Influence of contact length l_n on a front surface of a cutter on cutting temperature is presented on Fig. 6. As one can see from the diagram at increase of contact length of a chip at a front surface of the tool the cutting temperature decreases.

Conclusions

As results of computer simulation have shown, the greatest influence on temperature in a cutting zone is rendered by the following factors: cutting mode elements (V, t), thermal physical characteristics of a processable material (ω, λ), the main angle in the plan φ, tangential and radial components of cutting force (P_z,P_y). At change of cutting velocity twice the cutting temperature changes on 49 %; similar change of cutting depth gives the temperature response of 98 %. At change of factors of thermal diffusivity and heat conductivity of a processable material twice the cutting temperature changes on 55 and 98 %, accordingly. Change on 100 % of tangential and radial components of cutting force cause the temperature response of 58 and 34 %, accordingly. Change of an angle in the plan twice results in change of cutting temperature on 52 %.

The least influence from researched parameters is rendered by strength of a processable material (σ_v) and axial component of cutting force (P_x), temperature response is 4 and 8 % accordingly, at change of the given parameters twice. At change of other parameters (λ_p, γ, S, k, l_n) on 100 % the cutting temperature varies within the limits of 10...28 %.

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TECHNIQUE OF DEFINITION OF CRACKING RESISTANCE CHARACTERISTICS OF METAL PLATES AND ENVELOPES OF SMALL THICKNESS

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The technique of cracking resistance tests of metal plates of small thickness is given. Features of such tests, among which are occurrence of warp in the places of fastening of plates, occurrence of waves because of loss of stability at out-centre loading are shown. Ways to eliminate these shortcomings with the help of special equipment are specified. Tests by the proposed methods allow to make recommendations for technology and choice of steels at creation of valve tapes.

Problems in mechanics of destruction of metal products at presence of cracks till now are not solved up to the end. The greatest interest of domestic researchers to this problem has fallen to 70–80 years of the last century [1–3]. Intensive searches of the answer to behavior of cracks in metal by foreign researchers have resulted in occurrence of American and British standards for cracking resistance tests. In the USSR such result was occurrence of the method of destruction ductility tests (cracking resistance) at static [4] and dynamic [5] loading. However in 2005 they were cancelled without replacement [6]. In engineering practice and in research purposes it is remained necessity to estimate strength and durability of products at presence of cracks. Therefore the further making of experience of mechanical tests on cracking resistance, their perfection are actual.

At experimental definition of cracking resistance characteristics it is necessary to provide the decision of several problems:

1. To choose the most rational form of a sample.
2. To create an artificial fatigue crack.
3. To provide necessary accuracy of registration of fatigue crack lengths and loadings during test.
4. To carry out tests for destruction ductility with record of the loading diagram.
5. Using the diagram to define values of calculated parameters and to compute cracking resistance characteristics by authentic quantitative way.

The choice of the sample form is frequently predetermined by initial assortment of researched metal (a bar, a plate, a sheet, a strip etc.). The present methods are intended to define cracking resistance characteristics conformably to sheet metal, tapes, envelopes of small thickness. Catering for a valve tape, the flat sample with the central holes with length of 250 mm of the corresponding cross sizes with preliminary cut on the one side and artificially grown fatigue crack, Fig. 1, has been chosen.

The holes to base the samples in the claws of the test machine have been made with the help of the stamp.

Presence of the central holes in the sample was caused by the fact that loading of the hole-free sample clutched in the flat claws of the test machine resulted to slipping and distorting of the sample in relation to the loading axis that is inadmissible. Loading of thin samples with the central holes with axial force revealed one more lack – warping of a sample in the place of fastening, Fig. 2.

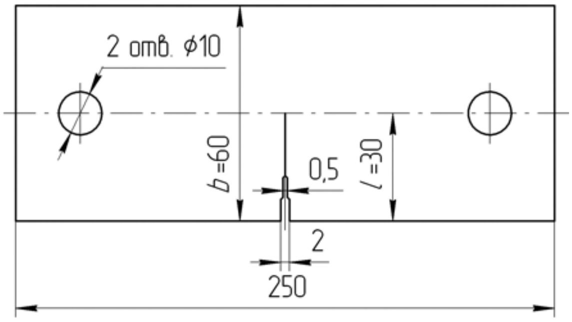

Fig. 1. *The schematic diagram of the sample for cracking resistance test*

To eliminate this effect the gadget, fig. 3 has been developed. For fastening the bush – 2 is put on the bolt – 1. The bolt and the bush are inserted into a fork staple – 3, simultaneously the bolt is passed in basing hole of the sample – 4 and the same second bush – 2. The nut – 5 is screwed and tightened on the bolt. The fork – 3 is fixed in the machine claws with the help of flat rusks – 6. Other end of the sample also fastens. Due to tightening of the nuts – 5 the bushes – 2 adjoin to lateral surfaces of the sample, i. e. basing of the sample occurs on the ring surface of contact of the bushes with the sample. The same surfaces transfer basically effort of a stretching of the sample. It excluded warping of the plates in the place of capture at loading of the sample. Mobile setting of the bushes in the fork holes allowed to the sample to self-set in the plate plane, and a small error in the perpendicular plane is provided by manufacturing techniques of bushes and the rigid admission on non-perpendicularity of bush but-end in relation to its hole.

At loading of wide thin plates according to the asymmetrical circuit (out – center stretching) loss of stability (as occurrence of waves) which did not depend on a way of fastening and basing of the sample was observed. At presence of the stress concentrator as a crack loss of stability can deform moving of fastening points of the sensor which is watching disclosing of a crack, and finally to influence the diagram «Effort – Disclosing of a crack *P-V*». It was succeeded to remove waving by installation of two small-sized, but powerful magnets – 7. The effort of shift of the plate on the magnet surface is negligible in comparison with loading on the sample and practically does not influence test results, and significant effort of constant magnets in a normal direction to the sample plane allowed to not admit loss of the sample stability. At comparative tests it especially does not influence an end result of an estimation of cracking resistance of metals.

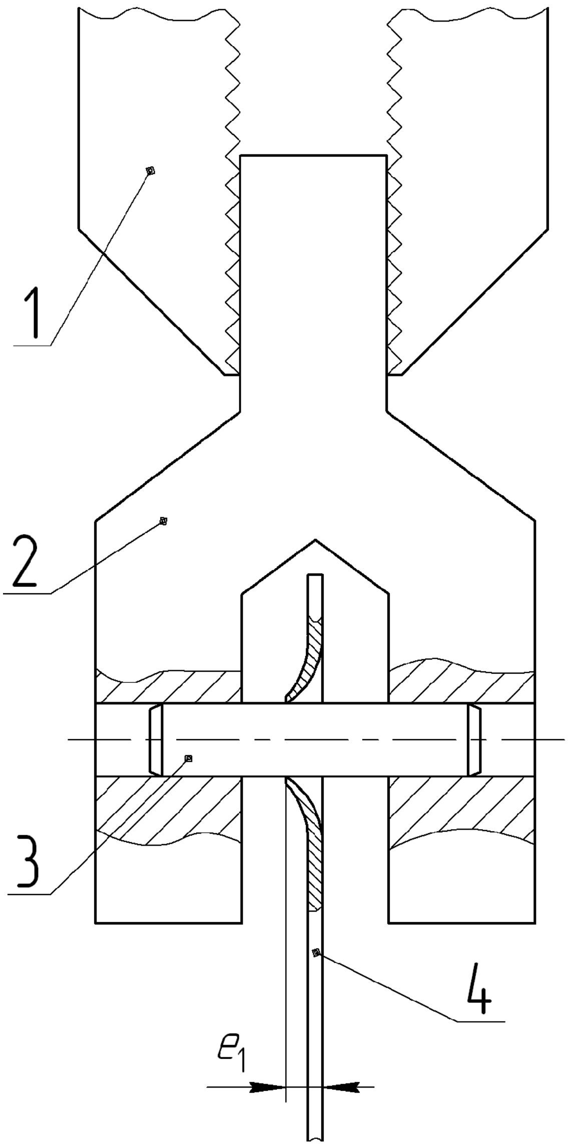

Fig. 2. *Warping of the sample in process of loading: 1) claws of the machine; 2) a fork; 3) a finger; 4) a sample*

Before creation of the fatigue crack the opening in the transverse direction was made with a 2 mm diamond circle, then the opening was lengthened with the 0,5 mm diamond circle with sharpening at the angle 30°, that in process of fatigue loading created conditions of the fastest occurrence of a crack. As samples had small thickness to growth a fatigue crack they were completed in packages. Plates in a package were tightened with the help of rods and bolts. Under the circuit of a three-point bending the package as a bar was loaded with variable loadings. The number of loading cycles at creation of a fatigue crack should be not less than $5\cdot10^4$.

If this condition is not fulfilled, it means that the condition [6] is not fulfilled in the crack apex:

$$K_{f\max} \leq 0,6K_{1c},$$

where $K_{f\max}$ is stress intensity factor at the maximal effort of cyclic loading; K_{1c} is critical value of stress intensity factor at the maximal constraint of plastic deformations.

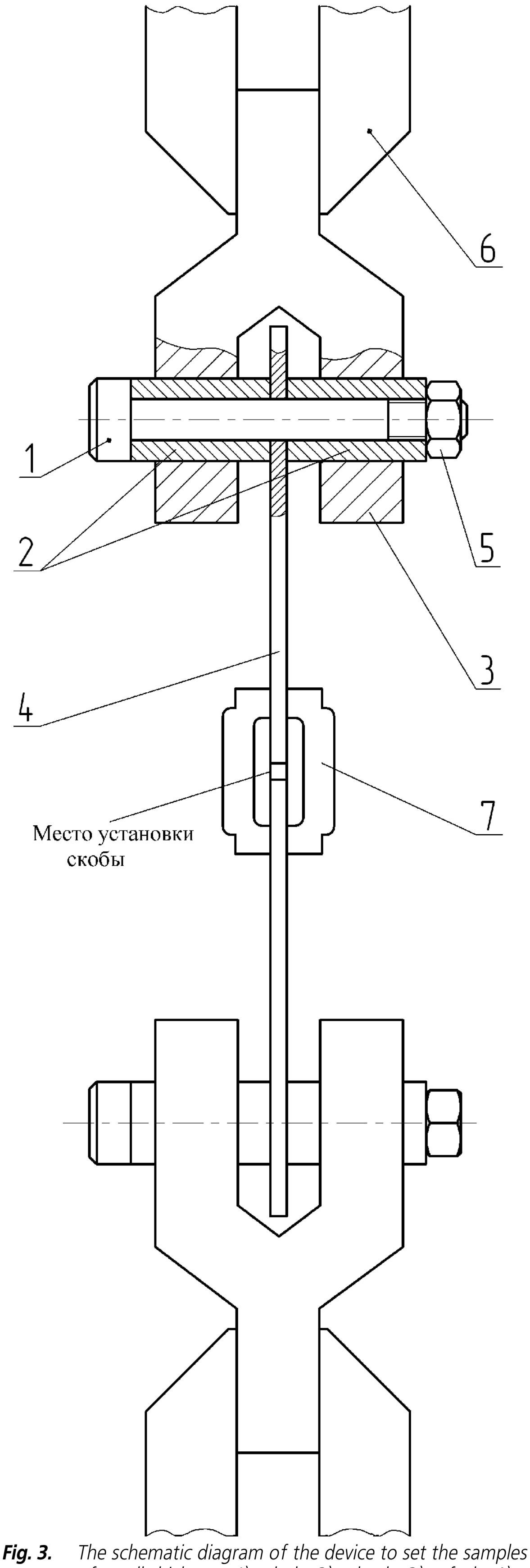

Fig. 3. *The schematic diagram of the device to set the samples of small thickness: 1) a bolt; 2) a bush; 3) a fork; 4) a sample; 5) a nut; 6) claws; 7) a magnet.*

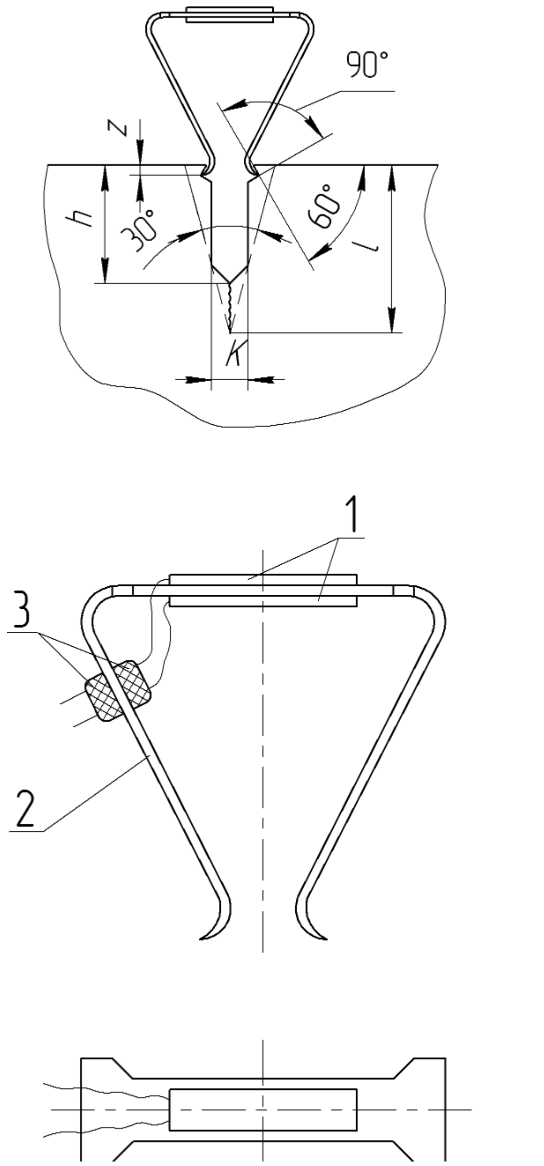

Fig. 4. *The design of the measuring clamp: 1) strain gauges; 2) elastic clamp; 3) terminal linings*

Fatigue cracks in each sample of the package are developed independently and velocity of their growth is various. Therefore cracks were raised not for all length (required length l=0,5b), but on 0,4b, measured on the lateral plates in the package. Other packages of one mark of steel were loaded by similar way. Then packages were dismantled, the samples with the same length of the crack, but smaller than required one, collected in new bars and a crack were grown up to finish. Length of the crack was measured with the tool microscope. In some samples the direction of crack development deviated from normal to a longitudinal axis. Such samples further excluded from experiences or used at adjustment of the machine and the equipment in trial tests. Results of these trial tests of cracking resistance did not include in an estimation.

The cracking resistance tests at static loading were carried out using the machine ZDM-10. During tests

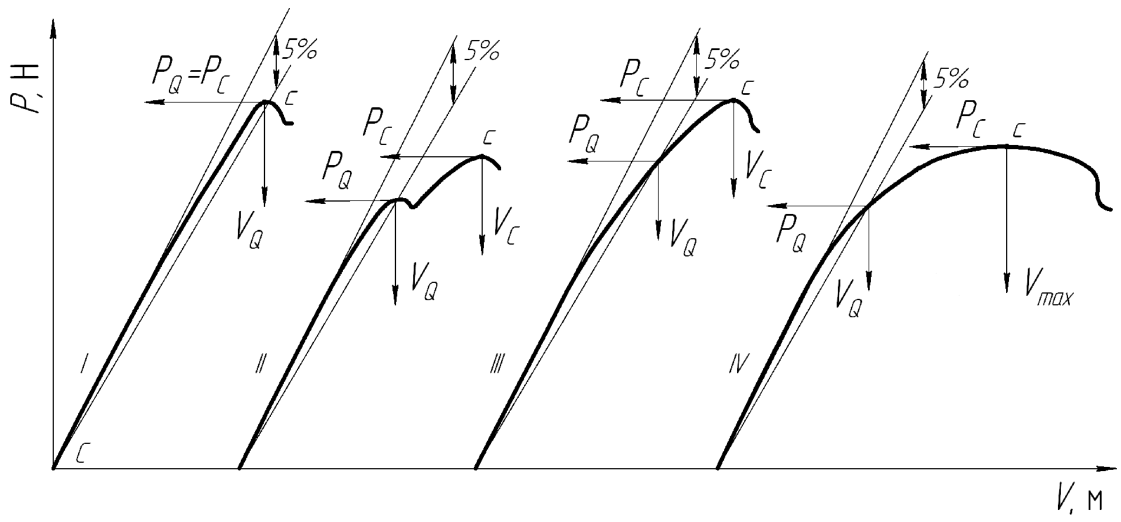

Fig. 5. *The basic types of curves «Effort – Disclosing of crack P-V» and circuits for their processing*

the diagram «Effort – Disclosing of crack *P-V*» was recorded by automatic way with the help of electronic two-coordinate self-recording potentiometer ПДС-021М. To provide work of the potentiometer the force-measuring device in form of a rheostat which worked synchronously with the force-measuring device of the machine has been made. Displacement of the crack edges in a point on distance (*l-z*) was monitored with elastic clip with strain gauge tranducers, Fig. 4, which was established in grooves of the sample. Signals from the force-measuring device and the elastic clip were brought through amplifier UT-4 on the electronic potentiometer. The clip was calibrated preliminary on the lengthmeter ИКУ-2. Thus, the diagram «*P-V*» which various types has form presented on Fig. 5 was recorded for each sample.

The effort corresponding to instability moment the crack P_Q was defined by the corresponding diagram. Definition of value P_Q by 5 % of secant is shown on fig. 5 and corresponds to the technique [5]. The stress intensity factor was calculated by value P_Q:

$$K_Q = \frac{P_Q}{t\sqrt{b}} Y_B,$$

where $Y_B = \sqrt{\frac{\ell}{b}} \cdot [1,99 - 0,41(\frac{\ell}{b}) + 18,7(\frac{\ell}{b})^2 - 38,5(\frac{\ell}{b})^3 + 53,8(\frac{\ell}{b})^4]$,

b, *t* and ℓ – were wide and thickness of the sample, the length of a crack.

Critical disclosure of the crack was defined as:

$$\delta_Q = \frac{V_Q}{1 + \eta \frac{(\ell - z)}{(b - \ell)}},$$

where $\eta = 3,75 \frac{b}{l} \frac{\sigma_{0,2}}{\sigma_H^Q} \geq 2,2$; σ_H^Q – stress in net section of the sample at the moment of the beginning of instability in the apex of the crack at effort P_Q; V_Q is displacement of the cut edges at effort P_Q. P_C and V_C are the maximal effort and displacement of the cut edges at this effort.

The given technique can be applied to an estimation of cracking resistance of the products concerning group of thin-walled vessels, envelopes, and plates made of metals and their alloys.

Comparative cracking resistance tests of sample sets of rolling and valve tapes with width 60 mm and thickness 0,3 0,4; 0,5; 0,6; 0,7; 0,8 mm made from steels У10А; 10Х14НС; 12ХНМКТЮ; 7С27МО2 with different technology of heat treatment and a tape «САНДВИК-20» were carried out by this technique. Comparison of cracking resistance characteristics of the samples from specified steels allowed to recommend the most perspective technologies of hire and steel marks for the further dynamic tests and finally to propose alloyed steel and technology of obtaining of valve tapes which characteristics are not inferior to the foreign analogues.

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