SUPERFINISHING FLAT AND CYLINDRICAL SURFACES OF GEAR PUMP PINIONS

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Abstract: *The quality of the flat and cylindrical surfaces of the gear pump pinions is a restrictive condition for a suitable work. The required quality of these surfaces is very high, R_a = 0, 04 – 0, 08 μm. As well, there are restrictive conditions input for the form and positioning deviations. So far, the manufacturing of these surfaces used to be achieved by grinding and no one could guarantee that the surface roughness was in accordance with the technical documentation. The presented constructive solution allows obtaining a good quality of the flat and cylindrical surfaces. It uses a superfinishing attachment that can be mounted on the engine lathe.*

KEYWORDS: SURFACE FINISH, PRODUCTIVITY, ATTACHMENT, ACCURACY

1. Introduction

The process of superfinishing is called sometimes micromachining and is a short-stroke honing working at low temperature and with low stock removal material. This method makes it possible to reach high and reproducible surface finish quality on rotationally symmetrical workpieces with practically every kind of material. The surface structure is improved in the micron range - up to 0,004 µm Ra. The main advantage of this method is consistent finish over the entire surface. Superfinish improves the bearing ratio (Tp) resulting in greatly improved wear resistance. Stock removal is typically in the order of a few microns. The achievable surface finish quality is comparable to levels reached only by honing or lapping.

Superfinishing removes the amorphous structure of the material, or „soft skin“. This layer is usually, 0.002 to 0.008 mm thick and is created by high temperatures generated by the grinding wheel. Superfinishing enables the user to achieve virtually any-surface texture parameter, because only the roughness peaks are removed. The geometry of the workpiece remains unchanged.

The superfinishing process results in a number of significant benefits including [4];

- Increased part life;
- Decreased wear rates;
- Higher load bearing surfaces;
- Improved sealing capabilities;
- Elimination of the “break in” period;
- Reduction in energy consumption.

During grinding, extreme heat and aggressive stock removal often alters micro structure and base metal hardness. This creates slight dimensional and surface imperfections such as smeared peaks, waviness and chatter. Superfinishing, a low temperature, low stock removal process, improves part geometry and surface finish by removing the amorphous layer formed during the grinding process. This dramatically improves these
imperfections, which can compromise part quality and performance.

The superfinishing process results in a controlled surface finish in which relatively small amounts of material are removed to achieve surface finishes as fine as 0.012um. While polishing processes attempt to achieve a mirror-like surface, superfinishing leaves a tightly controlled cross-hatch pattern. This pattern is attained by the interaction of three interrelated motions. These are 1) Oscillation of the stone, or wheel rotation; 2) Rotary movement of the component; 3) Pressure of the abrasive tool on the workpiece [3]. Stones are used to finish cylindrical shapes. Fine grit cups and cylinder wheels are used to finish flat and spherical surfaces.

During the superfinishing process, parts pass through several distinct phases. When the abrasive tool makes initial contact with the part, dull grains fracture or pull away from the matrix to produce a new cutting surface. As the tool “self dresses,” relatively large amounts of stock will be removed from the workpiece. Proceeding through the stock removal phase, abrasive grains begin to dull, while surface irregularities and geometry continue to improve. This results in a cross-hatched surface free of irregularities and amorphous material.

2. Method of superfinishing cylindrical surfaces of gear pump pinions

The pinions in the gear pump structure have a great constructive variety from the point of view of dimensions and shapes. In fig.1 you can see the surfaces that must be processed. These are ∅ A and ∅ B with the width K. The variation of these dimensions is between 0,05-0,016 mm, and the diameters A and B have values between ∅7 and ∅28, while K dimension is between 12,3 and 30,5 mm.

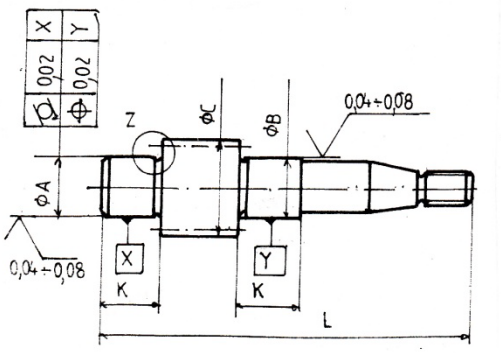


Fig.1 *Schematic illustration of a gear pump pinion.*

2. 1 The constructive solution and the way of processing

In order to process the cylindrical surfaces of the gear pump pinions, a superfinishing attachment, adaptable on the universal lathe, was designed (Fig.2). This superfinishing device is placed on the supporting plate (pos.6) fixed on the transversal slide (pos.8) of the universal lathe. The method was thought with two working stations to simultaneously process two work pieces. The rotating motion of the work pieces is achieved through the agency of the rolls (pos.9) fitted up on the shaft (pos.7) that, in turn, receives the rotating motion from the lathe. This constructive solution of obtaining the rotating motion allows a good positioning on the shaft (pos.7) for all the rolls (pos.9) in the range. The cutting speed must have a value between 20-25 mm/min, obtainable if the lathe has a rotary speed of 300-350 rot/min.

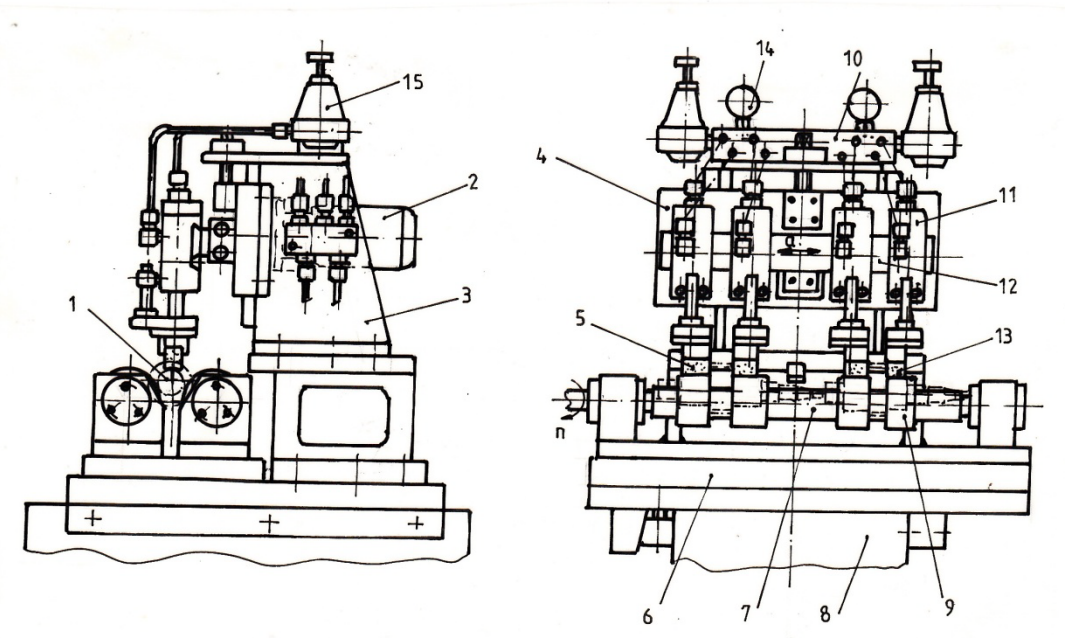


Fig. 2 *The superfinishing attachment to machining cylindrical surfaces of gear pump pinions.*

A very accurate positioning of the workpiece on the shaft (pos.7) is required, since between the external and the frontal surfaces there is only 1 mm (see the detail Z in fig.1). At the first working station, an abrasive stone (pos.5) is used with the granulosity of 600-800, while, at the second working station, the abrasive stone (pos.13) must have a grains size of 1200.

The abrasive stones are fixed on the supports (pos.11) that have a vibrating motion with an amplitude a = 1-2 mm and a frequency f = 1500 double stroke / min. All this assembly is set up on the plate (pos.4), where a mechanical generator, supplied from the electric motor (pos.2), could be found as well. The cutting force is achieved pneumatically through the agency of a regulator (pos.15) and a manometer (pos.14) mounted on the pneumatic distributor (pos.10). The processing lasts between 25-35 seconds and a new piece for processing will be manually placed. In order to process other type of work piece, a few adjusting movements are necessary. First, the rolls (pos.9) must be adjusted and fixed in a new position. Then, the abrasive stones for each working station will have a new dimension according to size K (fig.1). The last adjustment is made to regulate the compressed air pressure, by means of a regulator (pos.15) and to check-up with the manometer (pos.14). All this preparations are made at the beginning of the processing operation and take only 20-22 minutes, but results in a good flexibility for this superfinishing method.

3. Method of superfinishing flat surfaces of gear pump pinions

The flat surfaces of the gear pump pinions must have a high quality, as it is shown in Fig.3 and table 1 [1]. These parts could have a wide range of dimensions and are very restrictive in what concerns the shape and positioning errors, as it is indicated in Fig.3. The width "b" has a value between 2, 215 – 66, 35 mm and the variation of this dimension before and after the processing goes from 0,010 to 0,015 mm.

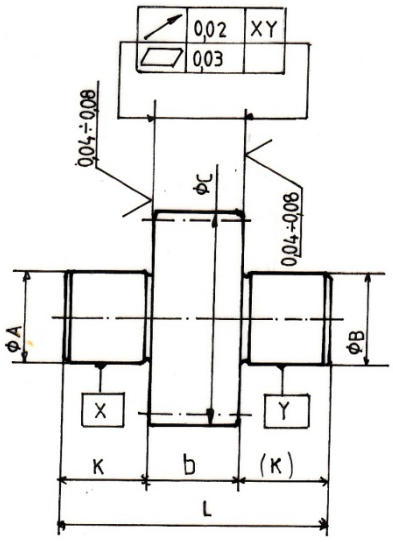


Fig.3 *Schematic illustration of a gear pump pinion whose flat surfaces are machining by superfinishing.*

3.1 Technological equipment to superfinishing flat surfaces of gear pump pinions

A superfinishing attachment, adaptable on the engine lathe, was designed in order to achieve a good quality of the mentioned plane surfaces (Fig.4). The presented method involves two working stations having the same construction. The only difference between the two working stations refers to the grain size of the abrasive stones to be used. So, for the first working station, the grain size is 600 while for the second, this is equal to 1200 [1].

The workpieces are fixed between the two centers of the lathe from which, one is movable. The rotary motion for the workpiece is achieved by the means of the following chain: lathe motor, gear, (pos.11), shaft (pos.1), gear (pos.3). The cutting speed must have a value between 20-25 m/min. The different cutting speeds for different sizes of work piece are obtained by only changing the gear (pos.15).

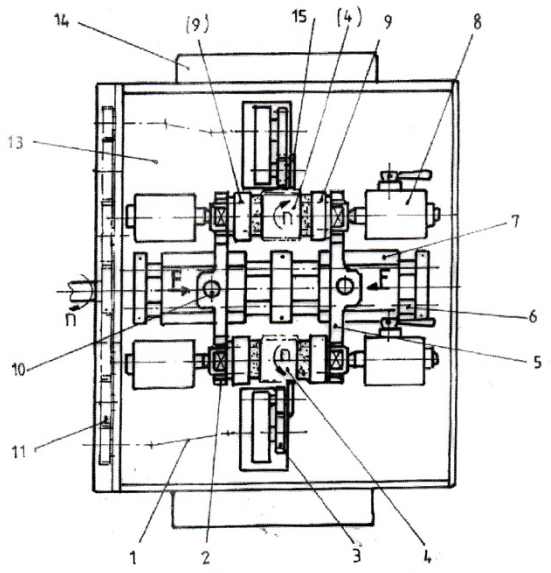
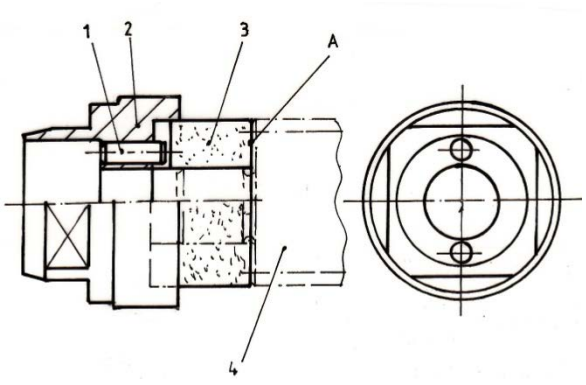


Fig.4 *Superfinishning attachment to machining flat surfaces of the gear pump pinions.*

The cutting force is achieved by the means of the pneumatic engine (pos.7) that has a longitudinal movement along the rods (pos.6). The body of the abrasive stones (pos.3) is fixed in the support (pos.2) and the bolt (pos.1). For each type of work piece, there is a type of abrasive stone that is fixed on the lever (pos.5) of the pneumatic engine, in a square space that ensures a good position during the processing.



The attachment system of the abrasive stone has two degrees of freedom, one of them given by the turning of the lever (pos.5) around the pin (pos.10) and the other, given by the turning of the tool support in the lever (pos.2). These two degrees of freedom provide a good positioning of the tool on the plane surfaces of the work pieces, which doesn't depend on the accuracy of the work pieces placing between the lathe centers. In that case it is possible that the longitudinal positioning errors of the work piece

The machining process is performed by the means of an abrasive tool, presented in Fig.5.

In order to process another type of work piece, it is only necessary to change the abrasive tool (fig.3) and to make an axial adjustment, according to the length of the work piece. The processing lasts 33 – 35 seconds and the resulted roughness of the surfaces is R_a = 0.04 – 0.08 μm.

4. Conclusions

The equipment for superfinishing the external surfaces, including two working stations, has the advantage of a large flexibility in processing all range of work pieces and of the possibility to be mounted on all types of universal lathe. The accurate position of the work pieces and the mechanical generation of vibrations can provide a good control of the stones movement.

This constructive solution represents an original system to machining flat surfaces and can be used for any other type of work piece [2]. The device was designed as easy-to-make equipment and it also has a great productivity.

Fig. 5 Abrasive tool to machining flat surfaces.

References

[1] Buzatu, C., Piukovici, I., Nedelcu, A., Lepadatescu, B: Processing work piece finishing in manufacturing technology, Lux Libris, Brasov, 1998.

[2] Lepadatescu, B.: Study of processing by superfinishing with abrasive tools – Master degree thesis, Brasov, 1998.

[3] Gebhardt, E., - Methods of finishing for manufacturing cylinders of rolling mills – In Werkstatz und Betriebs no.1, 1979.

[4] Harris, C.M., - Shocks and vibrations. Editura Tehnica, Bucuresti, 1985.

[5] Borkowski, J., A. Szymanski., - Uses of Abrasives and Abrasive Tools. Chichester, Eng.: Ellis Horwood, 1992.