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**CONCERNING ADVANTAGES OF PASSIVE OPERATIVE PART WITH ASYMMETRIC LEG**

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The parameters of modern power intensive tractors MXM-140, TS-130, TL-100 manufactured in the Republic of Uzbekistan jointly with “New-Holland” Company enable utilization of the combined soil cultivating machines which perform several agricultural operations per one pass.

The prevailing majority of combined soil cultivating machines is equipped with passive operative parts with an arrow-headed leg. The main shortcoming of these operative parts is that uncultivated sections in form of rest-balks remain when the operative parts have the single-in-line placement due to absence of overlapping between the adjacent legs; whereas, soil loading takes places when single-in-line overlapping is installed which causes drastic increase in tractive resistance of the machine and abnormalities in the technological process of soil loosening. Therefore, to ensure overlaps, the legs are placed in two and more lines thus increasing overall dimensions and, therefore, weight of the machine which his undesirable.

The studies held by us showed that these shortcomings may be eliminated by application of passive operative parts with asymmetric leg [1].

Passive operative part with asymmetric leg (Figure 1) consists of a shank 1, a chisel 2 and asymmetric blades 5, 6. As per customer request, the blades of legs may be implemented in provide for shank rigid fixed option or shank hinged movable option. In the hinging option, the asymmetric blades of the leg are hinged to the shank using a work drive 3 and a hinge 4; and blades’ angular oscillations are fixed with a balancer 7. In both options, the right (*П*) and left (*Л*) blade of the leg are implemented with different opening angles $\gamma_p^{(п)}$ *and* $\gamma_p^{(л)}$ and different coverage widths $в_п$ and $в_л$; the shank is implemented with frontal surface generated with two asymmetrically located surfaces [2]; whereas, its greater facet is located on the side of the blade with greater opening angle. Such shape of the shank prevents enveloping with plant residues during operation of the operative part.

In spite of the single-in-line installation with overlapping and due to presence of free space in the traveling direction of the machine i.e. “Ш” slots between the blades of the adjacent legs, plant residues freely come off shears of the blades and pass through these slots in the passive operative parts with asymmetric legs. Thereby, soil loading is prevented. Furthermore, such design implementation of the legs reduces the overall size of the soil loosening cultivator and reduces consumption of materials and power inputs.

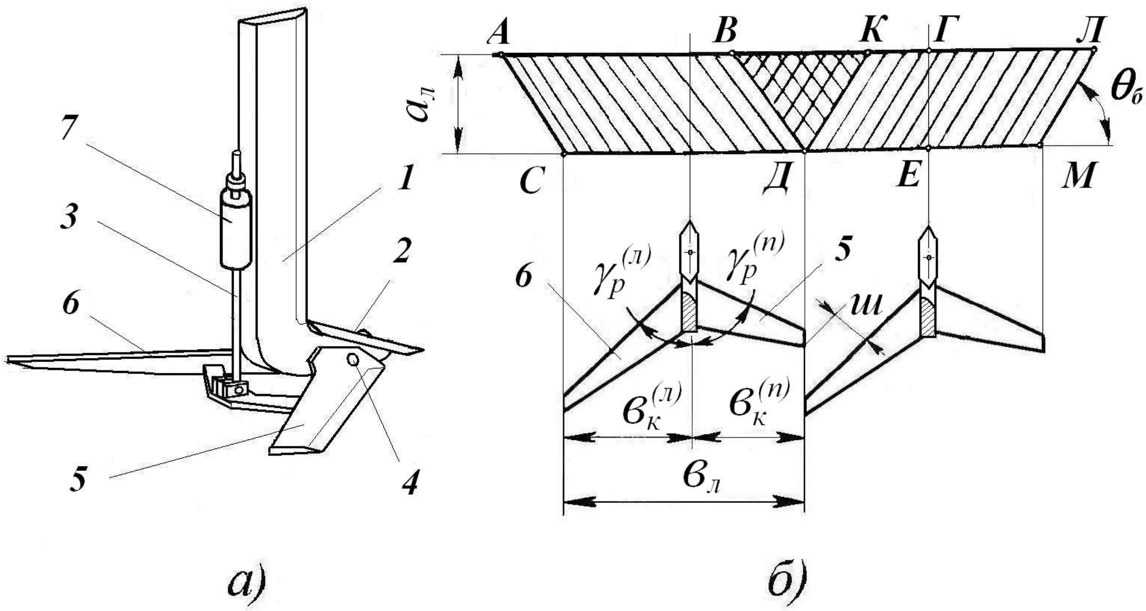


*Figure 1. Passive Operative Part with Asymmetric Leg (a) and Soil Deformation Diagram (б)*

Operating conditions of the asymmetric leg are somewhat different from those of symmetric arrow-headed legs. As for the asymmetric legs, soil to the left of КД line in transverse vertical plane (Figure 1б) is deformed with the right blade of the adjacent leg. Therefore, the left blade of the asymmetric leg makes soil displacement on the area which is equal to КГЕД trapezoid area when the plane exits to the surface of undisturbed soil and which is equal to ВКД triangle area when the plane exits to the disturbed zone to the left of КД line.

Therefore, the right blade of the asymmetric leg makes soil displacement for a bump enclosed on two sides i.e. it operates in blocked environment. Whereas the blade of the asymmetric leg operates for a bump open on one side i.e. in the soil environment unblocked on one side. As a result, the blade with greater opening angle destructs and loosens the soil at a depth $a_л$, and the blade with smaller opening angle undercuts the soil partially destructed with the blade (with greater opening angle) of the adjacent operative part. At the same time, the angle of soil side shearing - $\theta_б$ for these blades may be different.

Opening angles of the blade shears are the main parameters which determine distinctions in the design of the asymmetric leg. The opening angle of the blade with smaller length should be chosen so that weed cutting was made with sliding cutting, and they freely slide along the shears (Figure 2). If this condition is not met, weeds held at the shear with frictional forces $T_c$ will be accumulated on the blade of the leg; whereupon, the shear ceases cutting weeds and be raised from the soil.

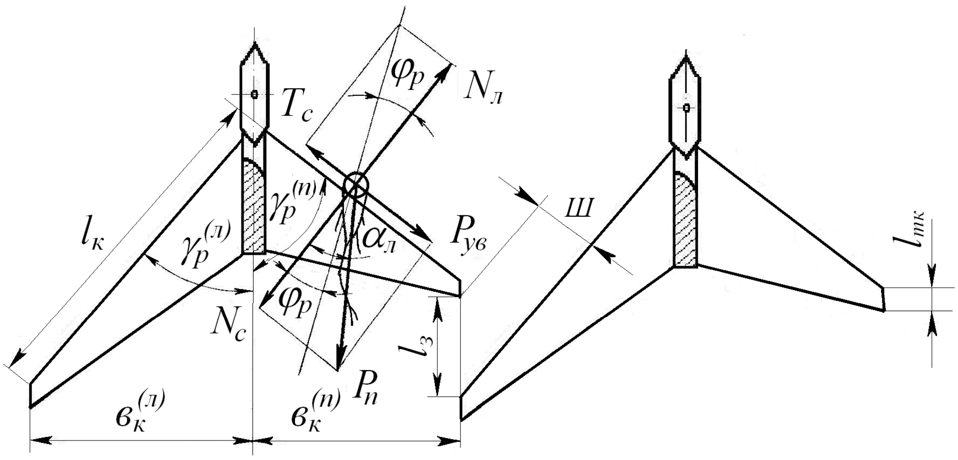


*Figure 2. Diagram for Determination of Opening Angles of Blade Shears*

To ensure sliding conditions along the blade shear, the direction of soil reinforcement force - $P_n$ made onto weed must occur outside the opening angle of plant reside friction against metal - $\varphi_p$. Otherwise, the force carries along the weeds - $P_{ув}$ will be smaller than the friction force - $T_c$, thus resulting in accumulation of weeds on the leg blade. Thereby, in order to prevent blade shear blocking with weed, the following condition must be satisfied:

$$P_{ув} > T_c \qquad (1)$$

or

$$\alpha_л > \varphi_p, \qquad (2)$$

where $\alpha_л$ is the angle between normal line $N_c(N_л)$ and direction of soil reinforcement force $P_n$, radian.

Then, taking into account the condition (1) and that

$$\alpha_{л} = 0{,}5\ \pi - \gamma_p^{(n)}, \tag{3}$$

the value of opening angle of he blade shears of smaller length may be determined using the following inequality

$$\gamma_p^{(n)} < 0{,}5\ \pi - \varphi_p\ , \tag{4}$$

where $\pi$- =3,14 radian.

Opening angle of the blade shears of greater length will be determined provided that overlapping between adjacent legs and unimpeded come off plant residues from the blade shears of adjacent legs are ensured. Such condition is ensured if there is a certain distance between ends of the blades of adjacent legs which is, given single-in-line location of operative parts, achieved with displacement along movement course of adjacent blades of the leg relative to each other or with change in opening angle thereof. In the latter case, equality of coverage width is ensured due to changing of their length.

Thus, opening angle of the blade with greater length may be determined using the following correlation:

$$\gamma_p^{(л)} < 0{,}5\ \pi - arctg\ [(\ l_з + B_k^{(n)}\ ctg\ \gamma_p^{(n)} + l_m\ )/\ B_k^{(л)}]\ , \tag{5}$$

where $l_з$ is a distance between rear end of the blade of smaller length and front end of the blade with greater length, m, $l_m$ is a length of face edge the leg blade, m; given the unchanged coverage width $B_л$ according to Figure 2

$$l_k^{n(л)} = B_k^{n(л)}\ /\ sin\ \gamma_p^{n(л)}, \tag{6}$$

Therefore, as the opening angle of shears decreases, the length of the blade increases, thus resulting in reduction of its hardness and increase in frictional force which is undesirable.

The studies also showed that increase in length of blade shears of the weeding leg results in growth of total weight of weeds hanging thereon. Thus, for example, given the same opening angle of shears which is equal to $40^0$, the quantity of weeds hanging therein will increase as the blade length increases from 237 to 320 mm.

Such phenomenon has a non-static, dynamic nature i.e. hang-up occurs not due to immovable weeds hung on the shear but due to weeds slowly sliding along the shear. At the same time, the quantity of weeds - $n_c^{n(л)}$ located on the shear per unit of time may be determined using the following formula

$$n_c^{n(л)} = i_c V_n l_k^{n(л)} / cos (\gamma_p^{n(л)} + \varphi_p), \tag{7}$$

where $l_k^{n(л)}$ is the shear length of the right and left blade, respectively, which are asymmetric to the weeding leg, m, $i_c$ is the quantity of weeds on per unit of field area, pcs/.$^2$, $V_n$ is the forward speed of the operative part, m/s.

According to the formula (7), the lengthier the blade shear is and the greater its opening angle is, then the greater quantity of weeds hung thereon is.

In order to assess performance of the passive operative part with asymmetric leg, there were carried out comparative laboratory and field experimental studies for its comparison with a passive operative part equipped with a mass production arrow-headed leg (control).

Results of the experiment show (Table 1) that, in respect to chopping quality, the passive operative part with a mass production arrow-headed leg is inferior to the passive operative part with asymmetric leg; the latter has < 10 mm fraction content 11.16^ greater than the control one. It is explained with following considerations.

Table 1

**Performance Indicators of Compared Passive Operative Parts**

| Comparable Passive Operative Parts Equipped with | Content of Fraction with Following Size, mm, in % | | | | | Cultivation Depth, cm | Tractive Resistance, N |
|---|---|---|---|---|---|---|---|
| | >100 | 100-50 | 50-25 | 25-10 | < 10 | | |
| Mass Production Arrow-Headed Leg | 5.93 | 16.69 | 19.72 | 16.72 | 40.94 | 15.54 | 776.2 |
| Asymmetric leg | 0 | 11.81 | 15.89 | 20.20 | 52.10 | 16.84 | 570.0 |

The asymmetric leg' blade with greater opening angle combined with the chisel makes soil displacement for a bump enclosed on two side i.e. it operates in the blocked environment. Whereas, the blade with smaller opening angle for a bump open on one side i.e. in soil environment unblocked on one side. As a result, the blade with greater opening angle destructs and loosens the soil, and the blade with smaller opening angle undercuts the partially destructed soil. Such consecutive impact of the chisel and the blades of the asymmetric leg of the designed passive operative part increase the crumbling quality and reduce power inputs by making semi-unblocked soil loosening.

The greater content of fraction greater than 50 mm in the passive operative part with arrow-headed leg in comparison with asymmetric leg is explained with presence of uncultivated sections due to spacing generated between adjacent legs, i.e. undercuts.

Somewhat greater value of tractive resistance in arrow-headed legs is explained that the leg tip, blades and tail impact the soil as one single sculpted surface along the entire coverage width of the leg which is equal to 360 mm. Whereas, the asymmetric leg's separated consecutive impact of the chisel and the right and left blades of the leg enables the blades to move in a partially loosen soil layer during the work process that certainly reduces tractive resistance of the operative part.

Thus, the conducted studies enable to make following conclusions:

1. The designed passive operative part with asymmetric leg enables its installation in the single line along the coverage width of the machine with overlapping of adjacent legs tracks and ensures unimpeded convergence with the blade shears of legs and passage of plant residues and soil lumps between the adjacent legs, thus excluding generation of "undercuts".

2. Separated consecutive impact of the chisel and blades of the asymmetric leg of the designed passive operative part improves the crumbling quality and reduces power inputs by making semi-unblocked soil loosening.

## Literature

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