

Technological Equipment for Finishing Treatment

Oleksandr Gavrilchenko¹, Viktor Zakharov², Vitaliy Korendiy¹

¹Department of Mechanics and Automation Engineering, Lviv Polytechnic National University, UKRAINE, Lviv, S. Bandery street 12, E-mail: vitaliy.nulp@gmail.com

²PAT "Iskra", UKRAINE, Lviv, Vuletska street 14, E-mail: vktzakharov@gmail.com

Abstract – The known methods of lap finishing (lapping) of vibrating finishing machines with circular trajectories of lap oscillations are analyzed. The theoretical overview of lap finishing (lapping) with the laps placed in the area of circular sector is presented in this paper.

Key words – abrasive, lap, vibration processing tool, lapping.

I. Introduction

The achievement of high indexes of flatness (planeness) of the working surfaces of machine parts, which are being worked up during finishing treatment, directly depends on the shapes accuracy of laps working surfaces of finishing machine. Taking into account the mentioned fact, we may state that the adherence to shape accuracy of laps working surfaces in the course of time is very important problem. The most perfect its solution is using of finishing machines, which allow the use of combined and kinematic dressing of laps working surfaces with a help of special dressers and parts which are being worked up.

II. Purpose of Investigation

The purpose of presented paper is carrying out of analysis of finishing equipment in order to ensure further improvement of technological processes of finishing lapping.

III. Main Material Presentation

The mechanisms of drives set in relative motion of parts along the laps working surfaces by combining of rotary, oscillatory and translational motions of laps with the motions of separators, in which the parts are placed and may be worked up being moved in cycloid, epicycloid, raster and involute paths.

The prospective method of parts machining is vibration lapping which is being carried out on various types of vibrating finishing machines.

Angular paths of oscillations of each point of laps and parts, which are being machined, cause the complicated character of vibration finishing treatment. In this case, the conditions of even (uniform) wear, quality improvement and accuracy increasing are ensured.

The drawback of all vibrating finishing machines, which use angular and circular oscillations, consists in the fact that the oscillations amplitude and as a result the wear rate is proportional to centers radiuses of separators with parts. This fact causes the decreasing of accuracy and quality of lapping due to spotty (irregular) wearing of working surfaces of laps and parts.

This drawback is absent in parts lapping technique by using which the lap is set in motion along two relatively perpendicular directions with different frequencies. In this case, each point of the lap describes the path in the form of raster, filling the area of rectangle. Vibrating finishing machines which ensures raster lapping technique allow considerable increasing of accuracy and quality of lapping and ensure high productivity. However, the use of crank-connecting rod, lever, and rack mechanisms as drives considerably reduces the reliability of machines because of the presence of friction units and high dynamic loadings.

In [1] the specific technique of vibration lapping is presented. The laps, between which the parts are placed, are set in directed circular motions in the plane of laps working surfaces. To ensure the additional rotary motion of parts around the axes of laps, the laps are set in motions the paths of which describe a cone.

According to this technique the two-disc vibrating finishing machines of PR 378 and PR379 types were developed. They ensure high productivity of lapping, high planeness (flatness) of parts (up to 0.001 mm on the diameter of 30 mm) and surfaces roughness ($R_a = 0.16-0.04$). The drawbacks of these machines consist in the following: the vibration exciter set in motion only the lower lap; vibration exciter with unbalanced mass reduces the reliability of such machines due to friction units, transmission of dynamic loadings to the machine frame and does not ensure the evenness (uniformity) of wearing of the laps working surfaces because of impossibility to control the parts lapping mode during the finishing process.

Taking into account the carried out analysis of existing structures of vibrating finishing machines, the two-mass vibrating finishing machine, which consists of two laps which are set in oscillatory motion with a help of six pairs of electromagnetic vibration exciters, was developed in Lviv Polytechnic National University. The electromagnetic vibration exciters set the finishing laps in antiphase translational oscillations with circular paths, which are parallel to the working surfaces of laps.

Compound planetary motions of the parts, which are being machined, are ensured due to using of lower lap oscillations. By using of specific technique of the parts and dressers placing on the working surfaces of laps, presented in [1], the opportunity of using of combined and kinematic dress and the evenness (uniformity) of wearing of the laps working surfaces are ensured.

The absence of friction units in the working zone increases the reliability of machine and ensures improved roughness of the parts surfaces which are being machined.

The drawbacks of presented structure are following:

- low productivity due to small speed of rotation of separator with parts (up to 5 rpm);
- losses of the efficiency coefficient of electromagnetic exciter due to increasing of power consumption during the increasing of the amplitude of the laps oscillations.

At the present time, existing two-mass vibrating finishing machines are structurally complicated and power-intensive.

The development and designing of energy-conservative vibrating machines may be improved by using the theory of in-phase oscillations [2; 3]. The active in-phase

movements ensure the minimal value of air clearance in electromagnetic vibration exciter because of the absence of relative amplitudes of oscillations between two contiguous masses. This fact allows considerable reducing of the current value, which flow in the windings of vibration exciters as it is presented in the Fig. 1.

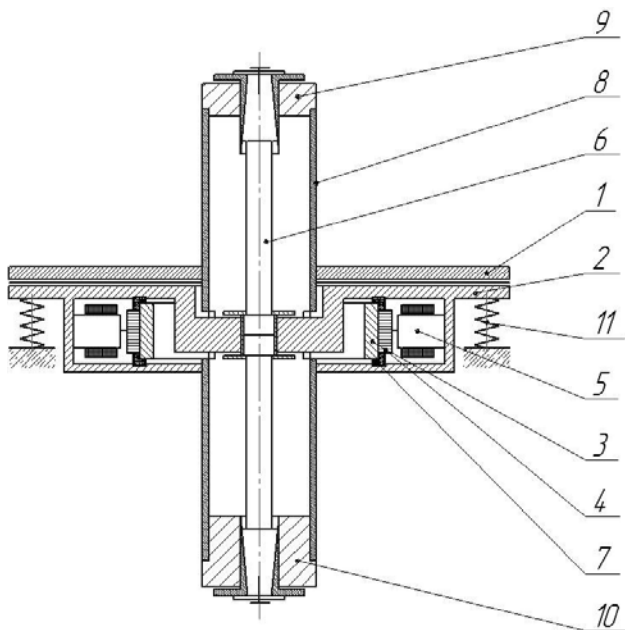


Fig. 1. Three-mass vibrating machine for finishing treatment

The machine consists of the overhead 1 and lower 2 laps, which are placed concentrically one with respect to another, and ring-type reactive mass 3, which is attached to the lower lap 2 with a help of elastic rubber rings 7. The armatures 4 of electromagnetic vibration exciter are places symmetrically on the circle and are fixed on the ring-type reactive mass 3. The cores with coils 5 are placed symmetrically on the circle and are fixed under the lower lap 2. The center of the vertically placed elastic rod 6 is rigidly constrained in the lower lap 2. The flanges 9 and 10 are attached to the ends of the rod and connected with each other by the empty cylinder 8, which is attached to the upper lap 1. The frame of the machine is placed on the vibration absorbers 11, which are attached to the lower lap 2. The separator with parts, which are being machined, is placed between the laps.

The presented vibrating finishing machine with electromagnetic drive forms the resonance three-mass oscillating system, which consists of only one elastic rod that represents one resonance elastic system. Instead of second elastic system the rubber seals were used. This structural concept ensures considerable simplifying of the machine structure. By choosing the inertial parameters of the reactive mass, which allows its in-phase motion relatively to the lower lap, we may minimize the influence

of the amplitudes of each lap motion on the air-gap (air-clearance) of electromagnetic vibration exciter. This concept considerably increases the efficient tractive force of electromagnets and the efficiency coefficient of the vibrating finishing machine.

On the basis of analysis of one-disc and two-disc structures of vibrating finishing machines for plane-parallel lapping of surfaces of precise parts, it is proposed to develop vibrating finishing machines, which consists of two laps. The laps are set in oscillatory motion by electromagnetic vibration exciters, which ensures the in-phase translational oscillations of laps in the form circular paths of equal amplitude that are parallel to the working ones.

Conclusion

On the basis of carried out analysis of existent structures of finishing machines, we may state the following conclusion. The vibrating finishing machines with circular paths of the laps oscillations have the following advantages:

- these machines ensure the stable wearing speed of each point of the finishing lap due to the constant amplitude of the drive oscillations;
- by using the technique of parts placing on the working surfaces of the laps, presented in [1], we may obtain the evenness (uniformity) of wearing with the use of combined and kinematic dressing and considerably increase the period between two scheduled dressings of the laps working surfaces;
- these machines allow to perform machining (working) of thin, flat and brittle parts at non-fixed free state;
- these machines have minimal overall dimensions and need lower drive power;
- the use of presented machines allows increasing of lapping productivity 2-2.5 times;
- the finishing treatment, made with a help of these machines, ensures the high roughness rating (degree of roughness) of the surfaces, which are being machined, with the planeness (flatness) deviation that is equals 0.1-0.01 μm .

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