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An Overview on Process Center-Less Recess Grinding and Its Applications

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ABSTRACT: The study deals with special center-less grinding process using various methods, particularly the center-less grinding recess method. The results of measuring the surface roughness of frontal and cylindrical areas and the roundness of the cylindrical surface of the work piece are shown in the paper. Qualitative parameters of the machined surfaces are supplemented by the manner of the grinding process. The modification in the shape of the work piece causes the change in the position of the work piece during the operation in the workzone.

Keywords: Center-less grinding, qualitative parameters, grinding process (mechanism)

I. INTRODUCTION

The principle of each method of grinding is withdrawal of material by abrasion phenomenon by the help of several segments of abrasive grains (held together by a binding material or bond). Abrasive grain is a cutting wedge with random geometry and orientation. When grinding, the work piece material is removed by a hard flint grinding wheel at high cutting rates.

Center-less grinding is used for grinding smooth cylindrical components, which are inserted between two discs. One of them is a grinding wheel and the other a regulating wheel. Work piece rotates at a peripheral speed of the rotating regulating wheel.

Center-less radial grinding (Recess): Recess grinding is used for machine parts that have a recess, shaped or conical surfaces, or, where appropriates, more coaxial cylindrical surfaces without centers. Work pieces are inserted into the backstop between the grinding and regulating wheels, the axes of which are parallel.

II. SPECIFIC FEATURES OF CENTERLESS RECESS GRINDING

Specific features of center-less grinding recess method are:

1. Movement (feed) of one of the discs in the radial direction of grinding. At the end of this movement (feed), the work piece receives the final dimension.
2. Axis of the wheels are parallel with the surface of the leading slide.
3. Smooth procedure, since there is no axial movement of the work piece.

However, in the real procedure, the regulating wheel forms a minute angle (0.5°) with the surface of the leading slide. This arrangement, which is typical for this method, is here to prevent the work piece from oscillating in the axial direction. The inclined axis of the regulating wheel is pressed against the front of the piece backstop. Wheels are converging either manually or automatically. In this method, we can grind the parts of various shapes to a certain length and l max $\leq$ H, where l max is the maximum length of the piece of ground. Work pieces are inserted and removed manually or by using tanks.

Grinding process is usually carried out with a surface of the work piece pressed to surface of the leading slide and regulating wheel. The change of the shape of the work piece in grinding leads to the change of the location of this work piece in the work zone.

III. METHODOLOGY

RECESS GRINDING PROCESS

In Fig. 1 is a scheme of instant positioning the work piece during a single revolution when in-feed grinding. The tool path feed rate is marked *t*. If allowance is taken with certain parts of the surface, the work piece decreases and is shifted to the regulating wheel Fig. 1 (b). Thus, the work piece does not have a correct cylindrical shape after one revolution, because the depth of grinding over the turn varies.

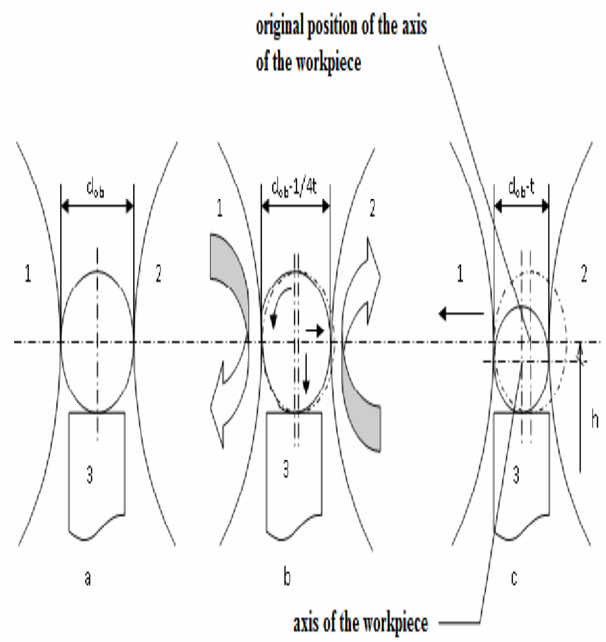

Fig. 1. Scheme of instant positioning of the work piece when in-feed grinding (a. starting the process; b. intermediate position of the work piece; c. position after one revolution of the work piece; 1. grinding wheel; 2. regulating wheel; 3. leading slide).

To receive the work piece of a precise circular shape, it must be kept rotating without lateral feed. When grinding, the geometrical axis of the work piece position is constantly changing while remaining parallel to its initial position Fig. 1 (c).

The property of centre work piece displacement is taken into account when setting the grinders. It should be noted that with increasing h, difference dob - dob.o is also growing fast. Line height h can be determined from the geometrical relationships. Similarly, this applies to center-less grinding-through manner, yet the nature of the work piece movement is much more complex. Work piece is rotated and thus its axis stops to be parallel with its original position. These movements in the piece-through grinding lead to reducing the work piece diameter approximately by variable t, which was previously set up in the grinding machine. With the same setup in center grinding, the work piece diameter would decrease by 2t. In center-less grinding, the variable-through dob - dob.o is usually called the depth of cut. A double depth of cut for grinding center is indicated t, respectively 2t. To avoid misunderstanding, variable t, which can only be regarded an instantaneous depth of cut will called allowance of angle.

IV. CHANGE PROFILE AND QUALITATIVE PARAMETERS SURFACES WORKPIECES

To determine the impact of in-feed center-less grinding on a circular profile and the parameters of the surface (roundness and surface roughness), we carried out a series of experiments within which the parts shown in figure were manufactured. Components were made of ST 37 - 2K. Their diameter was ø 9.96-0.01 (diameter of semi-product before grinding ø10.04+0.06). Grinding was made on MULTIMAT 208 machine while using the grinding wheel 400x30x203 99BA/96A 60N7V (STROH flat diamond), regulating wheel 300x30x127 A120RL152R7 and leading slide was straight. Grinding machine working time was 9.8 sec.

V. APPLICATIONS

- Shouldered pins
- Transmission bushings
- Ceramic shafts for circulator pumps used in home heating
- Ceramic shafts for circulator pumps used in valve seal inserts
- Ceramic shafts for circulator pumps used in aerospace fasteners
- Ceramic shafts for circulator pumps used in dowel pins

VI. CONCLUSION

The experiments proved that the center-less plunge grinding improves the parameters of circular profile and surface roughness. However, there are cases where grinding can worsen a qualitative parameter. It concerns particularly an accurate mutual positioning of the work piece surfaces. For example, in a way-through center-less grinding of outer surfaces (especially with a small of length/diameter ratio of a component, i.e. ring-shaped components) non-uprightness of the cylindrical surface of the work piece regarding its face can be a bit bigger. This will not happen with plunge grinding. All the methods of center-less grinding may cause that the outer (grinding) surfaces and the inner surfaces of the work piece are not exactly in alignment. Coaxiality of surfaces is changed by pass-through grinding along the length of the work piece. This is usually considered a random deviation. In fact, this phenomenon is caused by specific features of center-less grinding and it can be affected. If the grinder is properly adjusted, a larger amount of appliance is used and the optimum allowance of grinding is retained, it is possible to achieve the accuracy to the extent of the prescribed tolerances after grinding.

VII. FUTURE SCOPE

If the challenge is to machine large quantities of long and/or thin, round components made of pliable or brittle materials, then there is virtually no alternative to center-less outside diameter grinding. In addition, centre-less grinding is the only technique to offer grinding wheel sets which allow multiple tasks – e.g. roughing and finishing – to be performed in a single pass (picture shows Wendt camshaft and wheel set). The machining process itself corresponds to the other cylindrical grinding techniques like the ones already covered in the section "Outside diameter grinding" – even without centres the process still involves plunge grinding and through feeding techniques. However, not having any centers does offer a number of advantages:

-As the linear-shaped support for the work piece prevents large bending loads and torsional loads, even pliable or brittle materials can be machined with large grinding forces without any deformation.

-Exceptionally short set-up times – no preparation of the work piece is required for clamping or for transmission of the rotary movement (no sources of errors after centering, re-clamping).

-Work piece changes are straightforward and easy to automate.

-In continuous longitudinal grinding processes there is no downtime for work piece changes.

-Even extremely long parts can be machined with compact machines.

-Out-of-roundness errors and out-of-cylindricity errors are reduced to less than 1µm and are therefore around half as much as the equivalent values for grinding between centers.

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