Conclusion

At utilizing methods of recognizing of the image they made the specification of dissimilarities in forming of structures of the flow in counter - current and co - current flow of the two-phase mixture.

On the basis of experimental examinations test stand they depend strictly on given streams of the liquid and the gas and they have significant influence on rising structures of the flow.

After analysing received images it is possible to state that the analysis of grey levels and the probability density function they are able to be serving tool for the specification of forming structures of the flow.

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INCREASING THE TECHNOLOGICAL RELIABILITY OF SHAFTS' WITH SMALL STIFFNESS MACHINING

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In the paper they show the method of increasing the machining reliability, that consists in elastic-deformable state creating – for this purpose they worked out the construction of tailstock with vibratory walking pneumatic drive with linear action. They show the computational scheme of the drive and formulas to different dependences computing: dependence of tensile force change to normal stresses by parts' different diameters, dependence of tensile force change to pneumatic chambers diameters change, scheme of the system of elastic-deformable state controlling basing on the microprocessor, schematic diagram of winding gear controlling system basing on walking pneumatic drive, results of mathematical and physical modeling, results of experimental research.

In references [1, 2] they work out the technology of parts (shafts) with small stiffness forming and they present complex of means of automation and control, which contains devices and systems to program-following and adaptation control, electrical schemes of particular nodes and tailstocks construction, the complex enables, among all, increasing the accuracy and capacity of shafts with small stiffness machining.

For the purpose of enlargement the possibilities of functional automated machines systems for parts with small stiffness in the elastic-deformable state machining and increasing the reliability of technological machining, they worked out the construction of tailstock with vibratory walking drive with linear action [3], which drawing is presented in Fig. 1. The construction consists of frame 1, which can rotate owing to directional element 3. At the arbor's 2 left side on the thrust bearings they placed a sleeve 4 which is able to turn, there is the sleeve 5 with clamping screw 6 in it. The sleeve 5 is placed on a spring. At the right end of the tailstock's frame 1 there is the drive's body consisting of left half 7 and right half 8. The sleeve 9 (operating element) is able to move flat-parallel perpendicularly to axis. At the inner surface of the sleeve 9 there are circular concentric incisions, identical to arbor's 2 thread section shape, they contact with arbor's 2 thread and form a wedge-shape gear with it.

At the outer surface of the frame's surface there are "n" drives of progressive operation with short range of displacement (in this case 4-membrane pneumatic drives), which consist of arbors 10, membranes 11, frames 12 – at the surface there are coils 13 with windings 14, arbors' 10 ends come in them. Turn of the leading element 9 round the axis is enabled by elastic springs. Soils 13 with windings 14 are position sensors here. Mechanical gear applied in the drive is similar to waved gear but, in comparison, it has many advantages resulting from the fact, that the leading element is rigid and only elastic springs deform [4]. Owing to those facts, the construction can be simplified, the reliability and drive's power can be increased.

During the work, the air is given by electro-pneumatic distributors to pneumatic chambers' space and the arbors 10 push the sleeve 9 with inner ring-shaped incisions to screwed arbor 2. While making the right thread on the arbor 2 and even switching on pneumatic chambers: I-IV, IV-II, III-II, II-I etc., the arbor 2 displaces from left to right and the part fixed in spring sleeve is loaded by tensile force that create elastic-deformable state. At the same time, the tailstock's 1 stress gear can supply a part's clamp gear in process of another setting to parts with different length machining. The converse switch-off of pneumatic chambers: I-II, II-III, III-IV, IV-I etc. is realized and the arbor 2 moves from right to left. Electro-pneumatic distributors' commutation and interrupting the load mechanism are realized by control system basing on microprocessor.

Fig. 2a presents a geometry of elements' driving and driven interaction. The arbor 2 with right thread moves left. The motion is realized as a result of interaction in contact point A. During vibrations in inverse direction, the motion is realized as a result of interaction in contact point B (the arbor 2 moves right). When the driving element vibrates in one complete cycle, the driven element moves one pitch of thread "p". The vibration circle diameter d_k is equal $2r_k$ and it meets the maximum clearance between driving and driven elements. Setting the motion trajectory of driving element (in the shape of circle) in the parametric form and formulating the circle length by a central angle α_k which defines the displacement of leading element relative to initial position, we have:

$$S_{prz}(\alpha_k) = \alpha_k \cdot r_k \qquad (1)$$

Where $r_k = \sqrt{x^2 + y^2}$.

The point of instantaneous contact (A or B) describes the circle with diameter D. The mechanical system forms the two-stage wedge transmission gear, which complete coefficient is:

$$K = \pi d_k / p \ . \qquad (2)$$

When matching the physical and mathematical models, they assume, that mechanical system composed of driving and driven elements is considered as the system with one degree of freedom, that means, driving and driven elements are stiff fastened. Besides, they give one assumption for the purpose of simplification: contact of driving and driven elements has a place in points of driven element parallel axis (Fig. 2b).

That figure also presents the scheme of reactions of drives. Tangent force F_τ, normal force F_n, components of cutting force:

$$F_\tau = F_x \cos\alpha_k - F_y \sin\alpha_k, \ \ F_n = F_x \sin\alpha_k + F_y \cos\alpha_k, \qquad (3)$$

where: F_x and F_y – horizontal and vertical reactions, α_k – angle of displacement of driving element' instantaneous contact point.

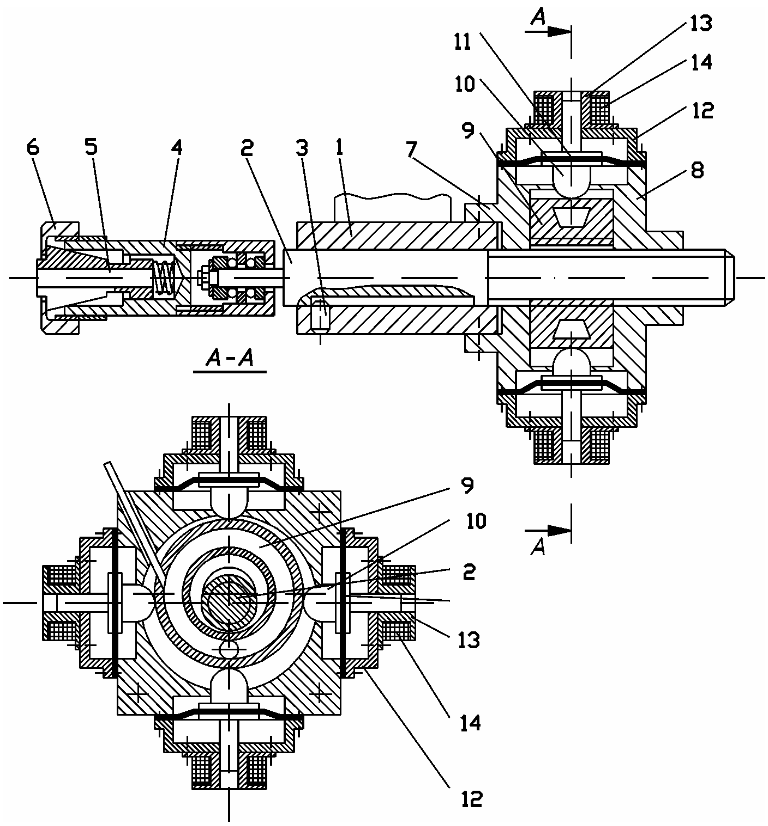

Fig. 1. The tailstock with vibratory walking pneumatic drive

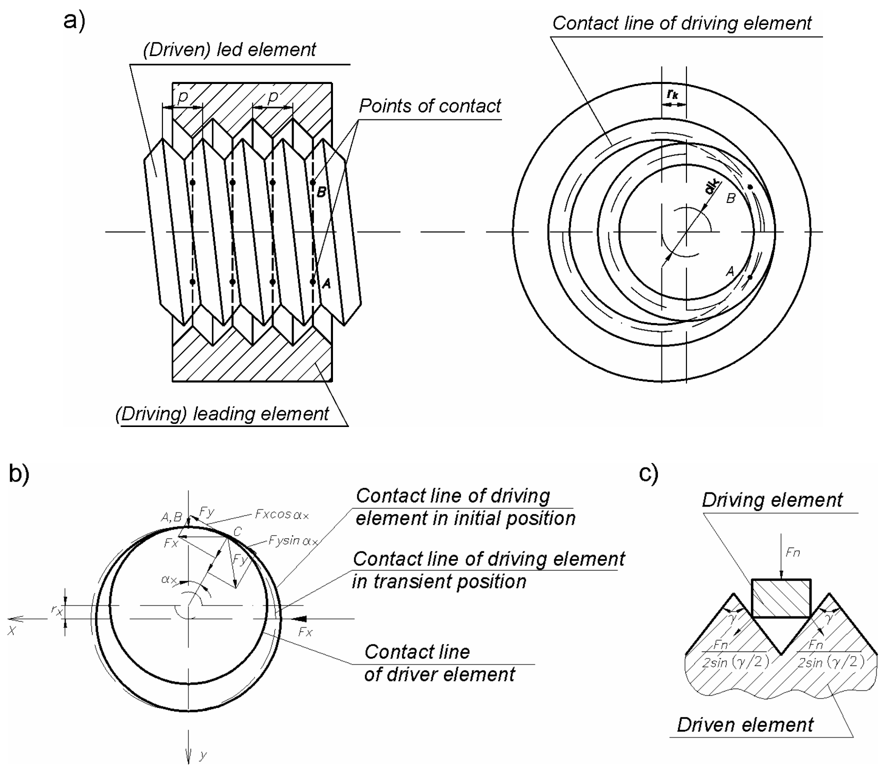

Fig. 2. Computational diagram of vibratory walking pneumatic drive: geometry of driving and driven elements' co-operation – a; scheme of driving and driven elements' contact – b; scheme of applying the component of force on the side of the drive

The normal component causes the friction force, Fig. 2c shows, how it is imposed to screw thread:

$$F_{tar.n} = \frac{F_n}{\sin(\gamma/2)} f \,, \tag{4}$$

where: γ – thread's angle, f – friction factor.

Resultant shearing force is:

$$F_{\tau skr} = F_{\tau} - F_{tar.n} = F_x \cos\alpha_k - F_y \sin\alpha_k - \frac{\sin F_x \alpha_k + F_y \cos\alpha_k}{\sin(\gamma/2)} f \,. \tag{5}$$

The force of arbor 2, when taking into account (2) and (4) is the tensile force:

$$F_{x1} = KF_{\tau skr} = \frac{\pi d_k}{p} F_{\tau skr} \quad . \tag{6}$$

In the model, driving element's angular position (which depends on extension ΔL of semi-finished product with small stiffness) should be taken into consideration:

$$\Delta L = F_{x1}/EF \,,$$

where F – semi-finished product's cross-section.

Displacement of driving element

$$S_{prz} = \Delta L \cdot K \,, \tag{7}$$

hence

$$\alpha_k = 2\pi\Delta L/p \,. \tag{8}$$

In the result, they have system of equations which define the tensile force:

$$\left.\begin{array}{l} F_{x1} = KF_{\tau skr} \\ \Delta L = F_{x1} L/EF \end{array}\right\}. \tag{9}$$

The system includes equations with $\sin\alpha_k$ and $\cos\alpha_k$ which should be decomposed into Taylor's series and the dependence for F_{x1} is:

$$F_{x1} = KF\left[1 - \frac{\pi^2 \Delta L^2}{p^2} - \frac{2\pi\Delta L}{p} - \left(\frac{2\pi\Delta L}{p} + 1 - \frac{\pi^2 \Delta L^2}{p^2}\right)\right]\frac{f}{\sin(\gamma/2)} \,, \tag{10}$$

where $F = F_x = F_y$

As the result of transformating the dependence (10), the dependence (9) is reduced to quadratic equation:

$$\frac{\pi^2 L^2}{F^2 E^2 P^2} F_{x1}^2 - \left[\frac{(f_1 - 1)}{KF} + \frac{(f_1 + 1)}{f_1 - 1} \cdot \frac{2\pi L}{pEF}\right] F_{x1} - 1 = 0 \,, \tag{11}$$

where: $f_1 = f/\sin(\gamma/2)$

the solution is:

$$F_{x1} = \frac{-\left[F^2 E^2 p^2 + 2\pi f_1 pEFL\right] + \sqrt{\left[F^2 E^2 P^2 + 2\pi F f_1 pEFL\right]^2 + 4K^2 F^2 f^2 E^2 P^2 \pi^2 L^2}}{2kF\pi^2/L^2} \,. \tag{12}$$

They assume, that forces F_x and F_y are generated by membrane drives and they change from 0 to the maximal value, because space volumes are extremely small and pistons' sticks displacement doesn't exceed 1,5-2mm.

In order to calculate the tensile force that is generated at the output shaft of tailstock tension mechanism according to (12), they worked-out the algrithm and computer program. Outcomes are shown in Fig. 3. Fig. 3a shows, that by increasing the L/d ratio from 20 to 50 with given pneumatic chambers diameter D_k=0,04m, the tensile force value which is necessary to generate the elastic-deformable state, decreases about 1,5-2 times for different diameters. Normal stresses which are generated by tension in parts with given geometrical parameters, don't exceed $5 \cdot 10^5$ N/m^2.

Dependences, that are shown in Fig. 3a, can be suitable to a choice of semi-finished products' load parameters in elastic-deformable state. In Fig. 3b, they present how the tensile force changes on the output shaft depending on pneumatic chambers diameter D_k for different parts' size. For received values of tensile force F_{x1}, the semi-finished product's extension doesn't exceed ΔL=0,14-0,17mm for d=2mm and L/d=20-50mm by pneumatic chambers' diameter change D_k=0,04-0,08m and ΔL=0,07-0,13mm for d=8mm by change D_k=0,04-0,08m by such ratio L/d.

In order to control the elastic-deformable semi-finished product with small stiffness in technological system, they devised the control system scheme basing on microprocessor K580 (Fig. 4), in addition they entered following devices to the scheme: US – system of controlling the walking pneumatic drive of tailstock tension mechanism MNK, KP – pneumatic chamber – I, II, III, IV, REP – electro-pneumatic distributors, CP – position sensor [4].

The control system of performing mechanism is the second level system and it consists of 5 functional nods (Fig. 4) sensors, converter, annular switch, counter and direct current amplifier. The position sensor, that signals switching-on the electro-pneumatic distributors, is made on the basis of inductive convertor and it poses the coil L1, that is situated on pneumatic chamber's cover, arbor's 10 end moves inside the coil. The arbor's 10 displacement causes coil's L1 inductance change and switching-on a position sensor basing on transistors VT1 and VT2, next, throughout an operational amplifier DA1, signals go to the section, which has DD1 scheme to contacts' vibrations eliminating, it permits using the control system with any types of sensors, it has also DD2 scheme to pulses forming. That gives an opportunity to control switching-on and releasing REP and CP.

Impulses that confirm REP and CP closure, run to counting binary-decimal counter DD7, DD10 input through DD5 element of pulses' counting control according to inputs V1 and V2. Computational impulses run to input C with position sensor. Direct input of impulse counter and possibility of outer setting "0" (input R) improve counters' functional potentials. Data from the counter and impulses flow to programmatic elaboration. The counter neutralization is realized manually or MP of first level by giving the positive polarization impulse to R input of DD7 scheme.

Direction of counter's counting changes as a result of giving the suitable code to input of work parameters control US of second level according to signification chart (Chart 1).

The annular switch consisted of impulses generator DD3, controlling system DD4 and element DD8 of forming a code "1000" which is necessary to pneumatic drive normal work, is intended for giving the voltage to REP. The impulses generator DD3 frequency can change in a wide range thanks to resistor R7 and connecting additionally the capacities C7.

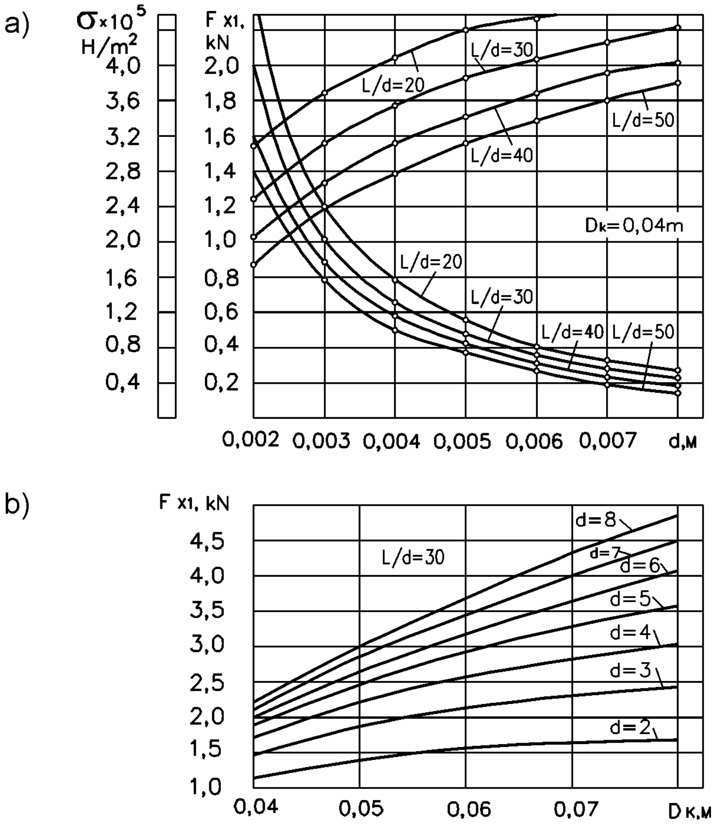

Fig. 3. Relationship between tensile force and normal stresses by different part's diameters D_k=0,04m – a; change of tensile force by change of pneumatic chamber's diameter – b

Table 1. Significant chart of input V1 and V2 signals

Nr	Course	V1	V2
1.	Vibratory course	0	0
2.	Displacement to the right (I-II; II-III; III-IV; IV-1)	1	0
3.	Displacement to the left (I-IV; IV-III; III-II; II-I)	0	1
4.	Forbidden combination	1	1

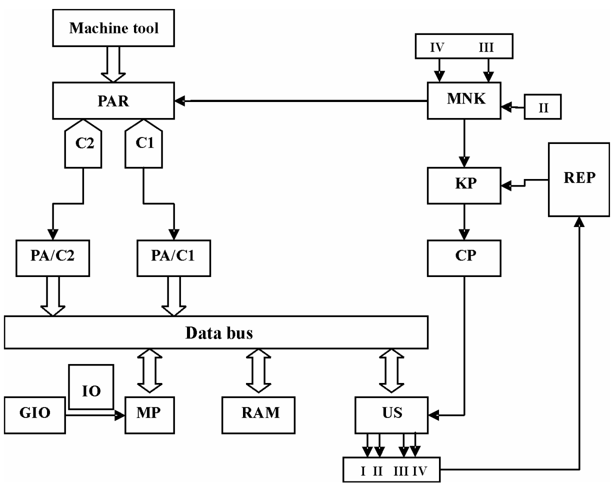

Fig. 4. Diagram of controlling system of elastic-deformable state basing on microprocessor

The switch is placed on reverse shift register DD6 and is able to work in the course of displacement to the right, to the left and vibratory course in two adjacent positions and the commutator's course controlling is realized according to significant chart. Switching-off the reverse register from the course of displacement to the right to the course of displacement to the left is realized by trigger DD4. From the commutator, the impulses run to the connectors, which are placed on DD9 schemes and transistors VT3-VT6.

The DD4 scheme of displacement direction controlling is placed on D-trigger, switching on according to trigger' scheme with calculating input. Inputs V1 and V2 of settings "0" and "1" are inputs of controlling the controlling system's parameters of the second level.

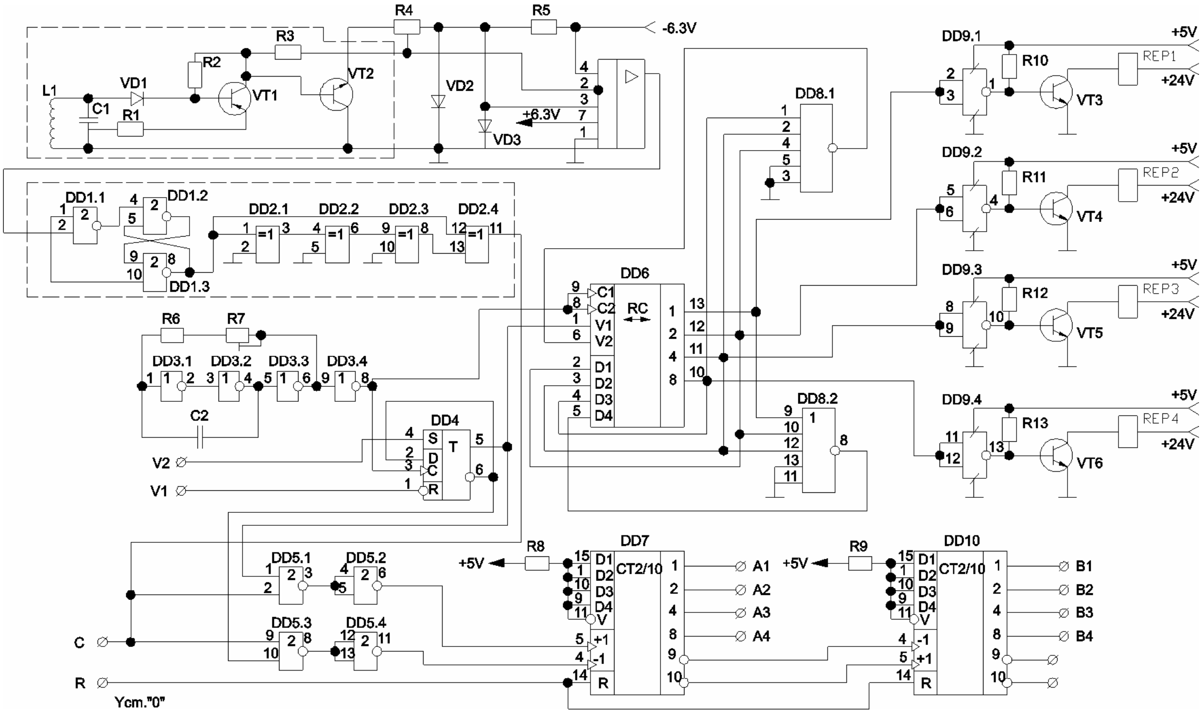

Fig. 5. Schematic diagram of the system of controlling the winding gear basing on the walking pneumatic drive

In references [2, 4] they presented the results of experimental research on parameters of quality of elastic-deformable state automatic control using tailstock (Fig. 1), controlling system (Fig. 4) and errors quantities, that appeared in mathematical and physical modelling.

When using the developed tailstock construction, it gives opportunity of increasing the technological reliability of shafts with small stiffness machining by attaining the reqested dimmnsional accuracy and surface texture while working in the safe machining conditions.

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