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Construction and Structural Analysis of Forced Vibration Generating Mechanism in Chisel-Cultivator

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Abstract: It is dedicated to the theoretical research of the construction and structural analysis of the mechanism that generates forced vibration in the chisel-cultivator. As a result of research, the constructive and kinematic scheme of the mechanism generating forced vibrations was developed, and the optimal values of the dimensions of its working bodies were determined.

Keywords: Oscillation, chisel-cultivator, mechanism, crank, connecting rod, koromislo, connection, key, bearing, spring, joint, hinge, ring.

Introduction: There are basic (deep) and additional (shallow) tillage systems. The main tillage is done in two ways - plowing with overturning and without overturning. Additional processing is divided into pre-sowing and post-sowing types. Recently, the need for rational use of energy and resource-saving methods in soil cultivation is increasing worldwide [1,2].

Vibration technology plays an important role in solving these problems[3]. It is necessary to develop this direction, because it is considered appropriate to use cultivators with a vibrating working body in soil cultivation [4]. The development of vibrations for agricultural machines has long been a priority[4,5].

Research Method: In order to solve the above problems, we selected the chisel-cultivator unit (ChKU-1.6), which is widely used in agriculture. This unit is used for tilling the soil after harvesting the first crop before planting the repeated crops. In this process, the physical and mechanical parameters of the soil differ sharply from the spring parameters, the soil is dry, hard, and plant roots and plant residues have a negative effect on the soil tillage process [6]. As a result, the soil tillage machine causes high power, high fuel consumption and straining of the aggregate parts [7,8].

Research results and discussion. As a result of the literature analysis and patent research, the construction of the mechanism generating forced vibrations used for soil cultivation was developed (Fig. 1) [9].

The mechanism that generates these forced vibrations is as follows: an oblique softener column 1, a column lock 3 for fixing it to the frame 2, a rotating shaft 4 for creating vibration, a bearing housing (wall) 5, an eccentric disk fixed by means of a splined joint 6, a rod that transmits oscillating motion 7, a bearing 8, an eccentric bearing housing 9, spring-like energy accumulator 10, movement limiting ring 11, adjusting-limiting ring 12 fixed to the holes in the spring bar by means of a spline, cutter base 14 attached to the bent softener column by means of a finger hinge 13, finger hinge 15 connecting the bar to the cutter base and the cutting worker the organ consists of 16.

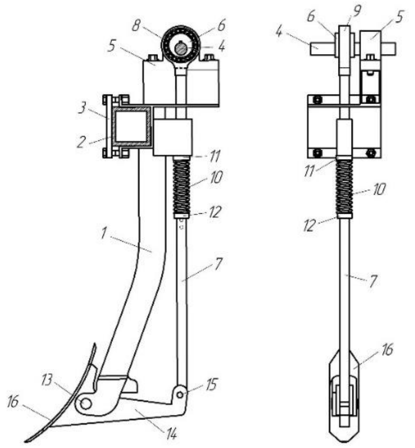

Figure 1. Constructive scheme of the mechanism generating forced vibrations

The vibrating chisel-cultivator works in the following order: when the device is started, a part of the resistance force coming from the soil to the cutting working body turns the base of the cutter to a certain angle and, in turn, compresses the spring, moving the rod up. The eccentric disk 6, fixed to the shaft 4, connected to the power take-off shaft (PTO) pushes the rod 7 down in a rotational motion. During this period, the energy stored in the energy accumulator, that is, in the compressed spring, helps to move the bar 7. As a result, the chisel base 13, which is connected to the bar 7 with a hinge 15, rotates and oscillates. The cutting working body, fixed to the base of the cutter, overcomes the resistance falling from the soil and ensures the crushing of the soil.

In order to create a kinematic scheme of the mechanism presented in Figure 1, it is necessary to determine its parameters. It is known that any mechanism serves to ensure the necessary and predetermined movement of the driving link included in its composition for a technological process. This movement of the driving joint depends on many factors. These factors include kinematic parameters such as the law of motion of the driving joint, the lengths of the joints in the mechanism, and linear measurements that determine the states of the moving kinematic pair [10]. The law of movement of the mechanism joints was determined based on the scientific research work on the vibration tillage of the soil and the working process of the existing device (Fig. 2).

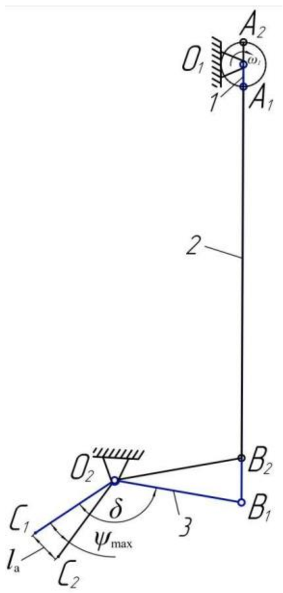

Figure 2. Kinematic scheme of the mechanism generating forced vibrations:
1-crivoship; 2nd connecting rod; 3rd koromyslo.

As an initial condition, the law of motion of vibration of the working body of the device at the point S of the mechanism with an amplitude of 20 Hz was obtained. The O_2C and O_2B parts of the driving link 3 (coromyslo) are integral, and their lengths are based on a constructive and theoretical solution. The distance O_2S from O_2B is relatively large to reduce the amount of resistance from the ground to the working body (point C). The dimensions of the driving link 2 (connecting rod) are determined based on the distance from the frame of the device to the working body. The location of the O_1 (fixed) joint is determined by the length of O_2B and the distance from the frame of the device to the working body. We determine the dimensions of the leading link 1 (krivoship) on the basis of the law of motion of point C of the leading link 3 (koromyslo). In this case, when the link 3 (coromyslo) is set to the initial position and the point S moves to a distance of la, the joints of the mechanism move from one position to another position C_2, B_2, A_2 when O_2S is turned by an angle of pmax. The radius of the circle drawn by the point A of the driving joint 2 (rod) is equal to the length of the joint 1 (crankshaft), that is, O_1A. Then, when the curve is fully rotated, the point C will oscillate a distance l_a. This means that the parameters of the mechanism generating forced vibrations are $O_1A=O_2C\cdot 19.7=$ 7.5mm; $AB=O_2C\cdot 0.2=695$ mm; $O_2B=O_2C\cdot 0.74=200$ mm; $O_2C=148$ mm; δ =136°; $O_2x=y=0$; O_1 $x=O_2C\cdot 0.74=200$ mm, $y=O_2C\cdot 0.213=695$ mm; It is realized only when $l_a=11$ mm and ψ_{max}=4°18'=4.3.

Summary. Based on the above, the movement of the working parts should be theoretically justified in order to make the construction of the developed soil processing device more efficient.

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