

[54] **PROFILE GRINDER**

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[58] Field of Search **51/100 R, 101 R, 94 R, 51/33 W, 34 A**

[56]

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[57]

ABSTRACT

A profile grinder including an abrasive grinding wheel adapted to move laterally for controlling the amount of abrasion independently of a follower means located in contact with a template while maintaining the abrasion point aligned with the center of the abrasive wheel along a normal line extending through the point of contact of the follower means on the template, whereby more precise and efficient abrading operation is possible.

1 Claim, 2 Drawing Figures

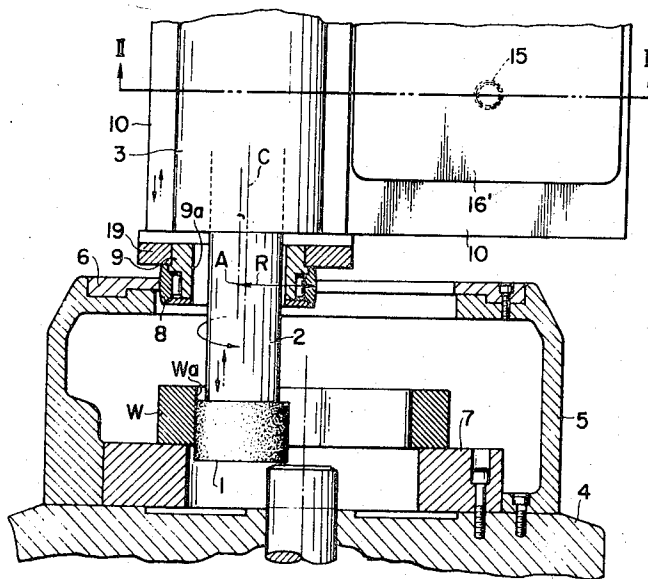


FIG. 1

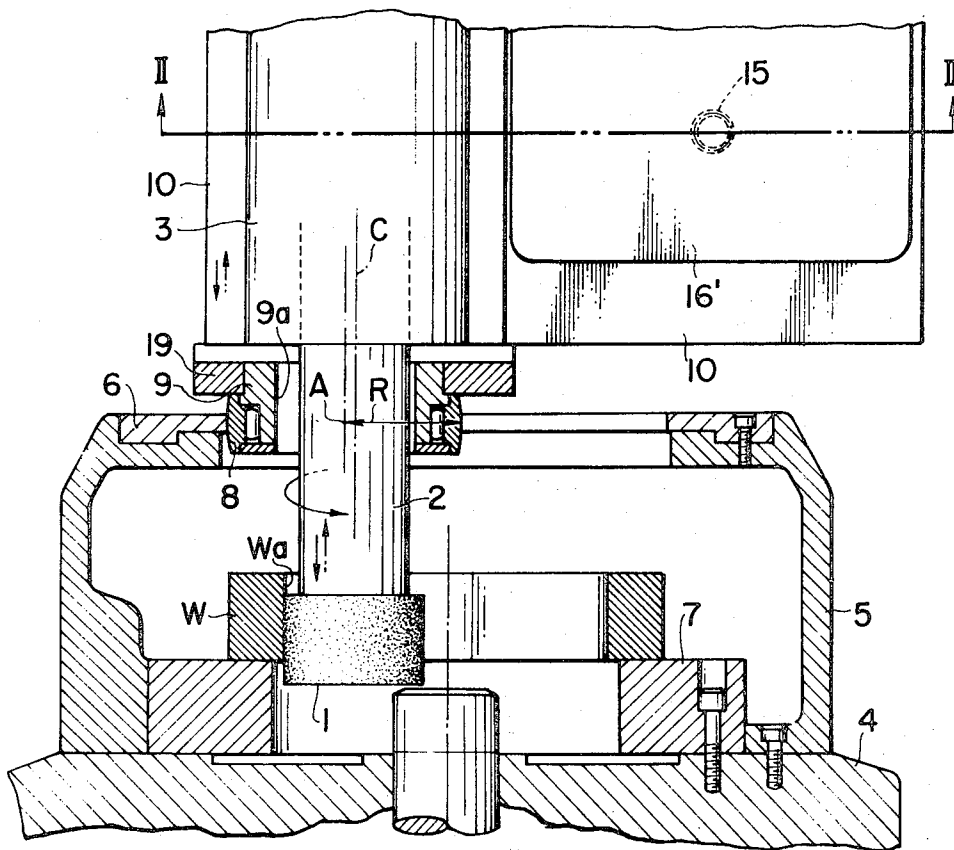
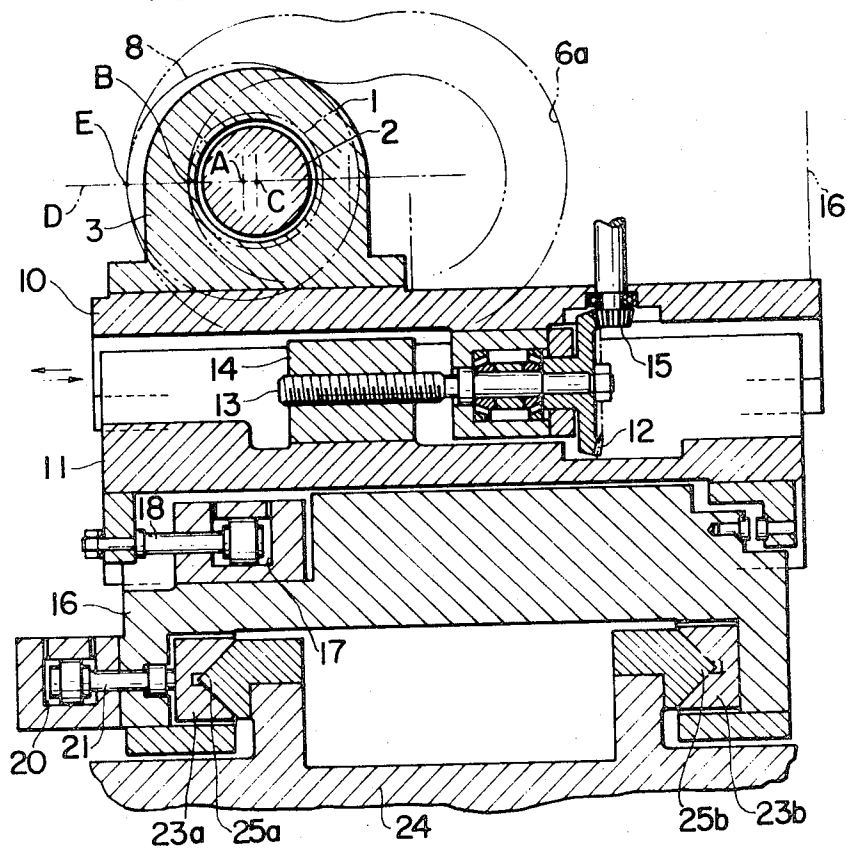


FIG. 2



1 PROFILE GRINDER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to profile grinders incorporating a follower means and, more particularly, to an improved profile grinder including an abrasive grinding wheel adapted to move laterally for controlling the amount of depth of abrasion while keeping the abrasive wheel and a work piece in a predetermined relation defined by the cam face of a template.

2. Description of the Prior Art

In the prior art profile grinders of this general type, the amount or depth of abrasion can not be controlled with the follower means fixed in a predetermined contact relation with respect to the template. Accordingly, the desired control of the amount of abrasion is preferably provided by raising or lowering a cylindrical tapered follower means along the spindle of the abrasive wheel extending coaxially with the follower means.

Such arrangement, however, generally requires an abrasive wheel having a spindle with an undesirable large axial dimension and a relatively small diameter because of the presence of the tapered portion of the follower means, and threaded members or other reciprocating means for raising or lowering the follower means on the spindle. The exact diameter of the spindle will vary depending upon the size of the template being used.

As a result, the abrasive wheel spindle provides poor rigidity and hence poor precision in the grinding operation.

When a non-circular surface of a work piece is to be ground with a conventional grinder, a template having a cam face substantially contoured similar to the desired non-circular surface is employed with a follower means carried by a suitable carrier or holding means in a spaced apart relation with respect to the abrasive wheel spindle. However, the direction of the force tending to urge the follower means against the template is not in alignment or coincident with the direction of abrasion which is essential for achieving precision in the abrading operation.

From the standpoint of achieving precision in abrading the non-circular surface of a work piece, it is desirable to locate the follower roller with respect to the abrasive wheel such that the line extending through the point or line of contact of the follower roller with the cam face of the template and to the center of the follower roller exactly coincides with the line extending through the point or line of abrasion on the non-circular surface of a work piece by the abrasive action of the abrasive grinding wheel and to the center of the abrasive wheel.

Such requirement however, necessitates the use of either a template having an undesirably larger cam face than the non-circular surface of a work piece to be ground or an abrasive wheel spindle having an extremely small diameter, when using the prior art grinders.

Either arrangement provides unfavorable effects, such as requiring a large and complex mechanism at the operating section of the machine or consideration reduction in the rigidity of the abrasive wheel spindle and

consequent impairment of precision in the grinder operation.

2 SUMMARY OF THE INVENTION

5 The present invention is directed toward the objective of overcoming the above-mentioned problems of the prior art profile grinders and provides an improved profile grinder which includes a simplified operating mechanism while assuring precision in the grinding operation.

Another object of the present invention is to provide a profile grinder in which an abrasive grinding wheel is adapted to move laterally for controlling the depth of abrasion independently of a follower means maintained in a predetermined contact relation to a template, wherein improved precision and efficiency of the grinding operation is possible.

A further object of the present invention is to provide a profile grinder in which an abrasive grinding wheel is adapted to move laterally for controlling the depth of abrasion independently of a follower means maintained in a predetermined contact relation to the template and the center of the abrasive wheel is maintained in alignment with the point of abrasion along a line normally extending through the point of contact of the follower means on the template to provide a more precise and efficient grinding operation.

A still further object of the present invention is to provide a profile grinder in which a line normally extending through the point of contact of a follower means on a template coincides with the direction of the force tending to urge the follower means against the template.

The above and other objects, advantages and features of the present invention will become apparent from reading the following detailed description taken in conjunction with the accompanying drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view, partially in longitudinal cross section, of a preferred embodiment of the profile grinder in accordance with the present invention; and

FIG. 2 is a transverse cross section taken along line II—II of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawings, a work piece W has a non-circular surface Wa, such as a trochoid surface of the rotor housing of a rotary piston engine, which is to be abraded and finished by an abrasive grinding wheel 1. The abrasive wheel 1 is rigidly mounted on a spindle 2 which, in turn, is mounted on a wheel head 3 for rotation and traverse motion imparted by a suitable rotating and traversing means, not shown. A table 4 supports a template 6 secured to the top of the table by a suitable connecting means, such as template support 5. The work piece W is supported and located on a work piece support 7 below the template 6.

The position of the work piece W with respect to the table 4 is controlled by a tool, not shown, such that the non-circular face Wa of the work piece W to be abraded substantially corresponds to the similar non-circular vertically extending cam face 6a of the tem-

plate 6. The table 4 is adapted to rotate by a suitable actuating and drive mechanism, not shown, so as to generate the desired non-circular curved motion between the surface *Wa* of the work piece *W* and the point of abrasion by the abrasive wheel 1. Riding and sliding on the vertically extending cam face 6a of the template 6 is a follower roller 8 having a curved and bulging outline configuration with a relatively large radius of curvature *R*. Alternatively, the follower roller may have a plain cylindrical shape.

Referring now to FIG. 2, the follower roller 8 is supported and located by retainer member 9 such that the center *A* of the follower roller 8 is on a line *D* extending through the point of abrasion *B* taking place on the work piece by the action of the abrasive wheel 1 and through the center *C* of the abrasive wheel 1. The retainer member 9 is mounted and disposed around the abrasive wheel spindle 2 with sufficient clearance to permit the desired control of the amount of the depth of abrasion obtained by the abrasive wheel 1.

The wheel head 3 is carried by a carriage 10 which is slidable on an auxiliary base plate 11 for movement along the line *D* extending through the point of abrasion *B* toward the center *C* of the abrasive wheel. A driven gear 12 for feeding the carriage 10 is integrally connected to a feed screw 13 which is threaded through a retainer portion 14 of the auxiliary base plate 11. Thus, by rotation of a drive gear 15 in mesh, with the driven gear 12 continuously or intermittently at a desired speed by operating a print feed motor or a power cylinder (not shown) contained in the feed box 16' mounted on the carriage 10, the carriage 10 with the abrasive wheel 1 is moved laterally along the line *D* so as to provide the desired control of the depth of abrasion imparted to the work piece *W* by the abrasive action of the abrasive wheel 1.

A vertically movable plate 16, shown in FIG. 2, is provided for supporting the carriage 10 by the interposition of the auxiliary base plate 11 which is mounted on the plate 16 in such a way as to permit sliding motion in the direction of the abrasion control as in a manner similar to the carriage 10 with respect to the auxiliary base plate 11. The auxiliary base plate 11 is connected to a piston rod 18 extending from a power cylinder 17 mounted on the plate 16 and adapted to provide pressure to urge the follower roller 8 against the cam face 6a of the template 6.

When a pressurized fluid, such as compressed air or oil, is introduced into the right side chamber of the power cylinder 17, the auxiliary base plate 11 with the carriage 10 mounted thereon is rapidly moved toward the left as seen in FIG. 2, causing the follower roller 8 supported by the retainer member 9 and a support means 19 on the auxiliary base plate 11 to move along the line *D* so as to be urged against the cam face 6a of the template 6. At the same time, indexing of the abrasive wheel 1 mounted on the carriage 10 is achieved so as to bring the abrasive wheel near the working area *Wa* and the point of abrasion contact *B* with the work piece *W* along the line *D*.

A power cylinder 20 is provided for retaining and securing the plate 16 in the desired vertical position. By introducing a pressurized fluid to the left side chamber of the power cylinder 20, a piston rod 21 is moved rightward, causing concave sliding elements 23a and 23b inserted in the plate 16 to engage and grip complementary convex rails 25a and 25b integrally connected

to a machine base 24, thereby fixing the plate 16 in the desired operative position with respect to the machine base 24.

A suitable lift means, not shown, is provided to move the plate 16 in the vertical direction such that the abrasive wheel 1 and the follower roller 8 are placed in contact with the surface *Wa* of the work piece *W* to be abraded and the cam face 6a of the template 6, respectively, whereupon the power cylinder 20 is then operated to retain the plate 16 in such desired operative position for performing the grinding operation on the work piece *W* by the abrasive wheel 1.

In the grinding process, the power cylinder 17 is operated to move the auxiliary base plate 11 toward the left, thereby urging the follower roller 8 against the template 6, and thereafter, the feed screw 13 is rotated to advance the abrasive wheel 1 in the lateral direction so as to obtain the desired depth of abrasion.

Abrasion is achieved by rotation and vertical traverse motion of the abrasive wheel 1, in conjunction with the contour motion of the work piece on the table 4 so as to machine the non-circular surface *Wa* of the work piece *W* into desired size and shape.

During the abrading process, the line extending from the point of contact *E* of the follower roller 8 sliding on the cam face 6a of the template 6 to the center *A* of the follower roller 8 is maintained in alignment with the line *D* extending from the point of abrasion *B* taking place on the surface *Wa* of the work piece *W* by the action of the abrasive wheel 1 to the center *C* of the abrasive wheel 1, as well as the normal line extending through the point of abrasion *B* on the surface *Wa* of the work piece *W* which continuously moves by the contour motion of the table 4. Such alignment is effective to provide great precision in the finished product.

At the completion of the grinding process, the power cylinder 17 is operated to move the auxiliary base plate 11 toward the right in FIG. 2, causing the follower roller 8 and the abrasive wheel 1 to move away from the cam face 6a of the template 6 and the surface *Wa* of the work piece *W*, respectively. At the same time, the power cylinder 20 is operated to release the pressure or restraining force imparted from the concave sliding members 23a and 23b to the convex rails 25a and 25b on the machine base 24, thereby permitting the movable plate 16 with the auxiliary base plate 11 and the carriage 10 to be lifted by the lift means described hereinabove.

This motion results in the retraction of the follower roller 8 carried by the auxiliary base plate 11 as well as the abrasive wheel 1 carried by the carriage 10 to their inoperative position above the template support member 5. The abrasive wheel 1 is then dressed by a suitable dressing means (not shown) while the finished work piece *W* on the turn table 4, which has ceased to turn at the time, is replaced by a new work piece for preparation of the next grinding operation.

While the motion tending to generate the desired surface contour is imparted to the work piece from the turn table 4 in the illustrated embodiment, the same motion may be provided by moving the abrasive wheel 1 with respect to the fixed work piece by a suitable actuating mechanism (not shown) mounted on the wheel head 3. Alternatively, well known actuating mechanisms may be incorporated into the table 4 and the wheel head 3 so as to combine the movement of the

table 4 with the motion of the wheel head 3 to generate the desired non-circular relative motion between the work piece W and the abrasive wheel 1. Also, the follower roller 8 may be pressed against the template 6 by any suitable pressure means, other than the power cylinder 17, such as a counter weight.

While the follower means has been shown and described as being a follower roller, it should be noted that other follower configurations, such as a bracket having a plain sliding surface which follows the cam face of the template, may also be employed.

From the foregoing description, it will be readily understood that the follower means following the vertical cam face 6a of the template 6 on the table on which the work piece W is mounted is fixed and maintained stationary at a point along the axial length of the abrasive wheel spindle 2 on the wheel head 3 during the grinding operation, thus simplifying the manufacture with great precision of the template having a non-circular cam face and the follower means having a relatively short axial length. Furthermore, a higher precision abrading operation is possible with an abrasive wheel having a relatively short and thick spindle 2 having sufficient rigidity. The spindle 2 can be moved to provide control of the depth of abrasion without danger of interference with the follower means, thus facilitating abrasion of a variety of sizes or work pieces W, as well as enabling the use of an abrasive wheel having a substantially large effective diameter.

We claim:

1. A profile grinder, comprising:

a machine base,

a rotatable abrasive wheel,

a spindle mounting said abrasive wheel for effecting abrasion on a work piece,

drive means for rotating said abrasive wheel,

a template having a cam face and being fixed in a predetermined position on a table supporting said work piece,

follower means adapted to slide on said cam face of

said template for guiding said abrasive wheel to a desired working point,

first pressure means for resiliently urging said follower means against said cam face of said template,

control means for moving said abrasive wheel relative to said follower means in the abrading direction for controlling the amount of abrasion while maintaining said follower means in a predetermined position in resilient contact with said cam face of said template,

said follower means, said spindle and said control means being mounted on a wheel head, said wheel head being connected to a machine base by second pressure means, said follower means on said wheel head being urged against said cam face by the action of said first pressure means, to effectively control the depth of abrasion, said follower means, said pressure means, said spindle and said control means being positioned such that the direction of the force tending to urge said follower means toward said template coincides with the direction of the movement of said spindle with respect to said work piece to effectively control the depth of abrasion,

said follower means and said spindle further being mounted such that a line extending through the point of contact of said follower means on said cam face of said template is in alignment with the direction of the force tending to urge said follower means against said template, and

said follower means being in the form of a cylindrical ring having said spindle extending therethrough, the inner diameter of said ring being larger than the diameter of said spindle so as to provide a sufficient clearance to permit lateral movement of said spindle relative to said follower means for controlling the amount of abrasion.

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