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Application Of Oscillating Shares In Machines For Harvesting Potatoes And Table Root Crops

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ANNOTATION

The article discusses the issue of using oscillating shares in potato harvesters with the aim of communicating forced oscillations to the share, which allows you to reduce tractive effort due to the separation in time of the processes of cutting, lifting and deformation of the soil layer, as well as due to the perception by the drive of some part of the resistance, overcome by a ploughshare. The use of an oscillating share for digging in the soil is also advisable from the point of view of the best energy use of the tractor.

Keywords: oscillating share, potato tubers, elevator, cantilever beam, separating grid, pendulum share, oscillating motion, soil deformation, rods, flexibility.

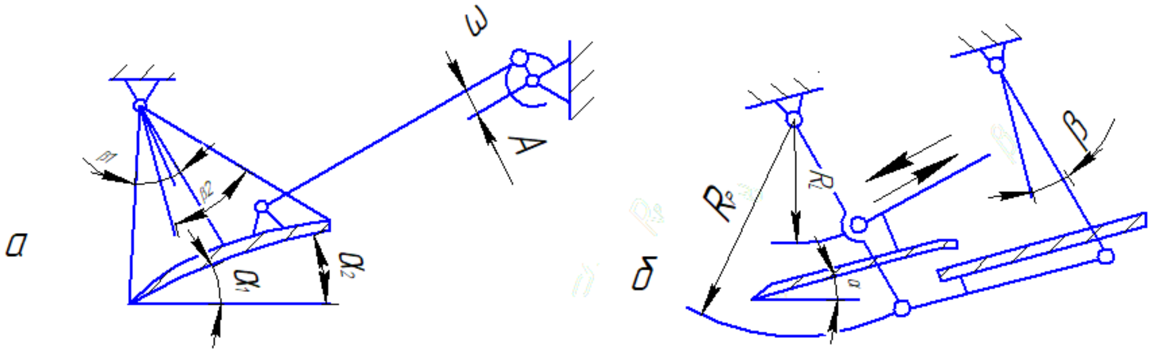
Introduction

Oscillating plowshares are widely used in screening machines for harvesting potatoes, root crops and onions: KGP-2, KVN-2, KG-2, KKU-2, KKG-1.4, LKG-1.4 and LKP-1.8. The role of the share in this case is played by the front edge of the screen [1].

The oscillating share is also used in elevator machines. In this case, it usually has a rigid connection with the suspension and articulated - with a connecting rod (Fig. 1). Such a performance predetermines a special law of relative movement in oscillatory motion: not plane-parallel (like in a ploughshare associated with an oscillating sieve), but pendulum along a circular path. In this case, different points of the ploughshare and the associated separating lattice move along different trajectories, which makes it difficult to optimize them and reduces the transporting capacity.

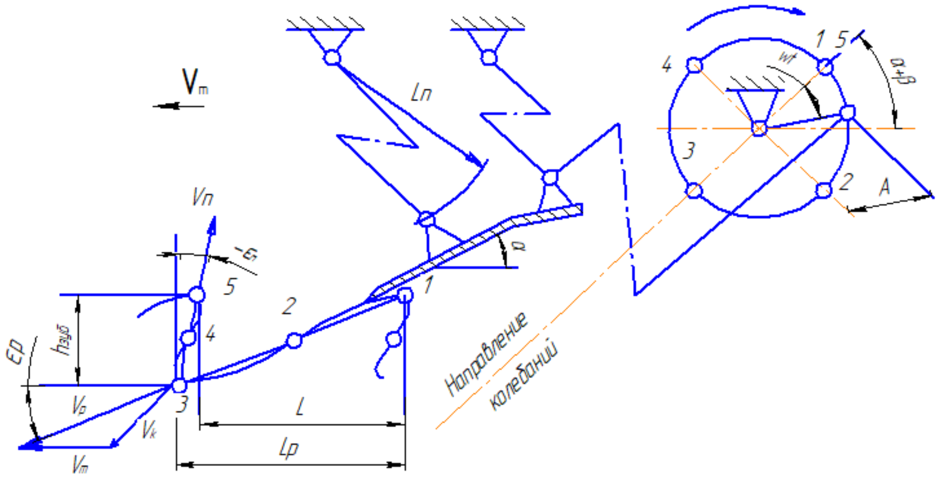
The highest speed of transporting the layer along the surface of the share is provided when the direction of vibrations is located to the plane of the share "at an angle"$\beta_{opt} = 13 - 15^0$. With a pendulum share, the cutting edge oscillates at an angle$\beta_2 < \beta_{opt}$, and the ends of the separating lattice are at an angle$\beta_2 > \beta_{opt}$(rice. 1, a).

The work of A.A. Dubrovsky, A. Eggenmüller, G. D. Petrov, A. A. Sorokina, N. F. Didenko is devoted to the study of oscillating plowshares in screening machines. and other scientists [2].



Rice. 1. Scheme of the oscillating ploughshare of the elevator machine:a - маятниковый; б - сактивнойрешеткой

In screening machines, the oscillating share (Fig. 2) oscillates along an arc with a radius equal to the length of the suspensionl_n.Considering that the radius of the crank (amplitude) A is much less than the length of the suspensions, and the ratioA/l_nclose to zero, the reciprocating movement of the share is taken as rectilinear, directed at an angle$(\alpha + \beta)$ to the horizontal plane.



Rice. 2. Scheme of movement of the oscillating ploughshare at absolute motion

During operation, the absolute speed of the share is the sum of the forward speed of the machine$V_M$and the speed of the oscillatory movement of the share itselfωA. As a result of the addition of these speeds in absolute motion, the share describes a sawtooth trajectory. The shape and dimensions of the trajectory depend on the amplitude, frequency and direction of oscillations, as well as on the speed of the translational movement of the share and are determined by the height of the teeth$h_{зуб} = 2A\sin(\alpha + \beta)$and the length of the plowshare path for one oscillation period

$$L = V_M t_{кол} = (\frac{2\pi}{\omega})V_M$$

The process of digging into the soil layer with an oscillating share can be divided into two periodically repeating phases: cutting, when the direction of movement of the share during oscillatory movement coincides with the direction of movement in a portable movement, and tossing, when these movements are opposite to each other.

In the cutting phase (Fig. 2), the share is mixed from point 1 to point 3, while in the interval between points 1-2, its speed increases, and between points 2-3 it decreases.

The resistance values and the nature of soil deformation in the cutting phase are determined by the values of the cutting (crumbling) angle. For a passive share, this angle, as a rule, is the angle of its inclination, for an oscillating share, the cutting angle depends both on the angle of inclination and on the operating mode and is determined by the ratio

$\alpha_p = \alpha - \varepsilon_p$,

whereα - share angle;

ε_p, - the angle between the direction of movement of the share in the cutting phase and horizontal.

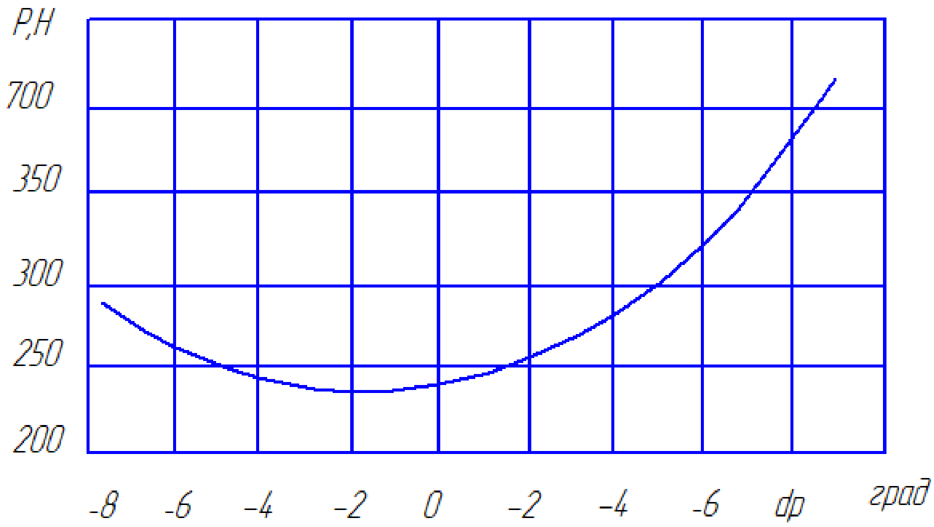
Injection$\varepsilon_p$is not constant and at each moment is determined by the ratio of the components of the absolute speed of the share$v_p$in the cutting phase: vertical$V_{p\cdot в} = \omega A\sin\omega t.\sin(\alpha + \beta)$to the horizontal

$$V_{p\cdot г} = V_M + \omega A\sin\omega t.\sin(\alpha + \beta)$$

$V_{p.г}$=V_M+ ωA sin ωt .cos(α + β),т.е. $tg\varepsilon_p = V_{p\cdot в}/V_{p\cdot г}$- However, it can be assumed with sufficient accuracy that in the cutting phase

$$tg\,\varepsilon_p = \frac{2A\sin(\alpha + \beta)}{\pi V_M + 2\omega A\cos(A + B)}$$

The value of the angle αp has a significant effect on the power consumed by the oscillating share, in particular on its traction component (Fig. 3.).



Rice. 3. Dependence of the pulling force on the angleα_p

The process of deformation of loamy and clayey soils under the action of an oscillating dihedral wedge in the cutting phase depends on the ratio of the anglesαandε_p.

If$\varepsilon p = \alpha$and cutting angle$\alpha p = 0$, то

$$\omega A = 1.57 V_M \frac{\sin\alpha}{\sin\beta}$$

In this case, the deformation of the soil is characterized first by elastic and then by plastic compaction in the plane of the working surface of the share. The cut layer, not receiving a force impulse upward, remains at rest (Fig. 4, a). In the general case, the lifting height of the cut soil at the end of the cutting phase is determined by the value

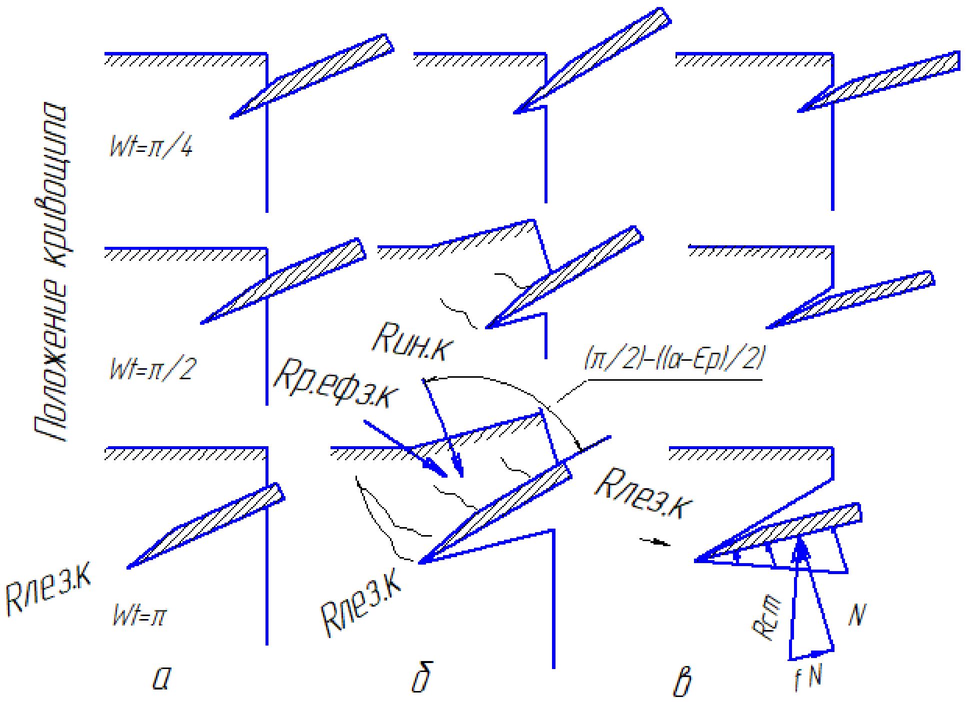
$$\Delta h = Ip(tg\alpha - tg\varepsilon p).$$

At$\alpha = \varepsilon p$lifting height$\Delta h = 0$, those. the cut layer of soil remains at rest; the resistance of the cut soil when overcoming the rest inertia in the cutting phase is absent, and the resistance$R$лез. кwhen digging in the soil with an oscillating ploughshare, it can be taken equal to the product of the cross-sectional area of the ploughshare$F$лon soil hardnessHn

$$R\text{лез. к} = HnF\text{л}.$$

If$\varepsilon p < \alpha$(Fig. 4, b), then the nature of soil deformation during the introduction of an oscillating ploughshare is similar to deformation during the operation of a passive ploughshare installed at an angle$(\alpha - \varepsilon p)$. Then, in the cutting phase with the share, the dynamic force is overcome, which is determined by the dependence

$$R_{ин\cdot к} = 2V_p^2 bhP_{об} sin\,[\frac{\alpha - \varepsilon_p}{2}]$$



Rice. 4. The nature of the deformation of the soil layer in the cutting phase when it is undermined by an oscillating ploughshare:

а - atαр $= 0$; б - atαр > 0; в - atαр < 0

In this case, the oscillating share, like the passive wedge, overcomes all types of soil resistance: blade penetrationRлез. к;deformationsRдеф. к;formation weightRG. K, FORCES OF FRICTION F AND INERTIA OF RESTR ин. к.

The plowshare operating modes that correspond to the lowest energy consumption occur under the conditionεp $=$ α, т.е. $= 1.57V_M \frac{\sin\alpha}{\sin\beta}$,for better performance of the technological process (crumbling of the soil layer), the most preferable modes areεp $<$ α.

Ifεp $>$ α (rice. 4, c), then the lifting heightΔhhas a negative meaning. This condition corresponds to the operating modes of the lemech, in which

$$\omega A > 1.57V_M \frac{sin\alpha}{sin\beta}$$

Such modes are unacceptable, since in the cutting phase, the lower surface of the share (the back of the blade) compresses the soil layer with a heightΔhat the bottom of the furrow. The result of compaction is the occurrence of normal pressures on the back of the blade-head, the resultant of which you have with friction forces gives the resultant crushing force$R_{см}$. The value of this force is most influenced by the height of the crumbling soil layerΔh,which, in turn, the greater, the greater the difference between the angles$\varepsilon_p$andα.Force$R_{см}$not only increases the tractive effort required to move the share, but also tends to push the share out of the soil, this can ultimately lead to the coulter sinking and to a significant increase in vibration of the machine frame.

Considering the above, it is necessary to deepen the oscillating ploughshare into the soil only when the machine starts to move, i.e. will have a translational speed vm.

In the second phase - the tossing phase, when moving the share from point 3 to point 5 (see Fig. 2), the direction of its absolute movement is determined by the angle of the toss$\varepsilon_п$, which can also be taken constant for the entire phase and is determined from the relation:

$$tg\varepsilon_p = \frac{\pi V_M}{2\omega\, a \sin(\alpha+\beta)} - ctg(\alpha+\beta \qquad (2)$$

The deformation of the soil in the tossing phase at small values of the crumbling angles is characterized by the formation of soil blocks in each cycle of oscillations.In the initial period, elastic compaction of the lower layers of the cut soil occurs, then a chipping crack appears in front of the cutting edge of the share and a prism-shaped lump of soil is formed. During the next cycle of oscillation, the formed lump continues to move up the surface of the share, and the blade cuts off a new layer of soil.The shavings formed during the operation of the oscillating ploughshare on loamy and clay soils with a large digging depth (15-20 cm) and optimal moisture have cracks only in the lower layer, and at a depth of 8-10 cm - tearing cracks along the entire layer thickness. When digging in dry cohesive soil with a share, soil blocks of irregular shape are torn off in several oscillation cycles.Thus, the communication of forced vibrations to the ploughshare makes it possible to reduce the tractive effort due to the separation in time of the processes of cutting, lifting and deformation of the soil layer, as well as due to the perception by the drive of some of the resistances overcome by the ploughshare. Therefore, the use of an oscillating share for digging in the soil is also advisable from the point of view of the best energy use of the tractor.The most important technological indicator of the quality of the digging working body is the speed of transportation of the cut soil layer.

Tests have confirmed the high transporting ability of the share, providing an increase in the working speed of the machine from 0.8 ... 1.0 m / s (for machines of the screen type) to 1.4 m / s and the high efficiency of soil separation by an oscillating grate.

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