 1948 2 SHEETS—SHEET 1

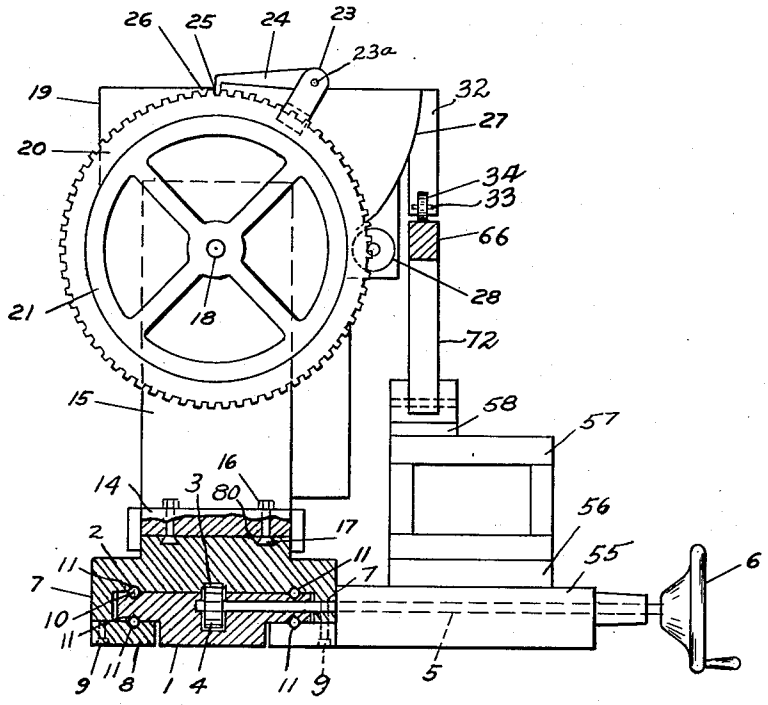


FIG. 1

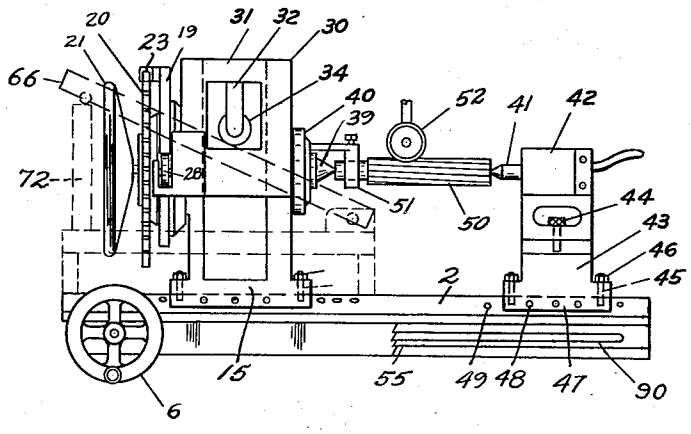


FIG. 2

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GRINDING MACHINE ATTACHMENT

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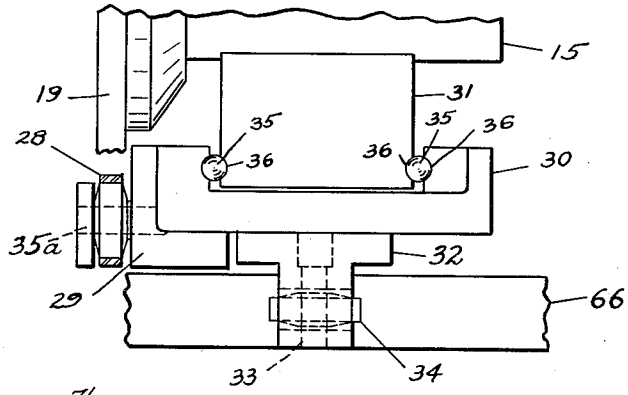


FIG. 3

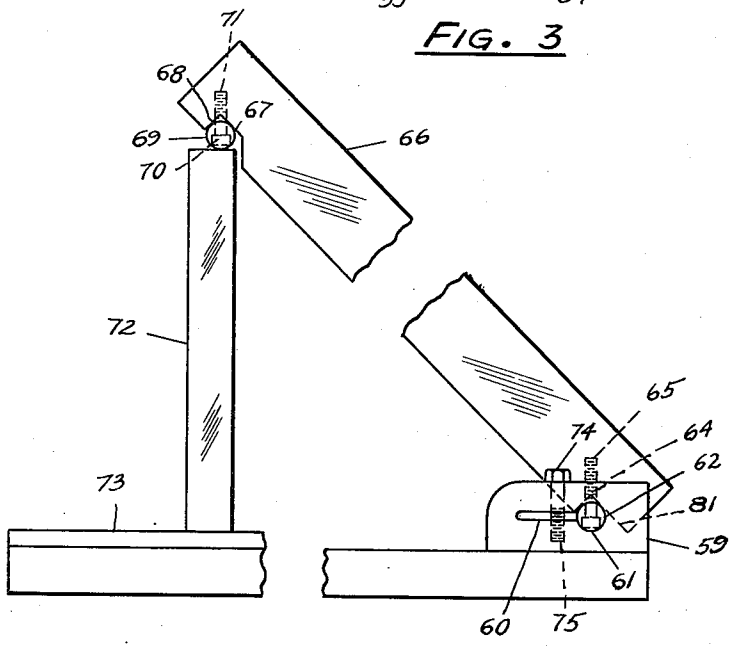


FIG. 5

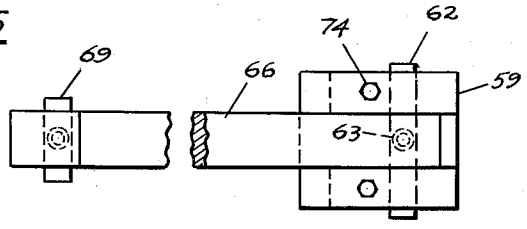


FIG. 4

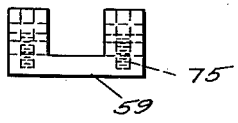


FIG. 6

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GRINDING MACHINE ATTACHMENT

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Application May 10, 1948, Serial No. 26,218

10 Claims. (Cl. 51—232)

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This invention relates generally to grinding machines and more particularly to a novel attachment for a grinding machine for grinding helical teeth. This invention is an improvement of the machine of my co-pending application, Serial No. 758,292, filed July 1, 1947.

It has been the practice to rotate the work piece in a grinding machine while the bed of the machine moves relative to the grinding wheel when grinding a helical tooth. There is no adjustment to provide for variations in the helix generated in the present methods of grinding helical teeth. Conventional methods of grinding helical teeth are permissible for the average job in that a slight variation from a true helix may be permissible without materially effecting the operation of the helical member, but in grinding teeth for a gage for helical grooves in a gun barrel, it has been found that conventional methods without any means of adjustment cannot be used because a true helix is not formed. In the use of conventional methods, the helix or spiral of the teeth varied as much as .0005 of an inch or more. This variation cannot be allowed in a gage. No means has heretofore been provided to grind a helical tooth with a true helix along its entire length within .0001 of an inch of error in the helix or spiral. Irregularities and wear in gears, worms and like transfer members in prior machines has invariably produced irregular and inaccurate helical or spiral teeth. Minute slidable engagement of gear teeth in prior attachments vary the width of the helical teeth and a true helix cannot be formed.

It is, accordingly, an object of my invention to overcome the above and other defects in attachments for grinding helical teeth and it is more particularly an object of my invention to provide an attachment for a grinding machine for grinding helical teeth which is simple in construction, economical in cost, easy to set up and operate and economical and efficient in manufacture.

Another object of my invention is to provide a novel attachment for grinding helical teeth which may be set up upon predetermined calculations to form a true helical tooth.

Another object of my invention is to provide a novel attachment for a grinding machine for grinding helical teeth which may be adjusted to grind a true helical tooth to an accuracy of .0001 of an inch or less as may be required by the job over the entire length thereof.

Another object of my invention is to provide a novel attachment for a grinding machine for

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grinding helical teeth wherein a cam member of predetermined contour is provided to provide for the rotation of the work member in cooperation with an adjustable guiding member.

Another object of my invention is to provide a novel attachment for grinding helical teeth wherein all members are in rolling engagement.

Another object of my invention is to provide a novel attachment for grinding helical teeth which may be used for determining the true helix of a tooth.

Other objects of my invention will become evident from the following detailed description, taken in conjunction with the accompanying drawings, in which

Fig. 1 is an end elevational view with parts thereof broken away, of my novel attachment for disposal on the table of a grinding machine;

Fig. 2 is a side elevational view of my novel attachment on the bed of a grinding machine with the extension table being broken away intermediate thereof for better illustration;

Fig. 3 is a fragmentary top plan view of the slide and cam roller movable therewith on my novel attachment;

Fig. 4 is a plan view of the novel guide bar on my novel attachment;

Fig. 5 is a side elevational view of the guide bar shown in Fig. 4; and

Fig. 6 is an end elevational view of the saddle for mounting the guide bar shown in Figs. 4 and 5.

Referring now to the drawings, Figs. 1, 2 and 3 show a base 1 with a movable table 2 mounted thereon having a depending rack 3 for engagement with a gear 4 fixedly mounted on a transverse shaft 5 journalled in the base 1. A hand wheel 6 is disposed on the shaft 5 to move the table 2 longitudinally. The table 2 has opposed, depending flanges 7 to which members 8 are attached by screw bolts 9. The depending flange 7 through which the shaft 5 extends has a longitudinally extending slot 90 which permits the movable table 2 to move relative to the shaft 5. Balls 10 are disposed in complementary V-shaped grooves 11 formed in the under side of the table 2 and the upper side of the members 8 for easy and accurate movement of table 2 and to get away from sliding, frictional engagement of any parts. Outwardly, oppositely flanged, apertured portions 14 of a head stock 15 are secured to the base of the table 2 by bolt and nut assemblies 16, the base portions 17 thereof being dove-tailed to slidably move in and engage the longitudinally extending dovetailed grooves 80 formed in the face of the table 2. A shaft 18 is journalled in

the head stock 15 in conventional manner and it has rotatably mounted thereon a cam member 19. The shaft 18 has secured to it an indexing wheel 20 and a hand wheel 21 for rotating the shaft 18 and indexing wheel 20. The cam member 19 is free to rotate on the shaft 18 on a single ball bearing race which eliminates radial and axial play. The cam member 19 has a bracket 23 mounted thereon with a laterally extending shaft 23a for mounting an indexing latch 24 having a depending finger 25 for engaging the spaced notches 26 in the periphery of the indexing wheel 20. A constant rise cam surface 27 is formed on one side of the cam member 19 engageable with a cam wheel 28 mounted on a shaft 35a journalled in a laterally extending bracket 29 secured to the channel shaped slidable member 30. The slidable member 30 also has an outwardly extending apertured bracket 32 carrying a shaft 33 mounting a guiding wheel 34. The slidable member 30 slides relative to member 31 on head stock 15. The members 30 and 31 have complementary arcuate shaped grooves 36 to receive balls 35. As shown in Fig. 3, member 31 is stationary and it is attached in a vertical position to the head stock 15 by spot welding or any other suitable means. The slidable member 30 reciprocates vertically relative to the member 31, the balls 35 engaging the grooves 36 being provided to decrease the frictional resistance and to accurately guide the member 30 on the support member 31. The wheel 28 carried by the bracket 29 attached to the vertically movable member 30, engages the cam surface 27 on the cam member 19 and causes the cam 19 and the shaft 18 upon which it is mounted to rotate upon vertical movement of the member 30 caused by the movement of the guide wheel 34 on the angularly extending guide member 66. The guide wheel 34 mounted in the bracket 32 attached to the movable member 30, causes the member 30 to move vertically on the member 31 when it is moved longitudinally in engagement with an angularly extending guide bar 66 hereinafter more fully described. The vertical movement of the member 30 causes the wheel 28 to rotate the cam 19 and the shaft 18 upon which it is supported.

The shaft 18 carries a center 39 and a face plate 40, the center 39 being in axial alignment with a tail center 41 mounted in a tail stock 42. Tail stock 42 is mounted on a base member 43 by suitable screw bolts 44. The base member 43 has outwardly extending apertured flange portions 45 for receiving bolt and nut assemblies 46, the bototm portion of the nut and bolt assemblies 46 having a dovetailed portion for engagement with the dovetailed grooves 80 formed in the face of the table 2 as has heretofore been described in securing the head stock 15. The base member 43 has depending flange portions 47 with apertures 48 for engagement with threaded apertures 49 formed in the side of the table 2.

A work piece 50 is normally held between the centers 39 and 41 and is held against rotation by a dog 51 engaging the face plate 40. An adjustable grinding wheel 52 of conventional structure is utilized for grinding the helical teeth of the work piece 50.

I show an outwardly extending table 55 on my machine on which is mounted in juxtaposed position a base plate 56, a rectangular shaped support member 57, a base plate 58 and a U-shaped supporting saddle 59. The saddle 59 is split longitudinally at 60 and it has transverse apertures 61 for journalling a shaft 62 as is shown in Figs. 4 and 5. The shaft 62 has a transverse aperture 63 intermediate thereof through which extends a screw bolt 64 for threadable engagement with a threaded portion 65 in a guide bar 66. The guide bar 66 has an L-shaped groove 81 cut out of the bottom end side thereof and the shaft 62 is secured transversely in one corner thereof. The opposite end of the bar 66 has a transverse groove 67 with a right angle portion 68 for receiving a transverse shaft 69 as shown in Fig. 5. The transverse shaft 69 is engaged with the right angle portion 68 of the cross groove 67 by a threaded screw bolt 70 in threadable engagement with a threaded aperture 71 in the guide bar 66. A sine bar 72 seated on a plate 73 is shown in engagement with the cross shaft 69. Screw bolts 74 engage threaded apertures 75 in the saddle 59 to secure the guide bar 66 in any predetermined position. The longitudinally split portion 60 permits some movement or distortion of the top portion of the saddle 59 but the bottom of the apertures 61 in the lower portion of the saddle 59 do not move upon the angular movement of the guide bar 66.

In operation, a sample gage or the like with helical teeth is disposed between the centers 39 and 41 and a conventional grinding wheel 52 with the desired contour is set up in a conventional manner at the desired angle required. A given sine bar 72 is then selected for the angle of the guide bar 66 desired and it is disposed under the shaft 69 as shown in Fig. 5.

By a simple trigonometrical formula, the angle of the guide bar 66 can be determined for any lead desired. As an illustration, the rise of the cam surface 27 may be set at 28.8 inches in 360 degrees of movement or 7.2 inches in 90 degrees of movement of the cam members 19. The distance between the centers of the shafts 62 and 69 may be given as 20 inches. The formula, therefore, for any lead desired on the work piece 50 is

$$\text{Height of sine bar} = 20 \times \sin\left[\arctan\left(\frac{28.8}{\text{lead}}\right)\right]$$

The movement of the guide wheel 34 on the guide bar 66 upon longitudinal movement of the table 2 causes the sliding member 30 to move vertically. When the cam roller 28 moves downwardly, the cam surface 27 of the cam member 19 will follow the cam roller 28 to cause the work piece 50 to rotate a predetermined amount upon a predetermined longitudinal movement of the table 2. The table 2 is moved longitudinally by the hand wheel 6 which rotates the gear 4 in engagement with rack 3 on the table 2. The movement of the cam member 19 causes rotational movement of the index wheel 20 through the latch member 24 thereby causing rotation of the shaft 18 and the work piece 50 held in the centers 39 and 41 and held against rotation by the dog 51. The index wheel 20 is then rotated by means of hand wheel 21 to index the work piece 50 so that the work piece 50 will be moved or rotated a distance equal to the distance between its teeth when the index wheel 20 moves from one notch 26 to the adjacent notch 26. When all adjustments are made, the machine is ready for production operation within extremely close tolerances.

My machine is particularly easy to set up and it has a minimum number of parts. It greatly simplifies the problem of grinding helical teeth. The backlash in my machine is practically negligible. All contact between the members is roll-

ing contact thereby making for ease of operation and accuracy of the entire machine in that there are no sliding parts and no sliding spur gear teeth to cause inaccuracies in the finished teeth of the work piece 50. The transverse spaced shafts on the guide bar 66 provides for accuracy in vertical measurements and the split saddle member permits distortion of the saddle member 59 upon angular movement of the guide bar 66 without changing the vertical height of any portion of the guide bar 66 and transverse shaft 62 engaging the apertures 61 in the saddle member 59.

The line from the numeral 52 leads to a symbolical character which indicates a conventional grinding wheel or a conventional checking device, both well known in the art, for use in checking helical gear teeth.

Various changes may be made in the specific embodiment of my invention without departing from the spirit thereof or from the scope of the appended claims.

What I claim is:

1. A machine for grinding and inspecting helical teeth comprising a table, a rotatable work holding means on said table, means for moving said table longitudinally, a support on said table for said work holding means, an off-center cam member movable longitudinally with said work holding means and supported thereby, an indexing wheel fixed for rotation with said work holding means, selective connecting means between said cam member and said indexing wheel, said cam member being rotatable with said work holding means when connected to said indexing wheel, a vertically reciprocable member on the side of said support, a laterally extending cam roller carried on said vertically reciprocable member engaging said cam member, an outwardly extending roller carried on said vertically reciprocable member, and a stationary, adjustable, flat surfaced guiding member angularly disposed in a vertical plane which is parallel to the path of movement of said work holding means engaged by said outwardly extending roller whereby said vertically reciprocable member is moved vertically upon longitudinal movement of said work holding means and the cam surface of said cam member moves over said laterally extending cam roller movable with said vertically reciprocable member to rotate said cam member and said work holding means.

2. A machine for grinding and inspecting helical teeth as set forth in claim 1 wherein said guiding member has means associated therewith for adjusting it angularly in a vertical plane parallel to the path of movement of said work holding means.

3. An attachment for a machine for grinding and inspecting helical teeth comprising a longitudinally movable, rotatable shaft, means for supporting said shaft, means for moving said shaft longitudinally, work holding means movable with said shaft, an off-center cam member mounted for rotation on said shaft and extending transversely laterally outwardly therefrom, an index wheel fixedly mounted on said shaft, means for selectively connecting said index wheel and said cam member whereby they rotate together, a cam roller engaging said cam member, a vertically movable slidable member carrying said cam roller movable longitudinally with said support for said shaft, and adjustable means for moving said cam roller and said vertically movable member vertically to rotate said cam member and said shaft upon longitudinal movement thereof.

4. An attachment for a machine for grinding and inspecting helical teeth as set forth in claim 3 wherein said adjustable means for moving said cam roller and vertically movable member vertically comprises a laterally extending roller on said vertically movable member and an adjustable guide member engaging said roller angularly disposed in a vertical plane which is parallel to the path of said work holding means whereby said movable member and cam roller move vertically a predetermined amount in proportion to the longitudinal movement of said rotatable shaft and work holding means.

5. A grinding machine for grinding helical teeth comprising a shaft, a support for said shaft, means for moving said support longitudinally, a cam member mounted for rotation on said shaft, an index wheel fixedly mounted on said shaft, means for selectively connecting said cam member and index wheel whereby each rotates with the other, work holding means rotatable with said shaft, a vertically movable slide member longitudinally movable with said support, a cam roller movable with said slide member and engaging said cam member whereby said cam member, shaft, and work holding means are rotated upon vertical movement of said slide member, an outwardly extending roller on said slide member, an adjustable stationary guide member engaged by said last mentioned roller angularly disposed in a vertical plane which is parallel to the path of said work holding means, said outwardly extending roller and guide member being adapted to move said slide member vertically upon longitudinal movement of said slide member and shaft support, and a grinding element for grinding helical teeth.

6. A grinding machine as set forth in claim 5 wherein said guide member may be adjusted angularly with respect to a plane parallel to the path of movement of said work holding means.

7. A machine for rotating a workpiece a predetermined amount upon longitudinal movement thereof comprising a longitudinally movable, rotatable work holding means, means for moving said work holding means longitudinally, means for supporting said work holding means, a cam member, selective connecting means between said cam member and said work holding means whereby they rotate in unison, a vertically movable member longitudinally movable with said work holding means, a laterally extending cam roller on said vertically movable member engaging said cam member for rotating same upon vertical movement thereof, an outwardly extending roller on said vertically movable member, an angularly adjustable guide bar for engaging said outwardly extending roller angularly disposed in a vertical plane which is parallel to the path of movement of said work holding means, and means for supporting said guide bar.

8. A machine as set forth in claim 7 wherein said guide bar has spaced transverse cylindrical shafts attached thereto, one of said shafts being journalled in transverse apertures of a saddle.

9. A machine as set forth in claim 8 wherein said saddle is slit horizontally from the transverse apertures therein intermediate thereof whereby the upper part thereof may be distorted without changing any portion of the lower part thereof.

10. A machine for grinding and inspecting helical teeth comprising a longitudinally movable, rotatable work holding means, means for sup-

porting said work holding means, means for moving said work holding means longitudinally, an index wheel for indexing said work holding means, a cam member supported by and extending outwardly from said rotatable work holding means, means for selectively connecting together said index wheel and said cam member, a vertically movable member longitudinally movable with said work holding means, a cam roller on said vertically movable member for engaging said cam member to rotate said work holding means upon longitudinal movement thereof, a second cam roller on said vertically movable member, and a flat surfaced guiding member disposed laterally of and angularly disposed in a vertical plane which is parallel to the path of movement of said work holding means and engaged by said second cam roller on said vertically movable member for moving said first mentioned cam roller vertically upon longitudinal movement of said work holding means whereby

said cam member moves over said first mentioned cam roller to rotate said work holding means a predetermined amount in proportion to the longitudinal movement of said work holding means.

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