Feb. 18, 1958 S. S. BOARD, JR 2,823,494

GEAR TOOTH GRINDING HAVING RADIALLY DIRECTED BELT

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Fig. 1.

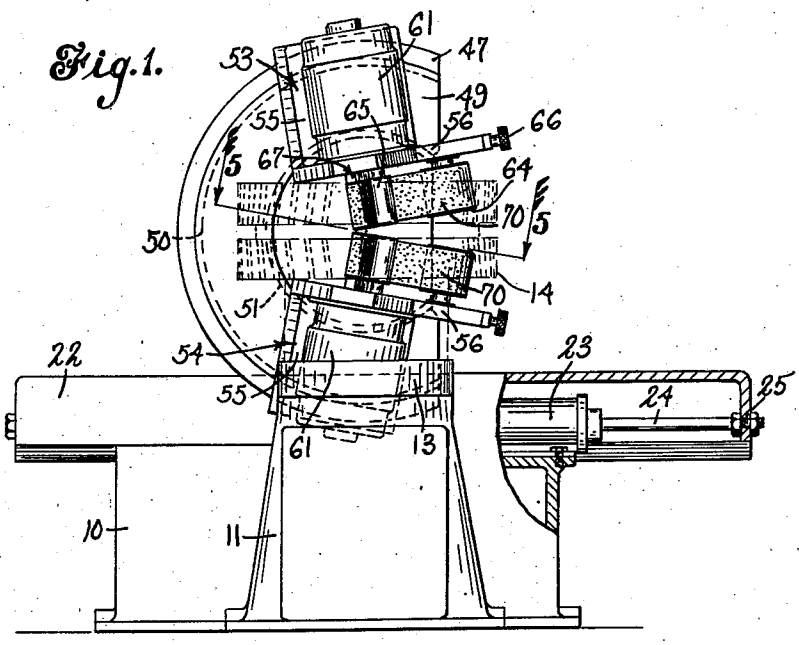
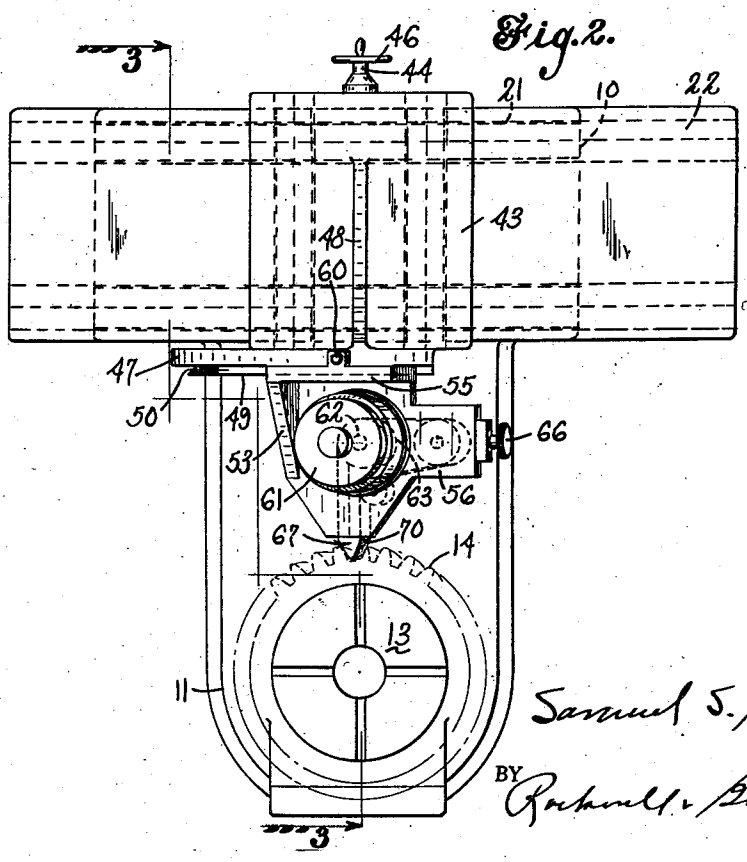


Fig. 2.



INVENTOR

Samuel S. Board Jr.

BY Rockwell & Barnhorn

ATTORNEYS

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Fig.3.

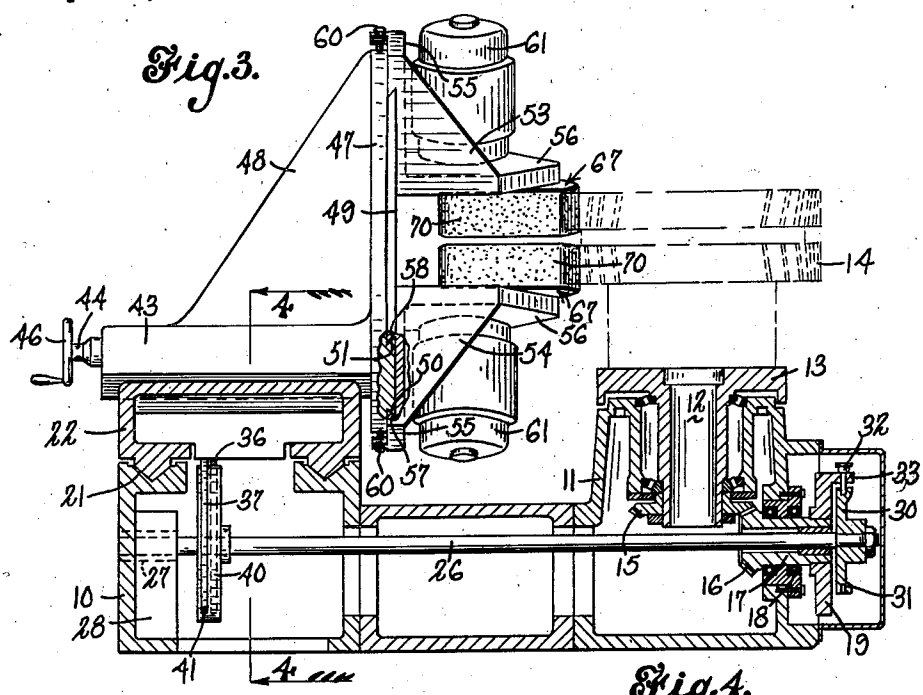


Fig.4.

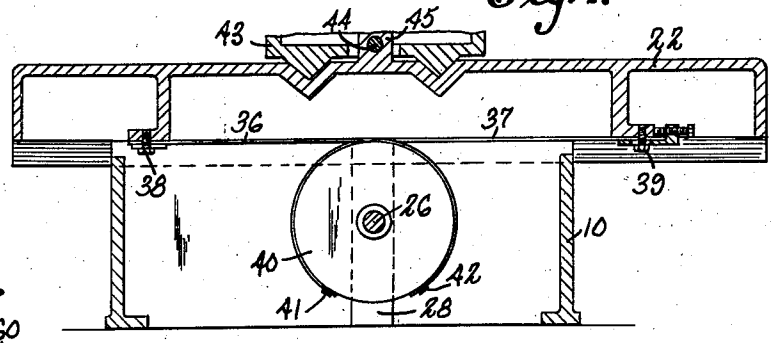
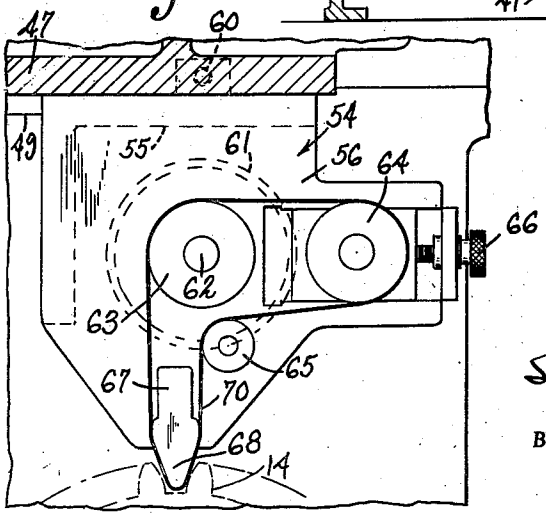


Fig.5.



INVENTOR

Samuel S. Board Jr.

BY Rockwell & Batchelder

ATTORNEYS

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GEAR TOOTH GRINDER HAVING RADIALLY DIRECTED BELT

Samuel S. Board, Jr., Snyder, N. Y., assignor to Farrel-Birmingham Company, Incorporated, Ansonia, Conn., a corporation of Connecticut

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9 Claims. (Cl. 51—142)

This invention relates to the grinding of gears and more particularly to a device for grinding or finishing the teeth of a gear blank by means of a traveling abrasive belt or other member traveling in a rectilinear path either covered with abrasive or having abrasive, cutting or grinding members secured thereto.

In the past gear-grinding machines have generally employed rotary gearing wheels, which wheels rotate on their own axis and are adapted to engage the tooth of the gear to be ground. With machines of this character the grinding process is a relatively slow one as the grinding wheel can only engage a local area on the tooth of the gear to be ground, and it is, therefore, necessary for the machine to operate through a combination of a rolling action to cover the curved portion of the tooth together with a motion parallel to the length (width of the gear) of the tooth to cover the whole face of the tooth.

In the gear-grinding machine of the present invention a rectilinearly traveling belt is employed, the operative portion of which travels in the direction of its length toward and from the axis of the gear, the operative portion of the belt being so guided that it enters into the space between the teeth so that it will grind over all or a large portion of the length of the face of the tooth at one time, and it is, therefore, only necessary to roll the gear relatively to the traveling belt to grind the entire face of the tooth.

This rolling action is obtained in the present case by a combination of a reciprocating movement imparted to the supporting mechanism for the traveling belt so that the belt is moved bodily in a reciprocating path during its traveling motion and a rotary movement of the gear blank. Moreover, as illustrated the rotary movement of the gear blank is effected from the same source of power as the reciprocating movement of the belt support so that the two motions are synchronized in order to effect per-face coverage of the gear tooth by the grinding element.

It is also contemplated to provide means for permitting the indexing of the gear blank so that one tooth after another may be presented to the grinding element, in this case a belt. It will be understood that the feature of actuating the grinding device so that it travels in a rectilinear path, the belt being of a width to contact the entire length of the tooth face, is an important one in effecting a saving of time in the operation of finishing gears and also in effecting a simpler and less complex mechanism than has been used heretofore as it eliminates the movement of a grinding device parallel to the axis of the gear blank when such device, as in the case of a grinding wheel, does not operate over the entire length of the face of the gear tooth, but only engages local areas thereof. As illustrated, the belt is moved in a rectilinear path toward and from the axis of the gear so that it moves in and out of the space between the teeth.

One object of the present invention is to provide a new and improved gear grinding mechanism.

A still further object of the invention is to provide a gear-grinding machine of simpler construction than those

previously employed and one which will be capable of performing its work more rapidly than prior devices of this character and which may be employed with any type of gears such as spur gears, helical gears or the like.

Still another object of the invention is the provision of a gear-grinding machine in which the grinding element is actuated over the face of the gear tooth in a rectilinear path substantially transverse to, or toward and from, the axis of the gear blank, the grinding element preferably being of a width to contact the entire length of the face of the gear tooth.

A still further object of the invention is to provide a gear-grinding machine of the character described wherein the grinding is performed by an endless traveling belt moving in and out of the space between two adjacent gear teeth and held firmly against the face of the tooth so as to perform its work effectively.

Still another object of the invention is to provide a gear-grinding machine of the character described in which the supporting mechanism for the grinding belt will be caused to reciprocate in timed relation with an oscillating movement of the gear blank about its axis so that the entire curved surface of the gear tooth will be covered during the grinding operation.

To these and other ends the invention consists in the novel features and combinations of parts to be hereinafter described and claimed:

In the accompanying drawings:

Fig. 1 is a front elevational view of a gear-grinding machine embodying my invention;

Fig. 2 is a plan view thereof;

Fig. 3 is a vertical sectional view on line 3—3 of Fig. 2, some parts being shown in elevation;

Fig. 4 is a sectional view on line 4—4 of Fig. 3; and

Fig. 5 is a horizontal sectional view on line 5—5 of Fig. 1.

To illustrate one embodiment of the invention, I have shown in Fig. 1 of the drawings a gear-grinding mechanism comprising base or frame portions **10** and **11**, the portion **10**, as will be hereinafter described, serving as a support for the grinding mechanism, and the portion **11** serving as a support for the gear blank. A hollow shaft **12** is rotatably mounted by suitable bearings within the supporting base portion **11**, this shaft carrying at its upper end a table or support **13** upon which the gear blank **14** is secured, as shown in dotted lines in Fig. 2.

Secured to the lower end of the shaft **12** is a bevel gear **15**, which gear meshes with a bevel gear **16** carried by a sleeve **17**. This sleeve is rotatably mounted by suitable bearings **18** in the support **11**, and secured to a projecting end of the sleeve is an indexing wheel **19**.

The base **10** for the grinding mechanism is provided with parallel ways **21** upon which is mounted a reciprocating carriage **22**. The reciprocation of the carriage may be effected hydraulically by means of a cylinder **23** carried by the support **10** and a piston rod **24** secured at **25** to the end of the carriage **22**. It will, of course, be understood that suitable connections (not shown) are provided for introducing fluid presure into the cylinder to effect reciprocation of the carriage over a path of the length desired depending on the dimensions of the tooth to be ground. The carriage may, of course, be reciprocated by means other than that shown without departing from the present invention.

As shown more especially in Figs. 3 and 4, a shaft **26** is rotatably mounted at one end in bearings **27** carried by a standard **28** which may be a part of the base **10**, and the other end of this shaft is supported within the sleeve **17** previously described. The shaft **26** projects outwardly from the sleeve **17**, and upon its outer end is secured a disk **30** having recesses **31** in its periphery,

this disk cooperating with the indexing wheel 19 previously described.

A pin 32 is movably carried by a flange 33 of the indexing wheel 19, the inner end of the pin being received in one of the recesses 31 so as to connect the disk 30 with the indexing wheel 19. It will be understood that when it is desired to index the work table 13 so as to present a subsequent tooth to the grinding mechanism, the pin 32 may be withdrawn from the recess 31 and the indexing wheel 19 rotated with respect to the disk 30.

It will be understood that the particular indexing means shown is merely illustrative and that other suitable indexing means, either manual or automatic, may be provided if desired. With the pin 32 engaged with the disk 30, it will be apparent that the work table 13 will be actuated by the shaft 26 so that when this shaft is oscillated through the reciprocation of the carriage, as will be hereinafter explained, the table 13 is also oscillated to move the gear blank or the gear tooth which is engaged with the grinding mechanism in an arcuate path which is coordinated with the reciprocation of the carriage.

The oscillation of the shaft 26 from the reciprocation of the carriage 22 is effected by means of flexible straps 36 and 37, one end of each of these straps being secured to the carriage as shown at 38 and 39 and the other ends being wrapped around a driving disk 40 and secured to the periphery thereof, as shown at 41 and 42. The disk 40 is secured to the shaft 26, and with this construction it will be apparent that as the carriage is reciprocated the disk 40 and shaft 26 will be oscillated thereby effecting oscillation of the work table 13 and the gear blank 14 carried thereon.

A tool support 43 is mounted upon the carriage 22 for movement transversely thereof so that the abrasive belt to be hereinafter described may be fed into the work. To this end an adjusting screw 44 may be mounted in the tool support 43 this screw being threadedly engaged in a nut 45 (Fig. 4) secured to the upper surface of the carriage. The screw carries a hand wheel 46 by which it may be manipulated so that it may be adjusted transversely of the carriage toward and from the work-supporting table 13.

The tool support 43 comprises a face member 47 of arcuate shape, as shown more especially in Fig. 1, this member being braced in an upright position by the strut 48.

The member 47 is provided upon its face with a projecting rib 49 and dove-tailed slots 50 and 51 are provided at each edge of this rib between it and the face of the member 47.

Secured to the member 47 are tool carriers 53 and 54 which, as will be hereinafter described, serve to support the grinding belts and also operating the driving means for these belts. Since these two mechanisms are identical, the description of one will suffice for both.

As shown more especially in Figs. 1, 2 and 3, each of these supporting members comprises a back plate 55 and a tool base 56. The back plate is provided with dove-tailed grooves 57 and 58 (Fig. 3) which are complemental to the grooves 50 and 51 upon the member 47 so that the tool carriers 53 and 54 may be adjusted in an arcuate path relatively to the member 47, thus adjusting the angle at which the grinding belt is disposed, as will be hereinafter explained, in order to grind gears having teeth of different helical angles. Any suitable means such as securing members 60 may be provided to hold the tool carriers 53 and 54 in their adjusted positions.

At one face of the base 56 is mounted the motor 61, this motor having a shaft 62 which extends through the base and carries on its extended end a drive pulley 36. Also rotatably mounted upon the base 56 on the same side as the pulley 63 are guide pulleys 64 and 65, and an adjusting screw 66 may be provided for the pulley 64 in order to adjust the tension of the belt. Also supported upon the same side of the tool base 56 is a backing member 67 having a tapered nose portion 68 adapted to project from the base 56 and extend between the teeth of a gear to be ground, as shown in Figs. 2 and 5.

An endless belt 70 is trained around the pulleys 63, 64 and 65 and the backing member 68. As illustrated in Fig. 5, the disposition of these parts is such that the belt travels over a path of substantially L-shaped form and the reach of the belt adjacent the backing member 68 is so directed that the belt will enter into the space between two adjacent teeth and move in a direction substantially radially of the gear blank shown in dotted lines at 14.

It will be understood that in the grinding of double helical gears, two grinding mechanisms may be provided, as shown in the drawings, each of these being adapted to cooperate with one half of the gear blank. Moreover, in the grinding of spur gears or helical gears, either single or double, the tool carriers 53 and 54 may be adjusted angularly or in an arcuate path with respect to the member 47 to change the angle of the plane of the belt with respect to the axis of the gear so as to adjust the belt for the tooth angle of the gear.

In the operation of the device the carriage may be drawn to one end of its stroke so that the backing member 68 will clear the gear blank so that the latter may be properly brought into position to be ground. By operation of the hand wheel the tool support 43 may be moved forwardly to set the belt in the proper position for the diameter of the blank and the tool carrier may be set at the proper angle demanded by the helical angle of the tooth of the gear.

The machine may then be started and, as the carriage reciprocates to move the belt bodily back and forth while at the same time it is actuated in the direction of its length by the motor 61 and pulley 63, the gear blank will be oscillated by means of the straps 36 and 37, shaft 26 and bevel gears 15 and 16.

It will be understood that the width of the belt is preferably as great as the length (width of gear) of the tooth to be ground, and this combined reciprocated motion of the carrier 53 or 54 and the oscillating movement of the blank 14 will result in the entire curved surface of the tooth being ground during this operation. The reciprocation of the table may be continued as is necessary to finish the grinding operation.

After one tooth has been ground, the carriage may be moved to a position at the end of its stroke, the pin 32 removed from the disk 30, thereby enabling the operator to rotate the indexing wheel 19 and bring a following tooth into position to be ground. This indexing may, if desired, be performed automatcally. It will be understood that the invention may be employed in grinding beveled gears and helical gears as well as spur gears, and the angular position of the abrasive belt may be changed for this purpose so that the surface of the belt will lie substantially parallel to the face of the tooth regardless of its angle.

It will be understood that the particular shape and size of the backing member may be varied to accommodate gears of different character such as gears having different diametral pitch or modified in other ways. This may be readily effected by providing interchangeable backing members so that the proper one may be employed dependng upon the characteristics of the gear blank being ground.

While I have shown and described a preferred embodiment of my invention, it will be understood that it is not to be limited to all of the details shown, but is capable of modification and variation within the spirit of the invention and within the scope of the claims.

What I claim is:

1. The method of grinding a gear blank which com-

prises moving an endless abrasive belt in the direction of its length along a rectilinear path toward and from the axis of the blank and into and out of the space between adjacent teeth on a gear blank, pressing the belt against a face of one of said teeth, reciprocating the belt in a direction transverse to the direction of said movement, and oscillating the gear blank in synchronism with the reciprocaton of the belt to cause the belt to make contact over the curved face of the tooth.

2. The method of grinding gears which comprises moving a flexible belt having abrasive elements thereon in the direction of its length over the face of a tooth on a gear blank in a path toward and from the axis of the blank to cause the belt to travel in and out of the space between adjacent teeth on the blank, and simultaneously rotating the gear on its axis and moving the belt in a direction transverse to the direction of its travel to maintain its engagement with the moving gear tooth, pressing the belt against the face of the moving gear tooth, and then indexing the blank with respect to the belt to engage the latter with another tooth thereof.

3. A gear-grinding apparatus comprising a support for carrying a gear blank, means rotatably mounting said support, a belt having abrasive elements thereon, means for supporting and guiding said belt for movement against the face of a gear tooth on said blank in a rectilinear path substantially transverse to the axis of the blank to cause said belt to move in and out of the space between two adjacent teeth, means on said belt support for moving said belt in the direction of its length relatively to its support, means for rotating the blank, means for moving the belt support in a direction to cause the belt to follow the face of the tooth during movement of the blank, and a backing member projecting outwardly from the supporting means and having a terminal nose portion extending into the space between two adjacent teeth on the blank, the belt being trained over the nose portion of said backing member so as to move substantially directly toward and from the axis of the blank.

4. A gear-grinding apparatus comprising a support for carrying a gear blank, means rotatably mounting said table, a belt having abrasive elements thereon, means for supporting said belt for movement against the face of a gear tooth on said blank in a rectilinear path in the direction of its length substantially transverse to the axis of the blank to cause said belt to move in and out of the space between two adjacent teeth, said supporting means including a backing member having a nose portion projecting into said space about which member the belt is turned, means on said belt supporting means for moving said belt in said path, means for rotating the blank, means for moving the belt supporting means in a direction to cause the belt to follow the face of the tooth during movement of the blank, and means to index the gear blank with respect to the belt to effect engagement of the latter with a succeeding tooth on the blank.

5. A gear-grinding machine comprising a table for supporting a gear blank, means rotatably mounting said table, a belt having abrasive elements thereon, means for supporting said belt for movement against the face of a gear tooth on said blank in a rectilinear path, and in a direction substantially radially of the blank, means on said support for moving said belt in said path, means for moving the support in a rectilinear path to move the belt bodily in a direction substantially tangent to the blank, and means connecting said rotatable mounting means for the gear blank to the support to effect rotation of the blank when the support is moved, said belt-supporting means including a backing member projecting from the supporting means in a direction radially of the blank and having a nose portion projecting into the space between adjacent teeth on the blank about which said belt is turned to reverse its direction and move in and out of the space between two adjacent teeth on the blank.

6. A gear-grinding machine as in claim 5 wherein said belt-supporting means is mounted upon a reciprocating carriage for movement transversely of the carriage toward and from the gear blank.

7. A gear-grinding apparatus as in claim 5 wherein means are provided for adjusting said belt support to vary the angle of the plane of the belt with respect to the axis of the gear blank.

8. A gear-grinding apparatus as in claim 5 wherein the belt-supporting means is adjustably mounted on a reciprocating carriage, and means are provided for adjusting said belt-supporting means to vary the angle of the plane of the belt relatively to the axis of the gear blank.

9. A gear-grinding apparatus comprising a table for supporting a gear blank, means rotatably mounting said table, a traveling belt having abrasive elements thereon, a belt-supporting member, means thereon for supporting the belt for movement against the face of a gear tooth on said blank in a rectilinear path substantially transverse to the axis of the blank, said means including a backing member having a nose portion projecting from the supporting member into the space between two adjacent teeth on the blank, said belt being trained about the nose of said backing member to be reversed in direction within said space, means on said support member for moving said belt along said path, and means for reciprocating said support and oscillating said blank in synchronism to effect travel of the belt over the curve of the tooth on the blank.

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