

Ruslan Gorbatyik*, Igor Palamarchuk*, Roman Chubyk**

*Vinnitsia National Agrarian University, Vinnitsia, Ukraine

**Drogobych State Pedagogical University, Drogobych, Ukraine

ELECTROMECHANICAL MODEL OF MACHINE FOR VIBROABRASIVE TREATMENT OF MACHINE PARTS

Received: May 19, 2015 / Revised: August 12, 2015 / Accepted: September 16, 2015

© Gorbatyik R., Palamarchuk I., Chubyk R., 2015

Abstract. A lot of operations on trimming clean and finishing – stripping up treatment, first of all, removing of burrs, rounding and processing of borders, until recently time was carried out by hand, and hardly exposed to automation and became a serious obstacle in subsequent growth of the labor productivity. Machines with free kinematics connection between a tool and the treating parts is provided by the printing-down of all of the surface of the machine parts, that allows us to effectively treat both internal and external surfaces of the machine parts. The analysis of literary sources, patents and charts of methods of the intensification of the processes of vibro abrasive treatment, allowed us to determine the basic directions of development of vibro machines constructions for intensification of the trimming - stripping of the machine parts in a freely granular environment in default of hard kinematic connection between the parts and the tool. The feature of vibro abrasive treatment is a free kinematic connection between a tool and the machine parts, i.e. there exists complication in providing with the stable beforehand set technologically optimum influence of abrasive grains on treated parts under variable parameters of the working chamber of vibroabrasive machine. The purpose of this work is the development of a structural electromechanical model of a vibromachine for adaptive vibroabrasive treatment of the machine parts. To solve this problem, the structural electromechanical model of vibromachine for adaptive vibroabrasive treatment of machine parts was developed. The offered machine is able to provide minimum energy consumption on the vibrodrive of vibroabrasive machine due to providing and maintenance of the permanent resonance mode of operations of working chamber.

Introduction

With the increase of requirements for the quality of products of mechanical engineering and instrument-making, the growth of amount of finishing – stripping of the details is observed. Most labour intensive is treatment of details of the complicated configuration, by cavities of asymmetric form.

According to existed classification, based on the principle of power influence, the methods of the, chemical and combined treatment are distinguished. Thus advantage is given to the methods of treatment, based on the use of flexible instruments and mediums – vibro abrasive treatment [1, 6], tumbling, centrifugal-abrasive [7], centrifugal, stream-abrasive, magnetic abrasive [8], to treatments by the compressed streak of abradant, ultrasonic treatment, treatment by mechanical abrasive brushers and leaf-typed circles, some methods of treatment with a plastic deformation, by metallic blades instrument, thermo oxidizing and electro chemical treatment (processing).

Problem statement

A lot of operations on trimming clean and finishing – stripping up treatment, first of all, removing of burrs, rounding and processing of borders, until recently time was carried out by hand, and hardly exposed to automation and became a serious obstacle in subsequent growth of the labor productivity. Complication and variety of forms of surfaces which must be treated, complicate the creation of universal kinematics schemes of equipment and proper instruments. In this connection, during the development of methods of trimming clean up treatment often the advantage is given to the use of flexible environments

and instruments ([9] which eliminate high conditions to exactness of relative orientation of treated detail and instrument. In addition, here, as a rule, secured the treatment of all the surfaces of details and is possible simultaneously the treatment of plenty of details, which provides a high productivity. Advantage of flexible environment and the instruments appears also in intermutation of the elements, conjugation of interface of contiguous surfaces of the details, while maintaining their perpetuity and continuity. This is achieved by formation of a transition element with a minimum radius between adjacent surfaces.

On the development of finishing polish and finishing – stripping treatment and the methods of treatment were defined scientific and practical groups and their associations, the systematical work [10] in technology is conducted, created the equipment, work environments and tools. Thus, in the sphere of vibration technology (vibro abrasive treatment) a complex of works on research and technology development (processes) is executed for to implement them in the industry with the production and supply of equipment, working environment and process liquids. The use of vibrating action [11] during the vibro abrasive treatment enables gives an opportunity along with the increase of intensity more evenly to treat the production, to optimize the process vibro treatment.

Analysis of modern information sources on the subject of the article

The machines with the free kinematics connection between an instrument and the details is provided by the printing-down of all of the surface of the details , that allows effectively to treat both internal and external surfaces of the details. At the same time, these machines [12] are different from other analog machines by simplicity of structural implementation and lightness of automation of the process of production and provide enough high performance of work. The process of treatment takes place under the action of freely granular working environment. In general case a working environment contains hard and liquid stuffs. Hard stuff shows by itself a cutting and deforming instrument or environment which prevents a mutual collision and clinging of the details. Liquid stuff is utilized for providing of delete of products of wear of the details and working granules, moistening and cooling of technological loading, intensification of the process of treatment (chemical and superficial active matters), storage of technological properties of hard stuff (for example, for prevention of “contamination by fat” of abrasive granules).

Absence of hard kinematic connection between the details and the instrument predetermines equable treatment of surfaces of the same type of part blanks (in the places of transition from one surface to another more intensive treatment is observed), but eliminates possibility of the managed influence on geometrical sizes and form of the details. In this case the parts of the mossy (granular) fill continuously flows around the surfaces of the details, leading to micro cutting, plastic deformation and promotes the realization of cleaning, polish - finishing and fortifying operations. For the effective, uniform and comprehensive treatment of the details in the absence of the hard kinematic connection between the details and an instrument it is necessary to provide three basic conditions: to give to the working environment the sufficient level of kinetic energy; to create the maximal difference of speeds between the details which are treated and by the abrasive granules of working environment; to provide regular and intensive shuffle of details and working environment.

The analysis of literary sources, patents and charts of methods of the intensification of the processes of vibro abrasive treatment, allowed to determine the basic directions of development of vibro machines constructions for intensification of the trimming - stripping of the details in a freely granular environment in default of hard kinematic connection between the details and the instrument.

Among the class of machines for vibro abrasive treatment [12] as most perfect and most perspective for subsequent development should be noticed the structural decision (Fig.1) [13] of machine for vibroabrasive treatment of details. This vibromachine [13] (Fig.2) refers to the vibro machines for trimming - stripping of details in a freelygranular environment with a cylinder partly flexible working chamber which is equipped with the mobile motion activator of working environment.

One of differences of the construction (Fig.1, 2) presented below, there is a presence of unbalanced of the motion activator of working environment, that allows to intensify the treatment of surfaces of the details.

The increase of intensity of vibro treatment in the given vibromachine is achieved by the increase of the size of the impulses which are passed to the working environment and mutual rate of movement of granules of working environment and treated details. The treated details with a working environment 14 through vent 15 are loaded in a container 1. Electric motor 8 through an elastic coupler 6 passes revolving moment on a shaft 11 with debalances 12. The activator 10 vested to the container 1 on a elastic hanger 9, carries out a hesitating motion the trajectory of which is close to the circle. Simultaneously with an activator 10 through an elastic coupler 6 from an electric motor 7 which gives to the container 1 vibration motions. The given vibro drive gives an activator 10 and to the container 1 vibrations, frequency and amplitude of which can change (in wide limits, that additional energy which is given by an activator 10 and by a container 1 to the working environment 14 with the details is added adjusting in a wide range, that it is important for the choice of the optimum of treatment of those or other details and materials.

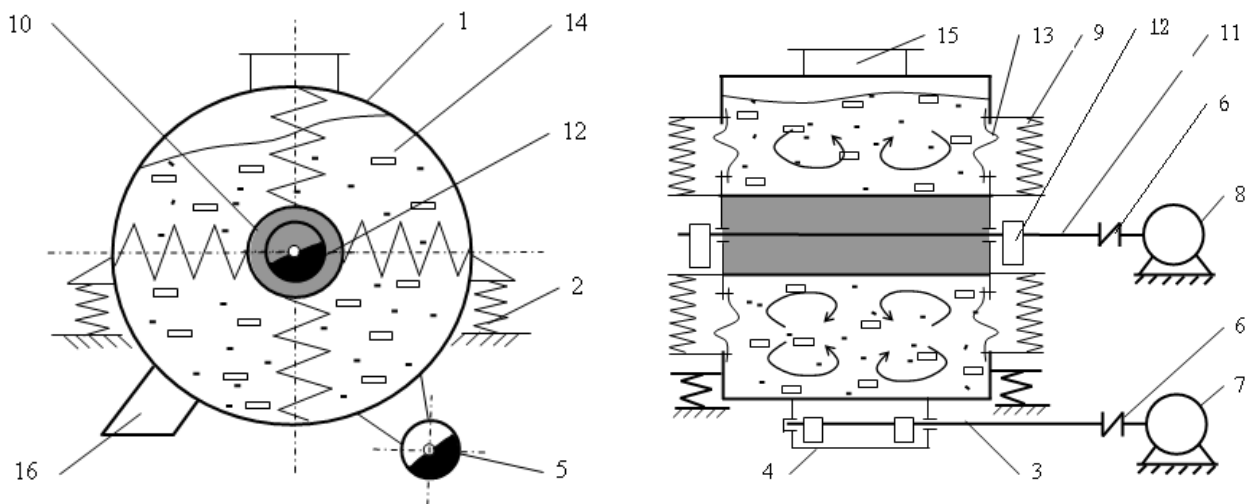


Fig. 1. A structural decision of device for vibro abrasive treatment of details

In addition, by regulation of rotation frequency of vibrodrive of activator 10 and container 1, it is possible to attain that activator 10 will vibrate in ant phase with a container 1. It will allow, at large enough amplitudes, in a few times to increase dynamic pressure of working environment 14, that will allow to intensify the process of vibro treatment. Layers of working environment and details 14, that are placed near the surface of container 1, move in the direction opposite to the direction of rotation of shaft 3 vibro exciters of container 1, and layers of working environment and details which are placed near the surface of activator 10 move in the direction opposite the direction of the rotation of shaft 11 vibro exciter of activator 10. Consequently the layers of working environment and details, which are located near the surface of container, move towards the layers of working environment which is round an activator 10. Such character of motion of working environment and details increase the productivity of the process of vibro treatment due to the increase of speed of the relative mutual moving of granules of working environment and treated details. Intensity of the mutual moving of working environment and the details which are located in the central part of container relatively of the same working environment and details which are located in peripheral part of container is also increased due to the vibrations of elastic cheeks 13 of container 1. After the completion of the process of vibro treatment the working environment 14 and the treated details unload through a neck outcome 16.

Structural decision [13] thanks to antiphase motion of activator 10 and container 1 allows effectively to force (to intensify) moving of granules of working environment and treated details, however don't allows to manage the size of energy which is transferred to the working environment from an activator and container. In other words at the different weights of loading with the details of vibro machine container (Fig. 2) will be a different amplitude of oscillations of the working environment (at constant frequency of oscillations of container and activator), and this will affect on the change of the specific work of the field of the container of vibro machine [13].

Two variants are possible as a result of this: the increase of specific work of the oscillation field will lead to

the surplus surveying of metal from the surface of the details (as a result of polishing and smoothing) and in the case of reduction of the specific work of the oscillation field of container we will not get the products of the set quality for the given time of technological process. Another significant disadvantage of this machine for vibro abrasive treatment is impossibility to provide and support resonance regime of the work which in its turn does not allow to get minimum energy consumptions on vibrodrive of vibro abrasive machine [13].



Fig. 2. A general view of machine for vibro abrasive treatment of the details

Statement of purpose and problems of research

The purpose of the work is the development of structural electromechanical model of vibromachine for adaptive vibro abrasive treatment of the details. Which will be able to provide minimum energy consumptions on vibrodrive machines for vibroabrasive treatment due to providing and maintenance of the permanent resonance regime of work of operating chamber and will have a possibility of power-handling of the oscillation field (on resonance frequency of vibromachine) for providing of stable beforehand set value of specific work of the oscillation field of container. That would allow at different mass loading of the working container by treated details to get the set technological effect (the set class of roughness of the surface of details during polishing and grinding, the set size of descale from the surface of the detail, during taken off of wire-edges and finish – felling treatment, the set strengthening of surface by plastic deformation etc.) at minimum energy consumptions.

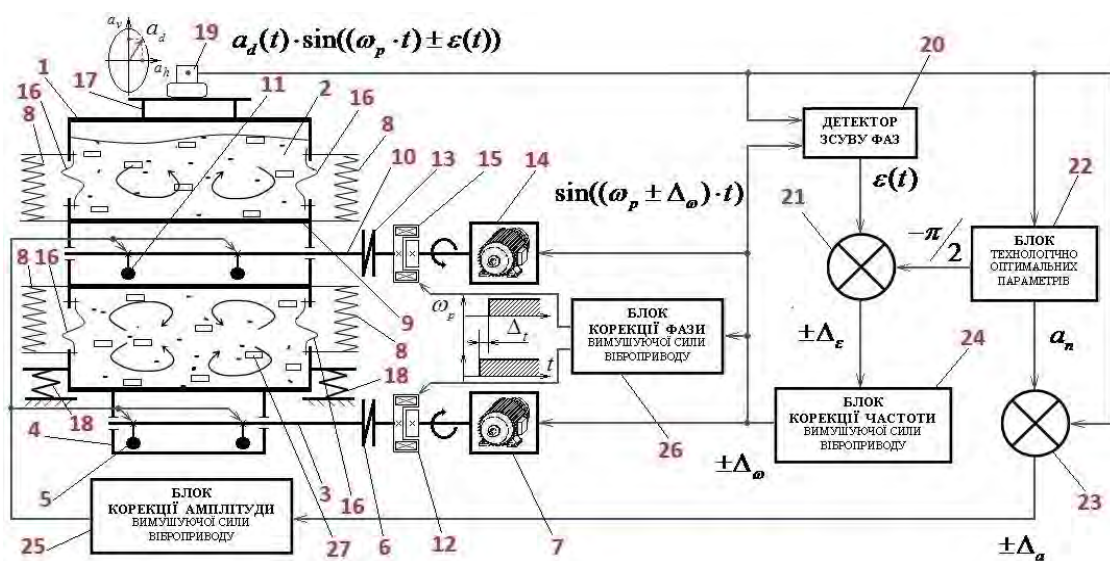


Fig. 3. A structural electromechanical model of oscillation technological machine for adaptive vibroabrasive treatment of details

Exposition of basic material

For realization of self-adjustment of the vibration system of machine for vibroabrasive treatment of the details on permanent resonance regime of work, it is necessary to apply the method of adaptation to the resonance mode of work of, which is described in the work [14]. For stabilization of the specific work of the oscillation field of working chamber of vibromachine it is necessary to apply two distantly – controlled debalanced vibrodrives. On the base of which it is expedient to realize the technique of stabilization of technologically optimum parameters of the oscillation field of vibration [15, 16]. On the basis of the above enumerated methods of controlling and stabilizing of parameters of the vibration field and the effective method of passing of impulse to the working environment, which is realized in the work, synthesized the structural electromechanical model of vibration technological machine [13] (Fig. 3 and Fig. 4) for adaptive vibro abrasive treatment of details.

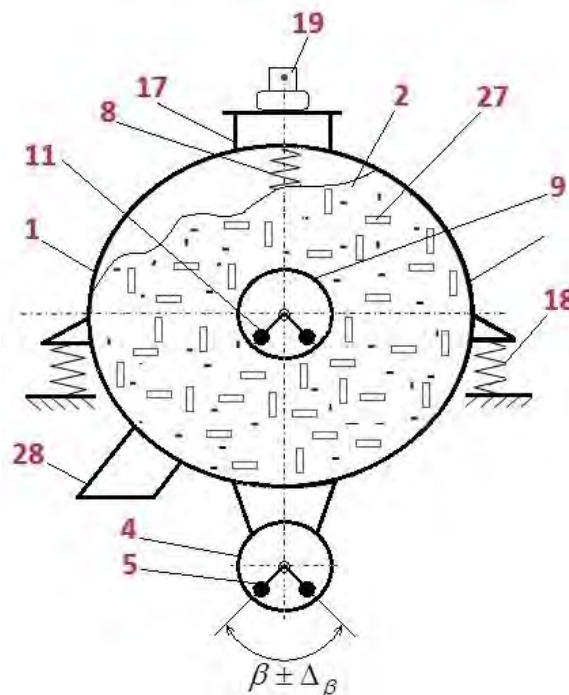


Fig. 4. The structural diagram of location of an operated synchronous debalanced vibrodrive of container and activator, in a machine for adaptive vibroabrasive treatment of details

On Fig. 3 and Fig. 4 the electro mechanics model of oscillation technological machine for adaptive vibroabrasive treatment of details. is represented .This vibromachine consists of resiliently set on the springs of a 18 container 1, which is filled with a working environment 2 and by treated details 27. In the underbody of container 1 a shaft 3 is placed of the lower guided debalanced vibrodrive 4, which has possibility [17] remotely to change the eccentricity of centre-of-mass debalances on account of an angle $b \pm \Delta_b$ between them. The shaft 3 through an elastic 6 [18, 19] is connected with an electromagnetic powder-like coupler 12 [20, 21], and it is connected with an electric motor 7. In the central part of container 1 placed on springs 8 the central body 9 (activator), which consists of shaft 10 and debalances 11 which have a possibility [17] to change distantly the eccentricity center of mass. Shaft 10 through an elastic coupler 13 is connected with an electromagnetic powder coupler 15, and it is connected with an electric motor 14. Activator 9 is connected with a container 1 with the help of elastic walls 16. From above the container 1 a loading chamber is roared 17, and from below unloadingchamber 28. To the load chamber 17 (or to upper part of container 1) Stiffly fastened the sensor of vibration 19 which is connected with one of the of the detector phase shear 20 with the one of of block of technologically optimum (parameters 22 and with one of of comparator 23.

The second of comparator 23 is connected with one of outputs of the block with technologically optimum parameters 22, and the second output of the block with technologically optimum parameters 22 is connected with one of comparator 21. The second input of comparator 21 is connected with the output of detector of change (of phases) 20, and the output of comparator 21 is connected with one of the outputs of the block of correction of frequency of extorted force of vibrodrive 24. The output of the block of correction of frequency of extorted force of vibrodrive 24 is connected with electric motors 7, 14 and is connected with one of the outputs of detector of phases shear 20 and the output of block of correction of phase of extorted force of vibrodrive 26. The outputs of the block of correction of phase of extorted force of vibrodrive 26 are connected with electromagnetic powder couplers 12 and 15. The output of comparator 23 is connected with the entrance of the block of correction of amplitude of extorted force of vibrodrive 25, and the output of this block is connected with the guided debalances 5 and 11.

The machine for adaptive vibroabrasive treatment of details works as follows. The treated details 27 with a working environment 2 through a chamber 17 are loaded into the container 1. In the process of launching of the machine for adaptive vibroabrasive treatment of details on frequency of work w (which does not equal to the natural resonance eigen frequency w_0 of the vibrational system of device of container 1 which is full with the details with certain general mass) electric motor 7 passes a rotation moment to the electromagnetic powder coupler 12. Coupler 12 on a command from the block of correction of phase of extorted force of vibrodrive 26 passes this rotary moment to the elastic coupler 6, this coupler 6 passes to a rotary moment of the shaft 3, that results in the rotation of debalances 5 (with the variable eccentricity of centre of mass) the guided debalanced vibrodrive 4. As a result, container 1 starts to realize the vibrations ellipsoidal trajectory from the real amplitude a_d (Fig. 5). The vertical component a_v of the amplitude of vibrations of container 1 (in the given case at constant w) is determined by the value of the angle b between the centers of mass of debalances 5 on the shaft 3. Along with the container 1, details 27 and the working environment 2 varies activator 9 (the central body), but activator 9 ranges always to meet the container 1.

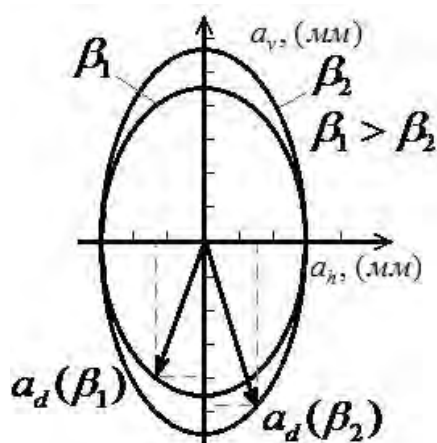


Fig. 5. The connection between the vertical component of amplitude of vibrations of the container 1 and the angle between the centers of mass of controlled debalanced vibrodrive

Such a character of vibration of the activator 9 is conditioned by the fact, that after engaging of the controlled debalanced vibrodrive 4 by an electromagnetic powder coupler 12 through the interval of time Δt the block of correction of phase of extorted force of vibrodrive 26 starts (turns on) an electromagnetic powder coupler 15. As a result she (15) transmits rotary moment from the electric motor 14 (which works on the same frequency w as the electric motor 7, but rotates in the opposite direction to it) to the elastic coupler 13, shaft 10 and driven debalances 11. Due to delay of starting of controlled debalanced vibrodrive - activator 9 on lapse of time Δt upper controlled debalance 11 begins to rotate with a frequency w in the opposite direction at that time when the lower controlled debalances 5 which are located in the upper point of the trajectory. Taking into account the fact that w of electric motors 7 and 14

have the same mass and dynamic characteristics of the top 11 and bottom 5 controlled debalances, in the steady regime after the starting we get their synchronous movements with some given phase. That is in the process of synchronous work of motors 7 and 14 they (debalances 5 and 11) will meet at the moment when the lower debalance 5 will be at the top point of the trajectory, the upper debalance top 11 in the lower point of the trajectory. At such motion (on meeting) of container 1 and activator 9 to the working environment 2 the energy is passed in the figure of the shock impulses. Thus the impulses which are transmitted from a container 1 to the environment 2 clashes with impulses which are transmitted from an activator 9 to the working environment 2, that is why general energy which gets working environment 2 equal to their sum. Also such a character of motion of container 1 and activator 9 creates the meetings streams of granules of working environment 2 and processing details 27. According to [13] the layers of working environment 2 and the details 27 which placing near the surface of container 1, moving in the direction opposite to the direction of rotation of the shaft of the controlled debalanced vibrodrive 4, and layers of working environment 2 and the details 27 which are placed near the surface of the central body 9 (activator) such a character of motion of the working environment 2 and the treated details 27 activates the technological process of vibroabrasive treatment of the details in a machine at the expense of the mutual speed of shifting of the grains of the working environment 2 and treated details 27.

After the starting of the mechanism (time 2-3 seconds) for adaptive vibro abrasive treatment of the details in the initial frequency w , during the stabilization of the vibration of the container, that is in the determined regime, the sensor of vibration 19 receives information about the dynamic parameters of container 1, in particular : amplitude $a_d(t)$, frequency $w_p(t)$ and phase $e(t)$, his vibration in the next form $a_d(t) \cdot \sin(w_p \cdot t \pm e(t))$. The given information comes to the detector of the phase shear 20, the block of technologically optimal parameters 22 and comparator 23. The second input of phase shift detector 20 receives the information $\sin((w_p \pm \Delta_w) \cdot t)$ about the corrected on the value $\pm \Delta_w$ (valid at this stage) the frequency of the work of the controlled debalanced vibrodrives (5, 11) container 1 and activator 9.

In other words in a block 20 in accordance to [14] we have comparison of two harmonious signals for the presence of the shift of phase of vibrations of container 1 relative to extorted cyclic force of the controlled debalanced vibrodrive of device for the adaptive vibro abrasive treatment of the details.

In other words, a block 20 of the detector of the phases shift conducts the permanent monitoring of reactions of the container 1 on a revolting factor (extorted cyclic force). According to [14] at the forced vibrations these signals have identical frequency, and at resonance phase $e(t)$ of amplitude of vibrations of container 1 will build on for adaptive vibroabrasive treatment of the details falls behind on an angle $p/2$ from the amplitude of cyclic extorted force of the controlled debalanced vibrodrive.

In such a way, the change of the mass of the details 27 by which the container 1 is loaded (charged) and the working environment will cause a change in its own resonance frequency of the device for adaptive vibroabrasive treatment of the details, and that at a constant (fixed) frequency of the controlled debalanced vibrodrive $w_p(t)$ cause [14] changes the angle of phase shift between the container 1 and cyclic extorted vibrodrive force.

That is why, while correcting ($\pm \Delta_w$) the frequency $w_p(t)$ of the extorted cyclic force of the controlled debalanced vibrodrive device for adaptive vibroabrasive processing of the details one or another way you can draw up from its own resonance frequency and thus change the magnitude of the phase shift between the container 1 and vibrodrive (5 and 11). Based on this in the comparator 21 the comparison of the phase shift between the current at a frequency w_p of controlled debalanced vibrodrive with the necessary optimal (from the energy point of view) value shift lagging $-p/2$.

Optimum value comes from the comparator block technologically optimal parameters 22, where the operator entered vibromachines. In the result of comparison of the information in the comparator 21, we

get the value, the value $\pm\Delta_e$ indicating how much vibrative system (container 1) deviated from the resonant mode, and its sign ($\pm\Delta_e$) indicates to what side the vibrating system of vibromachines departed from the resonant mode. On the basis of the magnitude and the sign $\pm\Delta_e$ in the block of the correction of the frequency w_p of the extorted vibrodrive force 24 on the basis of the laid down in it controlling laws (implemented in the classical functions) the determination of the magnitude and the direction of correction $\pm\Delta_w$ of the frequency of the extorted force of vibrodrive.

Corrected frequency $w_p(t) \pm \Delta_w$ of the extorted vibrodrive force will converge over time to its own resonance frequency w_0 of the container 1, owing to the operation $\pm\Delta_w$, until $w_0(t) = w_p(t) \pm \Delta_w$, that will not become equal $e = -p/2$.

Adaptation of frequency of the guided debalanced vibrodrive (5 and 11) for the resonance frequency of the mechanical vibrating system of vibromachine $w_0(t) = w_p(t) \pm \Delta_w$, allows to provide the permanent resonance mode of operations of container 1 at arbitrary (to different) mass of his load (will build on for adaptive vibroabrasive treatment of details) as by a working environment 2 by treated details 27.

Resonant mode of the device for the adaptive vibroabrasive processing of the details ensures minimal energy costs of the vibrodrive for the implementation of the technological process 1.

A constructive decision given on the fig. 3 and fig. 4 allows to realize not only energetically optimal regime of work of the machine for adaptive vibroabrasive treatment of the details but also to set technologically optimal regime of work at minimum energy expenses on a vibrodrive.

A necessity and expedience of the realization (for control and stabilization) of technologically optimum parameters of vibroabrasive treatment of details is conditioned by the vibroabrasive treatment must be done at set (determined) period of time at given dynamic parameters of the container 1. Under the dynamic parameters of container 1 it is possible to understand the amplitude and frequency of his vibrations. Inobservance of these dynamic parameters of container 1 during the set interval of time for vibroabrasive treatment of the details is the reason for violation of technology of treatment of details. Uncontrolled rejection of the dynamic parameters of the container 1 during the time of technological treatment in a less side will be a reason for obtaining of other from the set class of roughness of surface of details (at polishing and grinding), other size of remove of the metal, from the surface of the detail (at taken off of the wire-edges and at finish- stripping treatment). In such case the prepared products (treated details 27) on the merits will be defective. Rejection in the greater side of dynamic parameters of container 1 during the time of technological treatment in general can result in destruction of the details by the way of grinding (this vibromachine can be examined also as a vibro mill [22]).

On the basis of investigations [23, 24, 25] it is reasonable for the criterion of evaluation of dynamic parameters of the device for adaptive vibroabrasive treatment of details to take specific work $A_p = w_p^2 \times a_d^2$ of the vibrative field (working environment) of container 1 or integral criterion (specific power) $I_p = w_p^3 \times a_d^2$ for the estimation of the equivalence of vibrations of different frequencies. Sergiev A.P. showed in his work [26], that the removal of metal at vibroabrasive treatment of details remains permanent at the preservation of the value regardless of value $w_p^2 \times a_d^2$ without depending on the significance of the amplitude and frequency. Physical maintenance of specific work of the vibration field $A_p = w_p^2 \times a_d^2$ can be understood from the general determination of work ($A = F \times s$), in general the work is equal to the result of the power F on moving s . Taking into account, that the force is expressed as the product of mass on an acceleration ($F = m \times a$) and taking note that during vibrating motion of vibromachine in a constant mode of moving of container 1 in general is described by an expression

$a_d \cdot \sin(w_p \cdot t)$. Taking the second derivative from moving and putting him in expression of the work we will get $(m \times a_d \times w_p^2) \cdot a_d$.

Going out from the calculation of necessary amplitude of vibrations a_n on this resonance frequency w_0 ($w_0 = w_p$) it is expedient to conduct from next correlation $a_n = [w_z^2 \times a_z^2] / w_0^2$, where w_z and a_z the optimum parameters of the vibration field are beforehand set from the technological point of view for vibroabrasive treatment of details in a container 1. Parameters w_z and a_z (the time of treatment is at such mode) entered by the operator of vibromachine directly into block of technologically optimum parameters 22, where also goes the information about the actual value of amplitude a_d and resonance frequency of vibrations of container 1 $w_0 = w_p$ from the sensor of vibration 19 in a next form $a_d \cdot \sin(w_p \cdot t)$.

As a result of treatment of information from the sensor 19 the block of technologically optimum parameters 22 conducts permanent determination (shortchanging) of necessary value of amplitude of vibrations a_n , for to provide the constant value of specific work ($A_p = w_p^2 \times a_d^2 = const$) of vibrational container 1 on this (to new) resonance frequency w_0 during the time of treatment set by an operator. Information about the necessary value of amplitude of vibrations a_n constantly comes to comparator 23 where compared to the actual the value of amplitude a_d .

As a result of comparison we get $\pm \Delta_a$ size (and direction) on which it is necessary to make correction of vibration amplitude of correction of container 1 for to ensure sustainability of specific work of vibration field ($A_p = w_p^2 \times a_d^2 = const$) within a specified time of vibro treatment. The values (and the direction) of correction of vibration amplitude of the container 1 $\pm \Delta_a$ is transferred to a block of correction of amplitude of extorted force (controlled) debalancial vibrodrive 25. The block (25) on the basis of the laws of controlling outted into it (realized on classical function) implements the correction $\pm \Delta_b$ of the angle value b between eccentricity centers of mass of debalances 5 and 11 (fig. 4), that leads to the change of value of the amplitude of cyclic extortial force of controlled debalance vibro drive for vibro abrasive treatment of the details. In the result of the change (reduction, extension) of the value change of cyclic amplitude of extortial force of controlled debalancial vibro drive change the amplitude of vibrations of container 1 (fig.5) on the side which provides the stability in the time of specific work of his (1) vibrational field.

Application in a structural decision (fig. 3 and fig. 4) of another control loop of adaptation of revolving factor (amplitude of cyclical power of vibro drive) allows to get the stable in time value of specific work of the vibrational field of container 1 and in that way provides valuable realization of technological process of vibro abrasive process of details 27.

Stability of specific work of the vibrational field of container 1 during time of technological treatment is the pledge of obtaining of the set class of roughness of surface of details (at polishing and grinding), set size of extraction of metal, from the surface of detail (at taken off of burrage and at finishing – felling treatment).

Conclusions

A structural electromechanical model of vibromachine was developed for adaptive vibroabrasive treatment of machine parts. It realizes minimum energy consumption of vibrodrive of machine for vibro abrasive treatment of machine parts due to providing and maintenance of the permanent resonance mode of operations of working chamber. During the operation in the mode of minimum energy consumption, the structural design of device for vibroabrasive treatment of machine parts allows us to control the energy of the vibrational field (at resonance frequency of vibromachine) for providing the stable beforehand set value of specific work of the vibrational field of container. That allows us under variable mass of loading of

working chamber (container) with the machine parts to get the set technological effect (set class of roughness of surface of machine parts after polishing and grinding, set size of removing of metal from the surface of the part after taking off burrage and finishing – clearing treatment, set strengthening of surface with plastic deformation and so on) at minimum energy consumption.

References

- [1] Бабичев А. П. Вибрационная обработка деталей / А. П. Бабичев. – 2-е изд., перераб. и доп. – М. : Машиностроение, 1974. – 256 с.
- [2] Бурштейн И. Е. Объемная вибрационная обработка. Рекомендации / И. Е. Бурштейн, В. В. Балицкий, Л. Ш. Духовский [и др.]. – М. : ЭНИМС, 1977. – 108 с.
- [3] Бабичев А. П. Вибрационные станки для обработки деталей / А. П. Бабичев, В. Б. Трунин, Ю. М. Самодумский [и др.]. – М. : Машиностроение, 1984. – 168 с.
- [4] Бабичев А. П. Конструирование и эксплуатация вибрационных станков для обработки деталей / А. П. Бабичев, Л. К. Зеленцов, Ю. М. Самодумский. – Ростов-н-Д. РТУ, 1987. – 156 с.
- [5] Бабичев А. П. Вибрационная обработка деталей в абразивной среде / А. П. Бабичев. – М.: Машиностроение, 1988. – 91 с.
- [6] Бабичев А. П. Основы вибрационной технологии: ч 2. Технология вибрационной обработки : учеб. пособие / А. П. Бабичев // ДГТУ. – Ростов-на-Дону, 1994. – 89 с.
- [7] Субач А. П. Динамика процессов и машин объемной вибрационной и центробежной обработки насыпных деталей / А. П. Субач. – Рига : Знание, 1991. – 400 с.
- [8] Барон Ю. М. Магнитно-абразивная обработка / Ю. М. Барон. Механизация и автоматизация производства. Машиностроение. – М., 1990. – № 5. – С. 21–24.
- [9] Бабичев А. П. Классификация и перспективы развития оборудования для вибрационной обработки деталей / А. П. Бабичев, В. Б. Трунин // В кн.: Современные пути повышения производительности и точности металлообрабатывающего оборудования и автоматизации технологических процессов в машиностроении. Тезисы доклада Всесоюзной научно-технической конференции. – М. : Станкин, 1980. – С. 46–52.
- [10] Одинцов Л. Г. Комплексная программа развития и внедрения отделочно-зачистной обработки деталей. – М. : Машиностроение. Механизация и автоматизация производства Н5, 1990. – С. 1–4.
- [11] Берник П. С. Классификация способов вибрационной обработки / П. С. Берник, Л. В. Ярошенко // Международная научно-техническая конференция «Совершенствование и развитие отделочно-зачистной, финишной и поверхностной пластической обработки деталей» : матер. – Винница : ВСХИ, 1992. – С. 48–50.
- [12] Карташов И. Н. Обработка деталей свободными абразивами в вибрирующих резервуарах / И. Н. Карташов, Е. М. Шаинский, В. А. Власов. – К. : Наукова думка, 1974. – 83 с.
- [13] Пат. 32159 А Україна, В24В 31/06. Пристрій для вібраційної обробки деталей / Берник П. С., Ярошенко Л. В., Горбатюк Р. М. (Україна). – № 98126990; Опубл. 15.12.2000; Бюл. № 7, 3 ст.
- [14] Пат. 87776 А Україна, В65G 27/00. Спосіб керування роботою адаптивних вібраційних технологічних машин. / Серeda Л. П., Чубик Р. В., Ярошенко Л. В. (Україна). – № a200803685; Опубл. 10.08.2009; Бюл. № 15, 4 ст.
- [15] Чубик Р. В. Метод стабілізації технологічно оптимальних параметрів вібраційного поля адаптивних вібраційних технологічних машин / Р. В. Чубик, Л. В. Ярошенко // Вібрації в техніці та технологіях. – 2008. – № 2 (51). – С. 57–60.
- [16] Пат. 92041 А Україна, В65G27/100. Спосіб стабілізації технологічно оптимальних параметрів вібраційного поля адаптивних вібраційних технологічних машин / Л. П. Серeda, Р. В. Чубик, Л. В. Ярошенко (Україна). – № a200806209; Опубл. 27.09.2010; Бюл. № 18, 3 ст.
- [17] Берник П. С., Чубик Р. В. Аналіз структурних схем пристроїв для керування віброприводом вібраційних технологічних машин // Вибрації в техніці та технологіях. Всеукраїнський наук.-тех. журнал. 2005. № 3 (41). – С. 9–22.
- [18] Пат. 43813 А Україна, F 16D3/4. Пружна муфта. / П. С. Берник, П. Д. Денісов, О. В. Солонa. (Україна) – № 99116344; Заявл. 23.11.99; Опуб. 17.12.2001. Бюл. № 11. – 3 с.
- [19] Пат. 43814 А Україна, F 16D3/74. Еластична муфта. / П. С. Берник, П. Д. Денісов, О. В. Солонa. (Україна) – № 99116345; Заявл. 23.11.99; Опуб. 17.12.2001. Бюл. № 11. – 3 с.
- [20] Могилевский В. Г. Электромагнитные порошковые муфты и тормоза. – М. : Энергия, 1964. – 104 с.

- [21] Поляков В. С. Муфты. Конструкция и расчет. / В. С. Поляков, И. Д. Барбаш. – 4-э изд. перераб. и доп. – Л. : Машиностроение, 1973. – 336 с.
- [22] Овчинников П. Ф. Охарактере ударного разрушения в вибротельницах / П. Ф. Овчинников // Прикладная механика. – 1968. – № 4. – С. 104–110.
- [23] Сердюк Л. И. Различные подходы к оценке динамических, энергетических и технологических возможностей вибрационных машин / Л. И. Сердюк, Ю. А. Давыденко, Л. М. Осина // Вибрации в технике и технологиях. Всеукраїнський наук.-техн. журнал. – 2004. – № 3 (35) – С. 113–117.
- [24] Копылов Ю. Р. Амплитудные и фазо-частотные характеристики вибрирующей рабочей среды / Ю. Р. Копылов // Вибрации в технике и технологиях. Труды III Международной научно-технической конференции. – Евпатория: 1998. – С. 133–137.
- [25] Чубик Р. В. Метод стабілізації технологічно оптимальних параметрів вібраційного поля адаптивних вібраційних технологічних машин / Р. В. Чубик, Л. В. Ярошенко // Вібрації в техніці та технологіях. – 2008. – № 2(51). – С. 57–60.
- [26] Сергеев А. П. Исследование процесса обработки, механизация и автоматизация вспомогательных работ на машинах для объемной вибрационной обработки / А. П. Сергеев // Механизация процесса снятия заусенцев. МДНТП. – М., 1966. – С. 74–85.

