



Theoretical Substantiation of the Parameters of a Complex Device for Softening a Rail Track with a Rectifier

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ABSTRACT

This article found that to ensure high quality of work and energy efficiency, the traces formed by tractor wheels during grinding are mitigated by the use of swept claws and their parameters are in the range of the angle of entry into the ground within $20 - 26^{\circ}$, the angle of sharpening within $36 - 44^{\circ}$, the angle of wing opening 60° , the angle of blade sharpening within $12 - 15^{\circ}$, it was determined that the width the coverage should be 47 cm when using one working body and 26 cm when using two working bodies.

Keywords:

Leveler, rectifier, track softener, softener paw, axial paw, angle of entry into the soil, UV Angle, angle of opening of the wings, angle of sharpening of the beam, coverage width

In the soil and climatic conditions of our republic, agrotechnical grinding measures are carried out to level and compact the land before sowing [1]. Its main task is to level the surface of the field, compact it and create a soft layer of soil to create optimal conditions for high-quality planting, germination and seed growth. As a result, in addition to ensuring the sealing of seeds to the same depth and long-term preservation of moisture in the soil, the working conditions of the units used for sowing, row-to-row processing and harvesting are improved.

Currently used grinding machines (MV-6.0, MV-6.5, etc.) have the following disadvantages: because of the trailer, they are energy-intensive, inconvenient to operate, have low maneuverability and productivity; requires a large torsion area, the pressure on the ground is regulated by manually placing additional loads (metal or concrete ballasts, filled in sand or soil) or their removal over the entire width of coverage; the available planners are

powerful wheeled tractors (Magnum 8940, MX-255, PUMA, AXION 850, ARES 697 ATZ, ARION 640 CIS, NEW HOLLAND T7060), which are widely used in the main and pre-sowing cultivation of land in our republic, when using (aggregation) of their wheels, traces formed on the surface of the field, remain unmixed.

Based on the analysis of scientific and technical literature and conducted research, a suspended levelling comb with a wide range of quick and easy adjustment of ground pressure and equipped with trail softeners has been developed [2].

The complex equalizer is made in a suspended design and consists of a central, right and side sections. The side sections are pivotally connected to the central section and are transferred from the working position to the transport position and from the transport position to the working position by means of a hydraulic cylinder.

In the working position, the central and side sections of the complex grinding machine

are motionlessly connected to each other with the help of special brackets and fingers and form a single rigid system.

Each section of the extensive grinding machine consists of transverse and longitudinal brushes connecting them together.

The central section is additionally equipped with a suspension device and working bodies softening tracks formed by tractor wheels, i.e. softeners of tracks.

The developed planner provides for changing the vertical distances from its base plane to the lower suspension points and

between the lower and upper suspension points, which allows you to adjust the pressure exerted by it on the ground.

The workflow of the planner roller occurs as follows (Fig. 1): when the unit moves across the field, the planner roller cuts off the irregularities in the path of the roller and levels the surface of the processed field, pushing it to the depressions, and the roller compacts the surface levelled by the planner to the required level, the track softeners from tractor wheels soften the tracks.

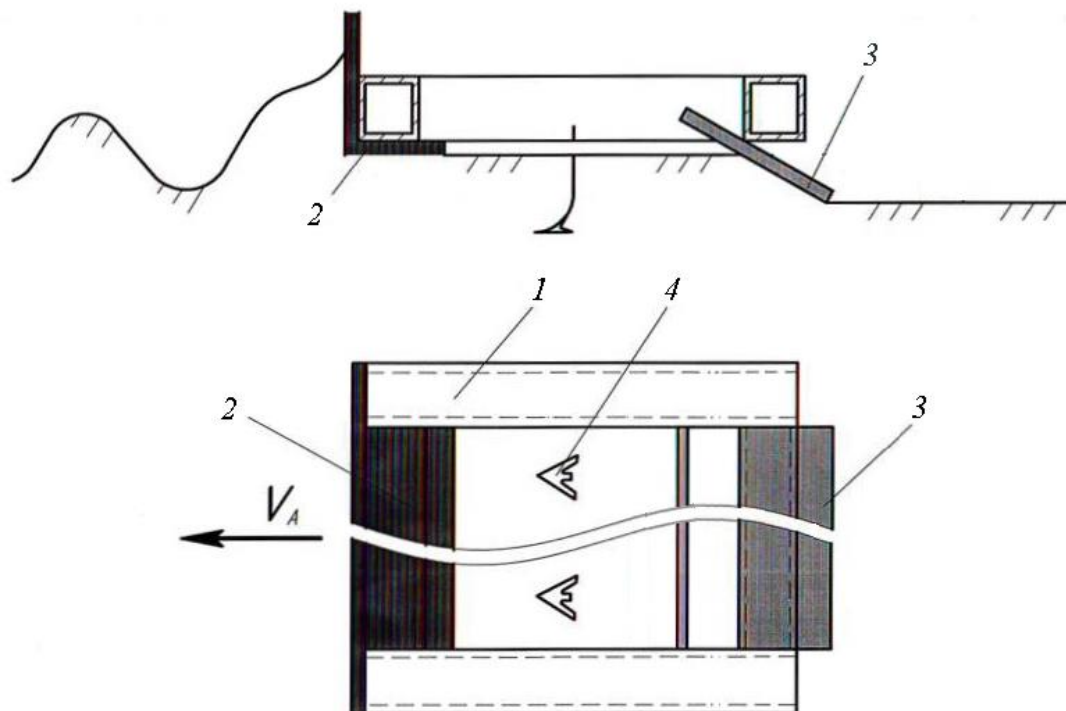


Fig.1 The working process of the developed grinding machine
1-frame 1; 2- leveller; 3-compressor; 4-component softener

This article presents the results of studies conducted on the basis of the type and parameters of extensive crushing-correct trace softeners.

Softeners and bullet-shaped claws are mainly used to soften the tracks formed by tractor wheels [3, 4].

When using softening claws, firstly, at the bottom of the layer they are processing, unmixed longitudinal irregularities (braids) are

formed, which negatively affects the development of plants, and secondly, they carry a lot of moist soil from the lower layer to the surface of the field. and this leads to a loss of moisture in the soil, and thirdly, with a large wheel track width to ensure its complete softening, it is necessary to install several (up to 6) softening dogs in two or three rows, and as a result, the material and energy capacity increases.

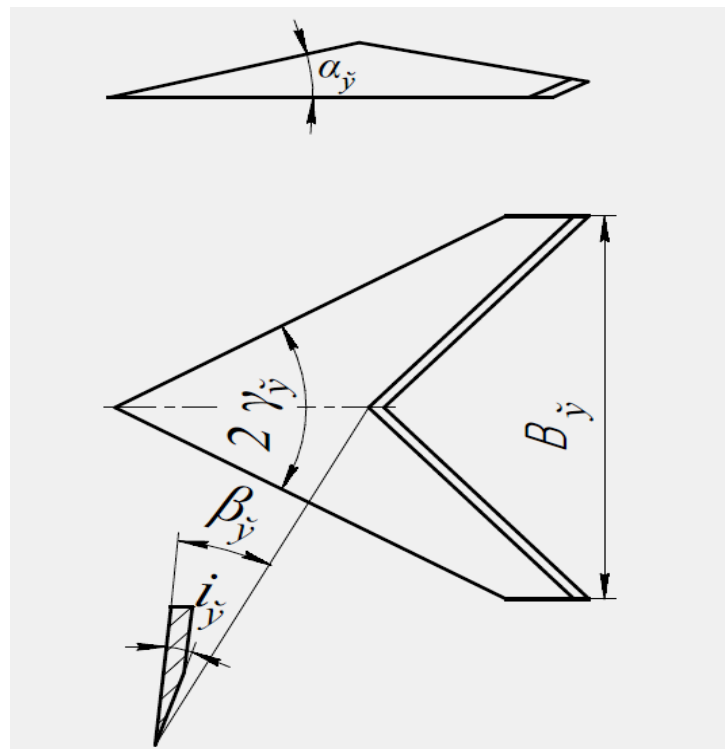


Fig. 2. The main parameters of the axial paws

When using axial paws, there are no undulating longitudinal irregularities at the bottom of the treated layer.

Based on the above, it is recommended to install a bullet-shaped gripper as a trace softener on a complex grinding and leveling machine.

The main parameters affecting the performance characteristics of the cylindrical grips [5] include the following: α_y - angle of

entry into the soil; β_y - angle of sharpening; $2\gamma_y$ - angle of wing opening; i_y - angle of blade sharpening; B_y - coverage width.

The angle of entry of the cylindrical blade into the ground is determined by the following expression obtained from [6], provided that high-quality crushing (grinding) of the treated soil is ensured at low energy consumption:

$$\alpha_y = \arcsin \left\{ \left\{ -\sin(\varphi_1 + \varphi_2) + \sqrt{\sin^2(\varphi_1 + \varphi_2) + \left[2 + \frac{1}{2} \cdot \cos(\varphi_1 + \varphi_2)\right] \cdot [1 + \cos(\varphi_1 + \varphi_2)]} \right\} : \left[2 + \frac{1}{2} \cdot \cos(\varphi_1 + \varphi_2)\right] \right\} \quad (1)$$

where: φ_1, φ_2 - the angles of external and internal friction of the soil, respectively.

$\varphi_1 = 25 - 35^\circ$ and $\varphi_2 = 35 - 45^\circ$ the calculation of the expression (1) showed that the axial paws should be $20 - 26^\circ$ within the angle of entry into the soil.

We determine the angle of opening of the wings of the axial paws by the following expression, provided that plant residues,

weeds and their roots freely slide along its blades [7]

$$2\gamma_y < 90^\circ - \varphi_\delta \quad (2)$$

or

$$\gamma_y < 45^\circ - \frac{\varphi_\delta}{2}, \quad (2a)$$

in which: φ_{σ} - the angle of friction of plant residues, weeds and their roots on the blades of the arrow-shaped paw.

Taking [5] $\varphi_{\sigma} = 30^{\circ}$ $\gamma_{\dot{y}}$ is no more than 30° , we determine $2\gamma_{\dot{y}}$ should be 60° .

We determine the angle of crumpling of the wings of a axial paws based on the values of its entry into the soil defined above and the angles of opening of its wings according to the following expression [5]:

$$\operatorname{tg} \beta_{\dot{y}} = \frac{\operatorname{tg} \alpha_{\dot{y}}}{\sin \gamma_{\dot{y}}} \quad (3)$$

Or

$$\beta_{\dot{y}} = \arctg \frac{\operatorname{tg} \alpha_{\dot{y}}}{\sin \gamma_{\dot{y}}}. \quad (3a)$$

Substituting the above $\alpha_{\dot{y}}$ and $\gamma_{\dot{y}}$ values into this expression, we determine that the angle of attack of the wings of the axial paws should be within $36 - 44^{\circ}$.

We assume the sharpening angle of the axial paws blades in the range of $12 - 15^{\circ}$ according to the information presented in the literature [5].

We determine the coverage width of the axial paw from the condition of complete softening by the entire width of the track

formed by the tractor wheels using the scheme presented in Figure 3. To do this, the following condition must be met

$$B_{\dot{y}} + 2h \operatorname{ctg} \psi_{\bar{e}} \geq B_u, \quad (4)$$

in which: h - the depth of processing of the softener of the trace (pulverized claw);

$\psi_{\bar{e}}$ - angle of lateral fracture of the soil;

B_u - the width of the track formed by the tractor wheel.

Solving expression (4) with respect to $B_{\dot{y}}$, we obtain

$$B_{\dot{y}} \geq B_u - 2h \operatorname{ctg} \psi_{\bar{e}},$$

(5)

When softening the track from the tractor wheel by two working bodies, expression (4) has the following form.

$$2B_{\dot{y}} - C + 2h \operatorname{ctg} \psi_{\bar{e}} \geq B_u \quad (6)$$

from this

$$B_{\dot{y}} > 0,5(B_u + C) - h \operatorname{ctg} \psi_{\bar{e}}. \quad (7)$$

where: C - the size that takes into account that the coverage of the axial paws covers each other in width.

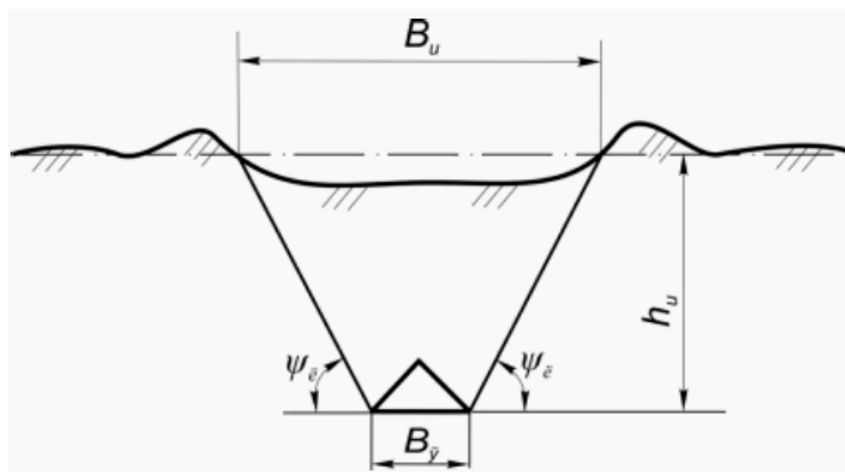


Fig. 3 Scheme for the justification of the coverage width of the axial paw

The "Magnum" 8940, MX-255, "PUMA", AXION 850, Ares 697 ATZ, ARION 640 CIS, NEW HOLLAND T7060 widely used in

agricultural production of the Republic, adopted the width of the tracks formed from tires mounted on the wheels of the driving

tractors $B = 70$ [3, 4] as well as $h = 20$, $\psi_y = 60^\circ$ and $C = 6$ [5] by adopting the (5) and (7) when softened, we determine that the coverage width of the axial paw should be 47 cm, and when softened with two working organs-at least 26 cm.

So, according to research, to ensure high-quality and energy-saving softening of traces formed by tractor wheels, they have an entry angle into the soil of $20-26^\circ$, a sharpening angle of $36-44^\circ$, a wing opening angle of 60° , a blade sharpening angle of $12-15^\circ$, a coverage width of 47 cm (when smoothing the track with one working body) and 26 cm (when smoothing the track with two workers organs) must be smoothed using axial paws.

To ensure high quality of work and energy efficiency during the operation of the integrated planner, the traces formed by the tractor wheels should be softened by using swept grips, while the axial paws should have the following parameters: the angle of entry into the soil - $20-26^\circ$; the angle of sharpening - $36-44^\circ$; the angle of wing opening - 60° ; the angle of sharpening blades - $12-15^\circ$; the width of coverage - 47 cm or 26 cm, respectively, when softening the traces formed by the tractor wheels, one and two working bodies.

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