DEVELOPMENT OF NEW TILLIN MACHINE FOR FLAX HARVESTERS

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Summary
The article contains the materials of theoretical research, which became the basis for the creation of a new design for the lifting machine of the flax harvesting combine. In the basis of creating a new design, the author posed the task of ensuring high quality indices of the process of flax loosening.

Keywords: flax, tearing apparatus, analysis, design, stretch, grip width.

Streszczenie
W artykule przestawiono materiały z badań teoretycznych które stały się podstawą do stworzenia nowego wzornictwa dla maszyny do zbioru lnu. U podstaw nowej koncepcji urządzenia stało założenie opracowania wysokiej jakości maszyny do zbioru lnu.

Słowa kluczowe: len, rozwłóknianie, uchwyt, szerokość urządzenia.
Statement of a question. At the present stage, the development of flax harvesting machine designs is based on numerous studies of working organs, including a trolley apparatus. Machines for harvesting flax have a number of advantages and can significantly reduce labour and money costs during the harvesting of flax with a long wolf. At the same time, they have a number of shortcomings that require elimination. So, during the cleaning of contaminated and flaxy flax, the trolley apparatus does not provide complete re-weeding of the stems. The stem tape, which is formed in the streamer’s streams, contains non-parallel, skewed stems; there is a significant displacement of the stems of the stems, which leads to an increase in the stretching of the flax tape.

Elimination of these shortcomings is impossible without thorough and comprehensive research of mechanisms.

Analysis of literary sources. Research and substantiation of individual working organs of flax harvesters were carried out by: N. N. Bykov [1], G. A. Haylis [2, 3, 4], M. M. Kovalev [5, 6], V. A. Sheychenko [7], A. Y. Gorbovuy [8], N. N. Tolstushko [9] and others.

Analysis of known studies and designs of trolling apparatuses has shown that the flax stalk's height, its density, the speed of movement of the flax harvesting machine, the height of the nozzle spacing, and other factors influence the efficiency of this machine working element and its performance index—the stretching of the flax stalk tape [2, 5, 8]. Studies have also revealed that the width of the tethering section has a significant influence [7, 10], that is, the spacing between the spouts of dividers, which in known machine designs is 38 sm. The use of trolleys with such a wide grip leads to an increase in the tensile index, which is a drawback of trolley apparatuses.

Taking into account the aforesaid, the development of theoretical foundations for the creation of an improved design of a lifting apparatus that will ensure the fulfilment of the process of loosening flax with a minimum stretch index is an important scientific and practical task to solve which this article is devoted to.

Objective. To carry out the theoretical substantiation of the improvement of the design of the lifting machine of a flax harvesting machine.

Statement of the main material. Flax-tillers with longitudinal creeks (Fig. 1, a, b, v) contain two belts, and the minimum number of rotating parts is five (there are designs with a large number of rotating pulleys and rollers). In a trolling machine with transverse streams, the entire apparatus has two belts, five pulleys and nine rollers. If you change the width of each trolley section with the same width of the device, the total number of sections, belts, pulleys and rollers will increase, which will lead to an increase in the material consumption.
The assessment of the complexity of the construction of various tearing apparatuses [10], carried out by the author of the article, revealed that the indicator of the complexity of the apparatus with transverse creases is much smaller than that of the apparatus with longitudinal creases, taking into account this, it can be concluded that work in the direction of reducing the width of the tethering sections with a slight complication. The design of the apparatus is best carried out for a device with transverse creases.

When developing a new device, it must also be taken into account that in each section the length of the tethering section (the length of the aircraft ВС, DE of the tight fit of the belt to the pulley, figure 1, d). Should be sufficient to ensure a full extension of the root from the ground. In accordance with [7], the length of the trolley section should be $S_p$ at least 25 cm. With this length of the trolley section, the transverse tethering section can function with a working width $b$ of up to 30 cm. If the length of the tethering section is reduced insufficient to provide the process of tethering $S_p$.

A further reduction $b$ is possible if the trolley rollers are moved forward and closer to the masters in order to ensure an increase in the arc of coverage of each
shoe by a belt (Figure 2). In Fig. 2, the length of the arc $C_2C_1$ of the belt 2 coverage of the rod 4 exceeds $\pi$ the value $2\alpha_0$, where $\alpha_0$ is the deviation angle of the radius $O_1C_2$ from the line $O_1a_2$, which is perpendicular to the machine's direction of travel. Taking this into account, the arc length $C_2C_1$ of tight fit a belt to the stems and a pulley: $(r_w + \delta_n)(\pi + 2\alpha_0)$, where is the radius of $r_w$ the pulley, $\delta_n$ -the thickness of the layer of stems. If given by an angle $\alpha_0$, the arc $C_2C_1$ will be equal to the actual length of the tethering section $S_p$. Taking into account what has been said in this apparatus:

$$S_p = (r_w + \delta_n)(\pi + 2\alpha_0)$$

(1)

Fig. 2. The scheme of the part of the tearing apparatus with crosswise arms and the position of the centers of the rollers is closer to the dividers behind the line connecting the centers of the pulleys: 1 – divider; 2 – a period; 3 – roller located to the right of the pulley; 4 – trolley pulley; 5 – the roller located to the left of a pulley; 6 – clamping rod.

On the other hand, the width of the gripper section is equal to the distance $O_2O_2$:

$$b = 2(r_w + \delta_n + \delta_p + r_p)\cos\alpha_0,$$

(2)

Where is the – $\delta_p$ thickness of the hoisting belt.

Solving equations (1) and (2) we find:

$$r_w = \frac{S_p}{\pi + 2\alpha_0} - \delta_n.$$  

(3)
\[ r_p = \frac{b}{2 \cos \alpha_0} - \frac{s_p}{\pi + 2 \alpha_0} - \delta_p. \] (4)

The boundary position of the rollers 3 and 5 will be such that the distance from the points \( K_1 \) and \( K_2 \) of the belts surrounding the rollers to the axis \( a_1Oa_2 \) is equal \( r_\text{III} \). Further moving of the rollers forward is not possible, since it will mesh the arrival of stems in the trolley handle. The boundary value \( \alpha_{\text{oni}} \) of the angle \( \alpha_0 \) in this case, as well as the values of the radii \( r_\text{III} \), are \( r_p \) determined by three equations:

\[ r_\text{III} + \delta_\lambda = \frac{s_p}{\pi + 2 \alpha_{\text{oni}}}; \] (5)

\[ r_\text{III} - r_p - \delta_\lambda - (r_p + \delta_\lambda + \delta_p + r_\text{III}) \sin \alpha_{\text{oni}}; \] (6)

\[ b - 2(r_p + \delta_\lambda + \delta_p + r_\text{III}) \cos \alpha_{\text{oni}}. \] (7)

By solving these equations, we find the parameters \( \alpha_{\text{oni}}, r_\text{III}, r_p \).

Taking into account the theoretical studies carried out by us, we produced a trolley machine of a flax harvesting combine with a working width of 26 cm [11], the scheme of which is shown in Fig. 3. In Fig. 4 shows a photo of a manufactured trolley apparatus that was installed on a flax harvester and passed field tests.

Advantages of the proposed design of the flax harvesting machine are that due to the possibility of adjusting the position of the trolley rollers relative to the pulling pulleys, the distances between the spouts of the dividers are reduced, which increases the quality of stalk loosening and the reduction of their stretching.
Fig. 3. Scheme of a tearing machine with narrow-clawed sections: 1 – tethering belt, 2 – trolley pulleys, 3 – trolley rollers, 4 – drive pulley, 5 – pulley of the cocking device, 6 – roller of the cocking device, 7 – guide roller, 8 – brackets for trolley rollers, 9 – brackets of trolley sheaves, 10 – bracket of the outrigger pin, 11 – bracket for the right pulling and guide rollers, 12 – bracket for the outfit roller, 13 – frame, 14 – bracket for connection to the tractor hitch, 15–16 dividers, 17 – tensioning devices, 18 – bars output device.

Fig. 4. A photo of the experimental samples of a lifting machine with a working width of 26 cm.
Conclusions

1. Analysis of ways to reduce the stretching of the stems during the weeping, which is achieved by reducing the width of the trolley section, it is established that it is easiest to reduce the width of the grip in curved devices with transverse streams.

2. If the width of the section is reduced, the diameter of the tearing creek must be reduced, which can negatively affect the amount of the tethering section of each section. To prevent this, it is recommended to decrease the position of the pinch roller in each brook by moving it forward towards dividers. At the same time in each creek, the angle of coverage of the pulley with a belt increases.

3. Testing of the proposed trolley apparatus with a 260 mm width allowed to reduce the stretching of the flax fiber ribbon and, consequently, to jiggle the yield of the fiber during the primary processing of the trusts, in a raving, by 10%.

Bibliography


