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The theory of the anti-bouncer of dynamic bumping on the plough at forced oscillations of the framework

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ABSTRACT

In the work the problem of the use of the external revolting factors is considered which arise from fluctuation of traction resistance of between each other pair-connected yoke and the hulls of the plow, within 27÷98%, with average coefficient of unevenness 3÷5 as power source for irrevocable performance of technological process with due quality.

For execution of the principal condition of support of normal operation of the conjugate casing - supports of identity of parameters of their oscillations and congestion avoidance and deviation prefir-trees of admissible amplitude in the case of accidental collision with a hindrance, on the middle of a balance the shock-absorber of dynamic shock is provided.

The solution of the task of optimization of parameters of the shock-absorber is based on value of admissible maximum amplitude of oscillations of the slave housing is made in three versions: plough share edge meeting with a motionless obstacle; case meeting with a mobile obstacle; operation of the fluctuating case in non-uniform, on specific resistance, soil conditions with unevenness coefficient to $\delta = 2,9$. After the analysis of results of the theory of calculation for three options is established: rigidity, C'' springs of an udarogasitel should be calculated by option at which the difference of resistance of forward and back cases is maximum.

At forced oscillations of the working organs of dynamic mechanical systems depending upon the values of the acting external disturbing factors, mechanical system enters into an unstable state of varying degree, hence bringing it into a stable condition requires the use of oscillation dampers of different design and operating principle. In different fields of agricultural engineering it is often necessary to use the power of external disturbing factors as a source of energy for the implementation of cost-free technological processes maintaining and in some cases improving the quality of the technological process.

These mechanical systems include the plough with forced framework oscillation which was developed by using the modifiability of specific resistance of soil within limits of the cultivated field [1].

The inhomogeneous structure of the soil, especially the existence of calculous encrusting matters, negatively affects on the sustainability of the plough operation, hence on the soil-cultivating device in general. This brings to the violation of the technological process of plowing on the entire surface of the field [2,3].

In order to reveal the real essence of the influence of the instability of the properties of the arable lands on the plowing quality, B.A. Kin conducted a number of experimental studies in 1930s [4]. Fig. 1 portrays the results of the fragments from these studies topographically.

The analysis of the "map" (Fig. 1) shows that tractive resistance of the plough at plowing the fields changed within the range of 1200–1700 pounds (544.8–771.8 kgf). For the confirmation of the reliability of the obtained data, experiments have been repeated during six years. The analysis of the obtained data has established that the position of isobar in each field is almost unchanged. The isobar level has changed by years which is explained by the weather conditions.

The results of the experiments conducted by I.K.Makarts [5] established that the coefficient of variation of the tractive resistance of one of the frameworks with a takeover of 35 cm under the operation of common economic conditions depending upon soil type and agricultural background fluctuates in the range of 27–98%. And short-term maximum values (P_{max}) of the tractive

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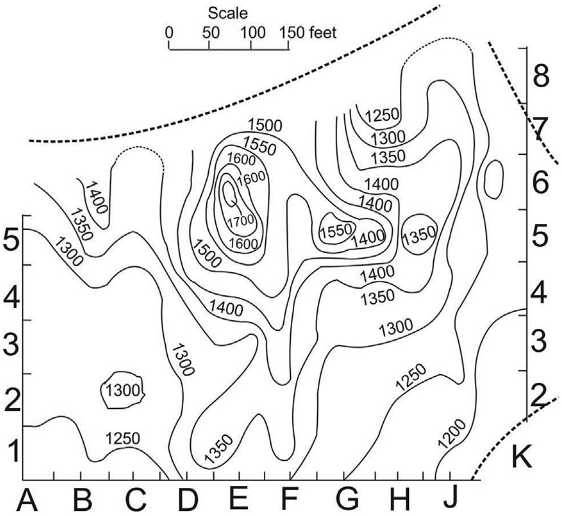

Fig. 1. The tractive resistance of the double-furrow plough in different points of externally of the homogenous field (by B.A. Kin). The numbers at isobars correspond to the resistance in pounds (1 pound = 0.45kgf).

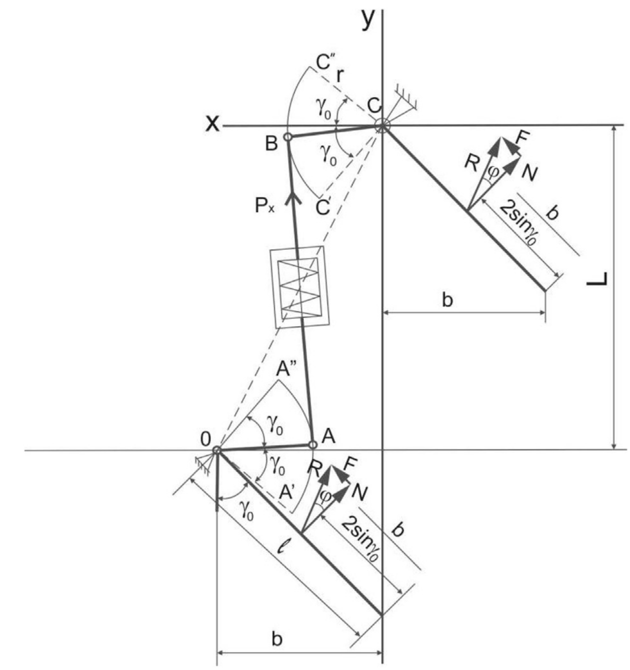

Fig. 2. The calculation scheme for the optimization of the parameters of four-link mechanism of the oscillation of plough frameworks.

resistance of the framework exceeds its average value (P_{med}) about twice and this ratio reaches up to 3÷5 under the soil conditions of crop farming in Armenia.

In addition $\delta_{max} = \left(\frac{P_{max}}{P_{med}}\right) = 2.9$ in those experiments, let's call this value as the coefficient of irregularity of the specific resistance of soil. In fact, expressing tractive resistance of the framework through generally accepted formula, we will get:

$$\delta = \left(\frac{P_{max}}{P_{med}}\right) = \frac{k_{max}ab}{k_{med}ab} = \frac{\mathrm{k_{max}}}{\mathrm{k_{med}}}, \tag{1}$$

where k_i is the specific resistance of soil, ab – the sizes of transversal cross section of the furrow slice.

The essence of the construction of the plough with oscillating framework in relation to its plow legs without landside plates is in the following.

With an increase in the tractive effort of one of the four-link *0ABV0* mechanism of the hulls, the width of the grip decreases, the grip of the second increases by a four-link, by the amount of the permissible buffer on the hinged arm of AB amplitude (Fig. 2). The frequency of oscillation of the frameworks depends on the frequency change of soil resistance.

The settings of the shock absorber of dynamic loads and shocks are closely dependent on the geometric and kinematic parameters of the four-link mechanism, connecting the two adjacent twin frameworks of the plow.

The main condition to ensure the normal operation of the four-link mechanism is the provision of identity parameter fluctuations of the periodic load growth on the front (rear) framework [3]. This requirement is easily met by the choice of ($\overline{OA}, \overline{CB}$) length and the angle of alignment ($\alpha = \widehat{x, \overline{BC}} = \widehat{x, \overline{OA}},$) of the two cranks of equal size (Fig. 2). At the same time it is possible to ensure the maximum angular velocity of the driven crank during the period of its return to the starting position. It should be noted that the optimum value of the length of the crank and the initial angle of its installation α depends on the possibility of increasing the efforts for increasing the working width of the "driven body" (Fig. 2). Let's analyze the foregoing (Fig. 2).

When tripping-over one of the frameworks on the obstacle, for example the front one, depending on its connection with the soil environment, the framework can rotate at angle γ_0 because the frameworks have no swath boards and if the obstacle is immobile, the width can reach to $b = 0$. At periodic increase of specific resistance of soil up to 2.9 times, compared with the average soil resistance of the given land plot, the plough frameworks rotates at a greater angle: $\gamma_i < \gamma_0$.

$$OC = \sqrt{b^2 + L^2}, \ \ AB = 2\sqrt{\frac{b^2 + L^2}{4} - r^2}.$$

As the meeting with an obstacle may occur both in the front and the rear framework, the values of the cranks should be equal, and the position in relation to the frameworks should be the same and mounted symmetrically in relation to them. The next mandatory condition is to ensure maximum traction of the reciprocating lever $AB - P_k$ from the torque reaction R to the body:

$$N\frac{b}{2 \cdot \sin\gamma_0} = P_k \cdot \overline{CB} = P_k r, \tag{2}$$

provided that four-link mechanism in the initial position must have the condition $r \perp \overline{AB}$.

The analysis of the formula (2) shows that in order to obtain the greatest possible coefficient of efficiency of the four-link mechanism it is necessary to have a crank of possible minimum value.

The condition 2 is carried out also in relation to the driven framework.

The length of the reciprocating lever and the starting position are determined by means of the tangent *AB* to the arcs of the upper and lower cranks providing the mandatory condition of the alignment of the cranks and reciprocating lever.

It should be noted that the angle γ_0 of the rear-driven framework is forcibly increased under the influence of P_k force. In order

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