United States Patent [19]

Batorski

[11] **3,782,041**

[45] **Jan. 1, 1974**

[54] **GEAR FINISHING APPARATUS**

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[73] Assignee: **Textron, Inc.,** Providence, R.I.

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[21] Appl. No.: **232,445**

[52] **U.S. Cl.** ..... **51/33 W,** 51/42, 51/52 R, 51/287

[51] **Int. Cl.** **B24b 17/00,** B24b 19/00

[58] **Field of Search** ..... 51/42, 33 R, 33 W, 51/52 R, 52 HB, 101 R, 287; 15/21 D

[56] **References Cited**

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Primary Examiner—Donald G. Kelly
Attorney—Anthony P. De Lio et al.

[57] **ABSTRACT**

A gear tooth finishing machine wherein finishing tools are simultaneously brought into engagement with the edges of gear teeth and withdrawn therefrom as the gear is rotated and rotates a master gear which controls movement of the finishing tools.

12 Claims, 7 Drawing Figures

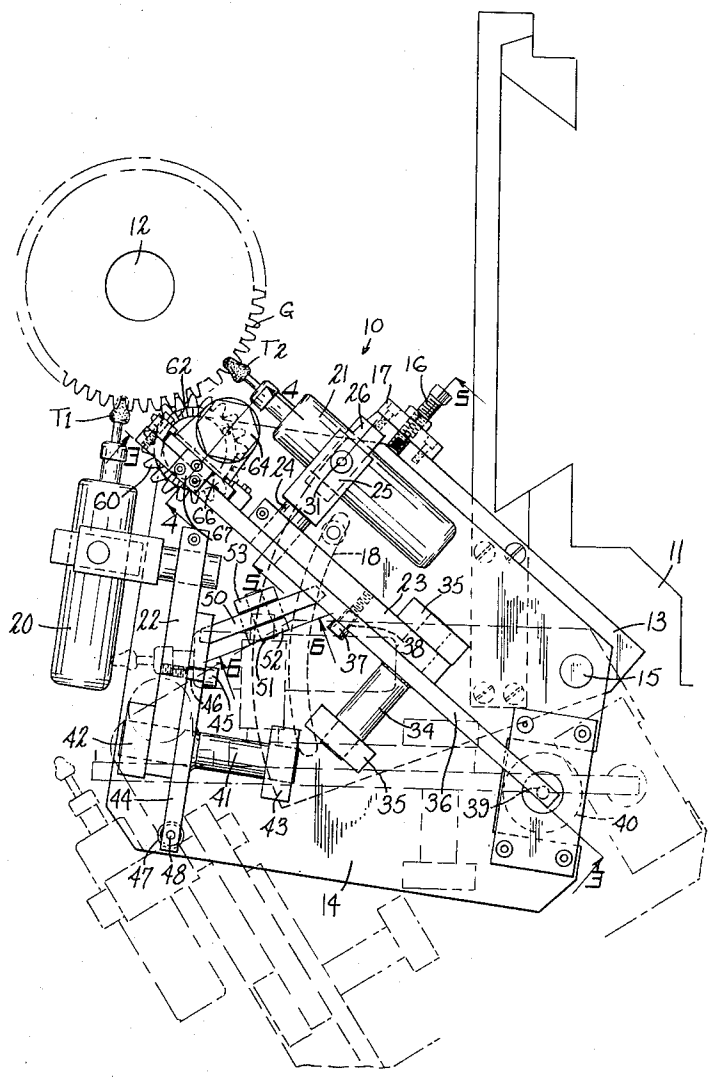


Fig. 1.

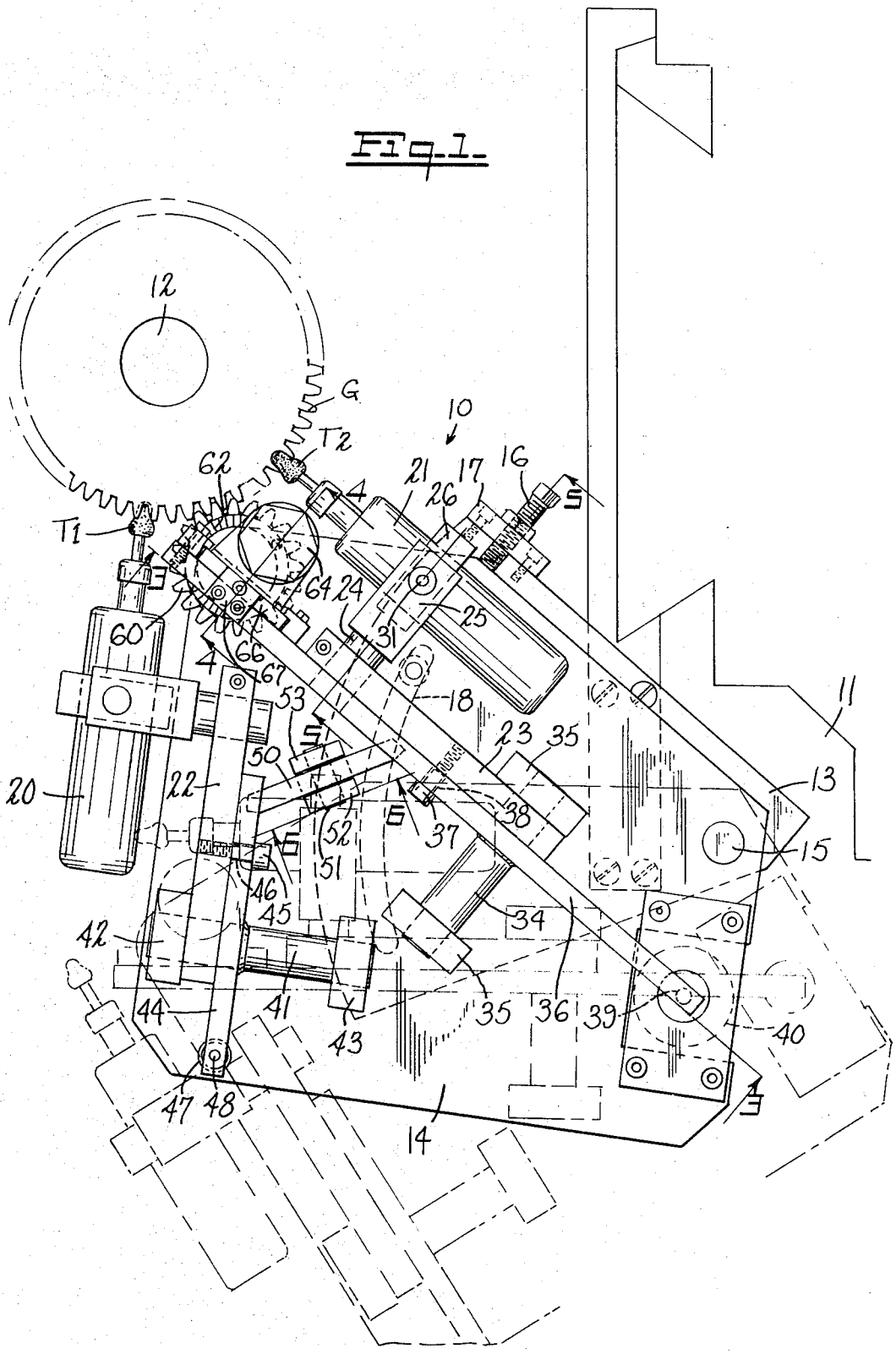

12
G
10
T2
62
21
17
16
T1
4
26
5
64
24
25
60
31
66
67
53
18
11
23
35
50
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38
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48
14
3

Fig 2.

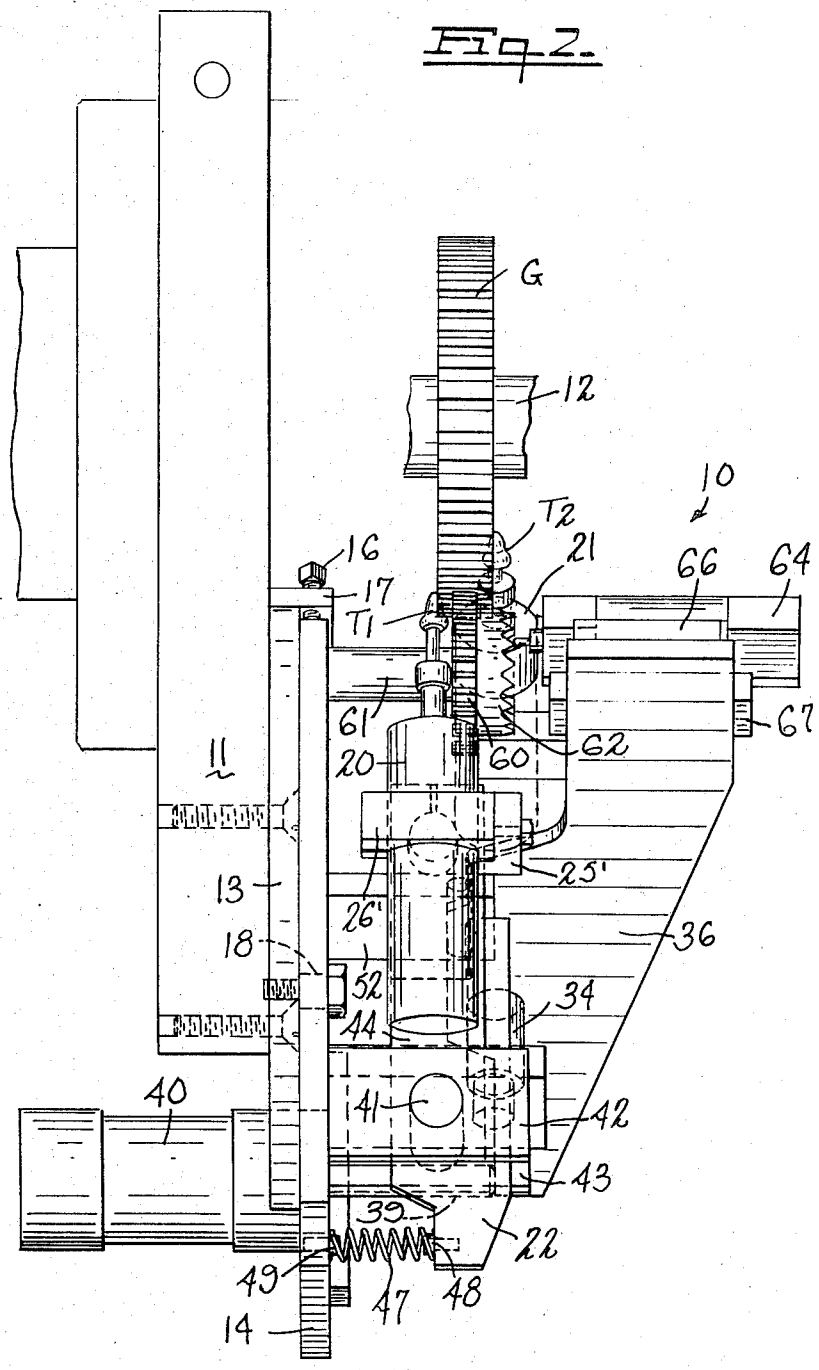

G
12
10
T2
21
16
17
T1
66
64
61
60
62
67
11
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13
25'
26'
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36
52
34
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40
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42
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22
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48
14

Fig-3.

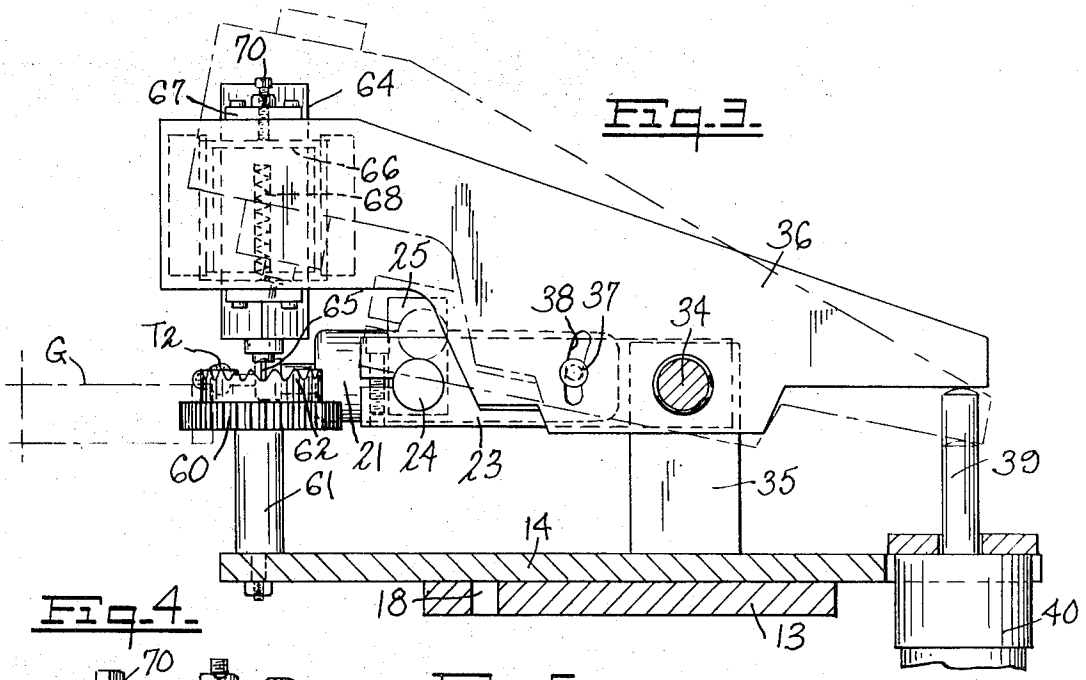


Fig-4.

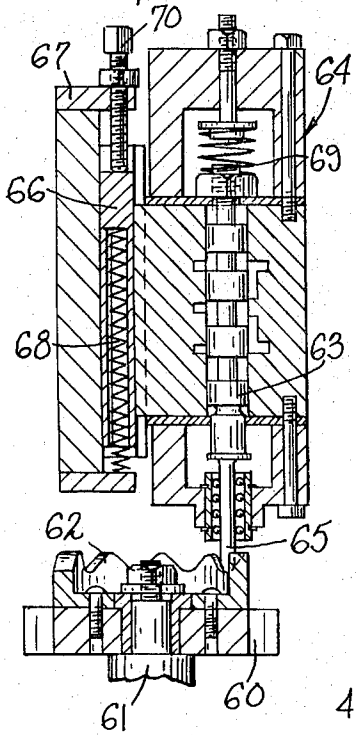


Fig-5.

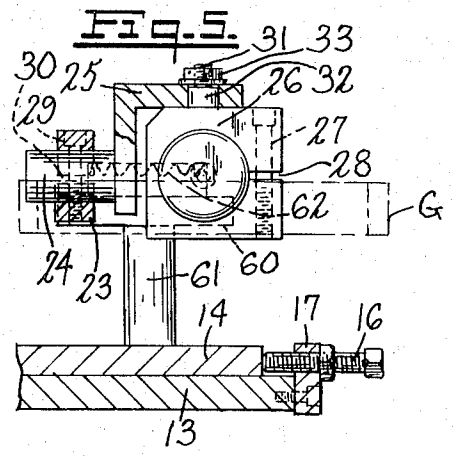


Fig-6.

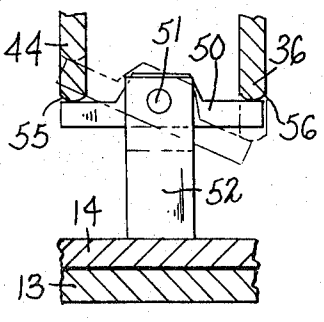
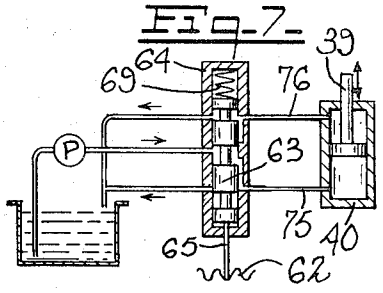


Fig-7.



GEAR FINISHING APPARATUS

This invention relates to gear cutting machines, and more particularly relates to a gear tooth end finishing mechanism.

When gears have been cut from a blank on gear cutting machines of various types, including hobbing machines, the edges of the gear teeth will be burred, and a finishing operation is necessary to debur the teeth. Machines used to perform this function are generally referred to as gear pointing machines, gear tooth rounders and gear chamfering machines. In practice, after a gear has been generated on one of the different types of generating machines, it is moved to an end finishing machine where it is deburred and any desired contours ground or cut on the sides of the teeth.

Such existing machines are generally separate machines which require removal of the gear from the gear generating machine and then positioning on the finishing mechanism.

The present invention provides a new and improved gear tooth end finishing mechanism which may be mounted to or incorporated on an existing gear generating machine and operated on both sides of the gear while it is still mounted to the spindle upon which it was cut.

In the present invention, a pair of cutting tools is arranged to engage a generated gear blank while it is still on its original cutting spindle. The finishing tools are moved into and out of engagement with the blank as it rotates and drives therewith a gear template which produces simultaneous inward and outward movement of the cutting tools.

An object of this invention is to provide a new and improved apparatus for finishing gear teeth.

Another object of this invention is to provide an apparatus for finishing gear teeth which has new and improved means for finishing both sides of the teeth simultaneously.

Another object of this invention is to provide a new and improved apparatus for finishing gear teeth including a pair of finishing tools which move into and out of engagement with the gear teeth as the gear is rotated so as to debur the edges of the teeth and provide a desired finished contour thereto.

A further object of this invention is to provide a new and improved apparatus for finishing gear teeth which may be mounted to or incorporated in a gear generating machine.

The features of the invention which are believed to be novel are particularly pointed out and distinctly claimed in the concluding portion of this specification. However, the invention both as to its operation and organization, together with further objects and advantages thereof, may best be appreciated by reference to the following detailed description taken in conjunction with the drawings, in which:

FIG. 1 is a top plan view of a mechanism embodying the invention as it is applied to a gear generating machine having a gear thereon;

FIG. 2 is a side elevation of the mechanism of FIG. 1 such elevation being shown rotated 90° from normal horizontal;

FIG. 3 is a view seen in the plane of lines 3—3 of FIG. 1;

FIG. 4 is a view seen in the plane of lines 4—4 of FIG. 1;

FIG. 5 is a view seen in the plane of lines 5—5 of FIG. 1;

FIG. 6 is a view seen in the plane of lines 6—6 of FIG. 1; and

FIG. 7 is a diagram of a hydraulic control.

The mechanism generally indicated by the reference numeral 10 is shown mounted to a gear generating machine which may be of the hobbing type and provides a support 11 for pivotally mounting the mechanism, and has a spindle 12 mounting a gear G whose teeth have previously been generated. The mechanism 10 is carried on a first plate 13 which is mounted to the existing machine, and a second plate-like base support member 14 is pivotally mounted thereto about a pin or equivalent connection 15. As shown in FIG. 1, plate 14 is pivotal between the position shown in broken line to the position shown in full line where it meets an adjustable stop comprising a large bolt 16 positionable through an upstanding member 17 secured to lower plate 13. Lower plate 13 has an arcuate slot 18 defined therein which receives therethrough a bolt threaded into plate 14. This allows plate 14 to be locked to plate 13 in a given position. Tool drives 20 and 21 for finishing tools T1 and T2, which may be of the pneumatic type, are carried on rocker arms 22 and 23, respectively. Rocker arm 23, as most clearly shown in FIGS. 3 and 5, carries a shaft 24 which is angularly adjustable therein and has attached thereto an L-shaped support 25 (FIG. 5) which supports therein a block 26 which engages the body of drive 21 and is clamped thereabout by means of a bolt 27 spanning cut-out 28 in member 26.

Shaft 24 is held about its periphery in rocker arm 23 and secured therein by a bolt 29 spanning a cut-out 30 in the end of rocker arm 23. Block 26 has a stud 31 extending therefrom through a sleeve 32 in support 25 (FIG. 5). A nut 33 draws block 26 up against the underside of support 25.

Rocker arm 23 is pivotal about a shaft 34 carried between supports 35 upstanding from plate 14. An actuating lever 36 is also pivotally mounted about shaft 34.

Rocker arm 23 may be locked to lever 36 in a predetermined angular relationship as by means of a headed bolt 37 extending through arcuate slot 38 in lever 36. Lever 36 is actuated in one direction by the piston rod 39 of a cylinder 40 carried on the underside of base 14. Lever 36 is returned after actuation as hereinafter explained.

From the foregoing it will be seen that the angle, attitude and depth of cut of the tool T2 on drive 21 may be set at different settings. The tool may be rotated about the axis of shaft 24, about the axis of stud 32 and the depth of cut may be varied by the position of locking bolt 37. The radial position of the tool with respect to the spindle 12 may be changed by moving drive 21 in block 26.

Drive 20 is mounted to rocker arm 22 in the same manner as described for rocker arm 23 and corresponding parts bear corresponding reference characters primed.

Rocker arm 22 is pivotally mounted to a shaft 41 carried between supports 42 and 43 on plate 14. A lever 44 is also pivotally mounted about shaft 41. Rocker arm 22 may be adjustably locked to lever 44 by means of a bolt 45 therein extending through an arcuate slot 46 in lever 44. This construction is the same as that previously described for rocker arm 23 and lever 36. A re-

turn spring 47 is disposed between a spring seat 48 on the other end of lever 44 and a seat 49 on base 14.

Means are provided to move rocker arms 22 and 23 simultaneously in opposite directions into and out of engagement with the teeth of gear G as the gear is rotated or angularly indexed. A lever 50 (FIG. 6) is carried on shaft or pin 51 mounted between supports 52 and 53 on base 14. The ends of lever 50 engage seats 55 and 56 on levers 36 and 44, respectively.

The gear G is disposed between the tools T1 and T2 which simultaneously move toward and away from the gear. Lever 50 serves to synchronize the operation of rocker arms 22 and 23. As rocker arm 23 goes down to bring tool T2 into engagement with one side of gear G it will move one end of lever 50 downwardly and the other end of lever 50 will raise rocker arm 22 to bring tool T1 into engagement with gear G as shown most clearly in FIG. 2.

The tools T1 and T2 are arranged to engage the edges of the gear teeth on each downward motion.

The motion of the rocker arms 22 and 23 and, hence, the tools thereon are hydraulically actuated in timed relation to the rotation of gear G. A master or control gear 60 is rotatably mounted to a shaft 61 extending upwardly from plate 14, as more clearly shown in FIG. 3. Carried on gear 60 is fixed relation thereto is a contouring element shown as a cam 62 having ridges and valleys thereon defining a contour corresponding to the desired shape of the edges of the teeth of gear G. The upper surfaces of cam 62 drive the spool 63 of a servo valve 64 through a tracer nib 65. Valve 64 is carried on a vertically positionable member 66, slidably mounted to a bracket 67 carried on the end of lever 36. Bracket 67 defines a slide or guideway which receives member 66. Member 66 is urged upwardly under the bias of a spring 68 and is downwardly positionable as by means of bolt 70. Spool 63 is urged downwardly by a spring 69.

With this construction it will be apparent that as piston rod 39 moves lever 36 upwardly, rocker arm 23 affixed thereto will move the see-saw pivot lever 50 downwardly as shown in broken line in FIG. 6, and this will result in lever 50 moving lever 44 and rocker arm 22 upwardly so that the tools will simultaneously advance toward the gear blank.

Control gear 60 is in meshing engagement with gear G and is driven thereby in timed relation to rotation of gear G.

The contour of cam 62 is made complementary with the shape of the design contour of the gear teeth ends. Cam 62 is supported on the face of gear 60 such that as gear 60 is rotated the spool of the servo valve will follow the cam contour. This movement of the spool of the servo valve will control the movement of piston rod 39 to actuate lever 36 and, hence, rocker arm 22.

The spool 63 of servo valve 64 is moved in one direction by engagement of tracer 65 in contact with contour cam 62 and in the other direction by spring 69. As the spool moves upwardly due to the tracer 65 moving upwardly on one of the ridges of the contour cam pressure in the lower portion of cylinder 40 is relieved via line 75 (FIG. 7) and pressure is applied to the upper portion via line 76. The piston rod 39 is then retracted. Spring 47 acting on lever 44 then moves rocker arm 22 away from gear G and simultaneously through the action of lever 50; lever 36 and rocker arm 23 are raised to pivot tool T2 away from gear G. Then as spool 63 moves downwardly, as viewed in FIG. 4, under the influence of spring 69, pressure is applied via line 75 to the lower portion of cylinder 40 to extend rod 39, and again simultaneously bring the tools T1 and T2 into contact with the gear G.

The above-described action is repetitive and the result is simultaneous inward and outward movement of the tools T1 and T2 which will engage the gear G on opposite sides thereof at the edges of the teeth.

By virtue of the various angular adjustments previously described, a chamfered gear tooth contour can be made to any configuration desired by varying the shape of the cutting tool, such as a tapered, convex or concave milling tool; the angle of the milling cutter with the part; the angular address of the cutter with respect to the radial center line of the tooth; and/or shifting the center line of a cam ridge with respect to the tooth center line.

To set up a device for operation, the plate 13 is pivoted to bring the master gear 60 into contact with the gear G. At this time, plate 14 engages preset stop 16. This may be done automatically at the end of a gear generating cycle of the gear cutter. At this time, spring 47 holds the rocker arms and the toolings thereon away from the gear G. Then the hydraulic system is activated to apply fluid to servo valve 64 which will cause the piston rod to pivot lever 36 and bring the tracer 65 into contact with contour cam 62 and position the spool in a null balance position. As the master gear 60 is rotated by the workpiece, the tracer 65 and spool 63 will follow the contour cam and impart a reciprocating motion to the rocker arms. This motion will duplicate the desired relationship between the cutters and the gear teeth edges.

The servo valve is positioned on arm 36 by means of positioning bolt 70 to obtain the desired depth of cut by the tools T1 and T2. It is within the scope of the invention to replace the positioning bolt 70 with an automatic feed screw to automatically position the servo valve. Then the cutting tool can be automatically fed into the workpiece until the desired dimensional contour is obtained.

While one preferred embodiment of the invention has been disclosed, various changes and modifications may be made therein without departing from the scope of the invention. For example, the cutting tools may be actuated pneumatically, hydraulically or electrically; the servo valve or other tracer device may operate hydraulic or electrical controls; the contour cam may be a face cam or side cam.

It may thus be seen that the objects of the invention set forth as well as those made apparent from the foregoing description are efficiently attained. While preferred embodiments of the invention have been set forth for purposes of disclosure, modification to the disclosed embodiments of the invention as well as other embodiments thereof may occur to those skilled in the art. Accordingly, the appended claims are intended to cover all embodiments of the invention and modifications to the disclosed embodiments which do not depart from the spirit and scope of the invention.

What is claimed is:

1. A device for simultaneously performing a finishing operation on the teeth of a work gear mounted to a shaft and rotatable thereon, comprising a base member, first and second finishing tools pivotally mounted to said base member to operate on opposite sides of the

gear, a control gear adapted to be driven by the work gear, a contour cam mounted to said control gear, cam follower means responsive to the contour of said cam, and means responsive to said cam follower means for producing simultaneous motion of said finishing tools toward and away from the work gear.

2. A device for simultaneously performing a finishing operation on the teeth of a gear mounted to a shaft and rotatable thereon, comprising first and second finishing tools mounted to operate on opposite sides of the gear and means for simultaneously moving said tools into and away from engagement with said gear as said gear is rotated so that said tools engage said gear on the edges of teeth thereof on opposite sides of said gear, a base member, first and second rocker arms pivotally mounted on said base member, said rocker arms carrying said tools, and a lever pivotally mounted on said base member and engaging said rocker arms so that movement of one of said rocker arms produces equal but opposite movement of the other of said rocker arms.

3. The device of claim 3 further including means for driving one of said rocker arms toward the plane of the work gear, and spring return means for returning the other of said rocker arms away from the plane of the work gear.

4. The device of claim 3 wherein said base member is pivotally mounted to a gear generating machine having a spindle for supporting a work gear thereon, and said base member is pivotal in a plane perpendicular to the axis of the spindle.

5. A device for performing a finishing operation on the teeth of a gear mounted to a shaft and rotatable thereon comprising first and second finishing tools, first and second rocker arms, means mounting said tools to said rocker arms, means for simultaneously pivoting said rocker arms to advance said tools toward opposite sides of the gear and retract said tools therefrom in timed relation with rotation of the gear.

6. The device of claim 5 wherein said mounting means includes means for varying the angle of the center line of the finishing tool with respect to the gear teeth.

7. The device of claim 5 wherein said mounting means includes means for varying the angular address of the finishing tool with respect to the radial center line of the gear teeth.

8. The device of claim 5 wherein said mounting means includes means for varying the distance between the finishing tool and the center of the gear.

9. A device for performing a finishing operation on the teeth of a gear mounted to a shaft and rotatable thereon comprising first and second finishing tools, first and second rocker arms, means mounting said tools to said rocker arms, means for moving said rocker arms to simultaneously advance said tools toward opposite sides of the gear and retract said tools therefrom, a base member, said rocker arms being mounted to said base member, said base member being pivotal to a position to present said finishing tools to the gear and to a position where said finishing tools are removed from the gear.

10. The device of claim 9 further including a lever pivotally mounted on said base member, one of said rocker arms being carried on said lever, a control gear rotatably mounted to said base member and adapted to be engaged and driven by the gear, a contouring cam on said gear, tracing means on said lever adapted to follow said cam, said simultaneously moving means including a second lever between said lever and said other rocker arm adapted to produce equal and opposite movement of said lever and said rocker arm upon movement of one, means for moving said lever, servo means responsive to said tracing means for actuating said means for moving.

11. The device of claim 5 wherein each of said mounting means comprises a tool support member extending transversely from the rocker arm and rotatably positionable with respect thereto, and means supporting said tool on said tool support member.

12. A device for simultaneously performing a finishing operation on the teeth of a gear mounted to a shaft and rotatable thereon, comprising a base member, first and second finishing tools carried on said base member and arranged to operate on opposite sides of the gear, a control gear rotatably mounted to said base member and adapted to engage the gear and be driven thereby, a contour cam on said control gear, tracer means carried in fixed relation to one of said tools adapted to follow said contour cam, and servo means responsive to said tracer for simultaneously moving said tools into and away from engagement with said gear as said gear is rotated so that said tools engage said gear on the edges of teeth thereof on opposite sides of said gear.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,782,041 Dated January 1, 1974

Inventor(s) Edward J. Batorski

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 3, line 1, "3" should read --2--.
Claim 4, line 1, "3" should read --2--.

Signed and sealed this 2nd day of July 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER,JR.
Attesting Officer

C.MARSHALL DANN
Commissioner of Patents