DESIGN IMPROVEMENT OF A COMBINE HARVESTER THRESHING UNIT USING AUTOMATIC BALANCERS

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Abstract: *The paper presents a design improvement of a combine harvester threshing unit intended for corn grain harvesting. The proposed solution supplements the conventional threshing drum with automatic balancing devices installed at both sides of the drum. Freely moving balancing bodies change their angular position under centrifugal forces and compensate for variable mass imbalance during operation. The modernization is aimed at reducing drum vibration, dynamic loading of the shaft and bearings, and improving the uniformity of threshing without changing the basic technological principle of the combine harvester.*

Key words: *combine harvester, corn harvesting, threshing drum, automatic balancer, rotor imbalance, vibration, threshing quality.*

The threshing unit is one of the principal working systems of a combine harvester because its operating stability directly affects grain separation, grain damage, losses and the reliability of the harvesting machine. During corn harvesting, the drum operates under strongly variable loading caused by differences in ear mass, moisture, size and crop flow. Material can also accumulate unevenly on beaters and internal surfaces. The resulting mass eccentricity generates centrifugal forces that are transmitted to the drum shaft, bearings and supporting structure. Rotor imbalance is a well-known source of vibration in rotating machinery. Automatic balancing devices are attractive when imbalance changes during operation because their correction masses can redistribute without stopping the rotor [1–4]. Recent research also confirms that imbalance-induced vibration of a combine harvester threshing drum is an important practical problem and that balancing systems can be integrated into agricultural threshing equipment [5]. Therefore, the objective of this work is to

substantiate a structurally simple modernization of the threshing drum using passive automatic balancers.

The modernized unit consists of the threshing drum shaft, the drum with working elements, supporting discs, beaters, side discs and two balancing automatic balancers. The shaft is the main load-bearing element and transmits torque from the combine drive. Supporting discs provide rigidity and retain the working elements, while the beaters act on corn ears in the drum–concave zone. The essential design difference is the installation of automatic balancing devices on both sides of the drum.

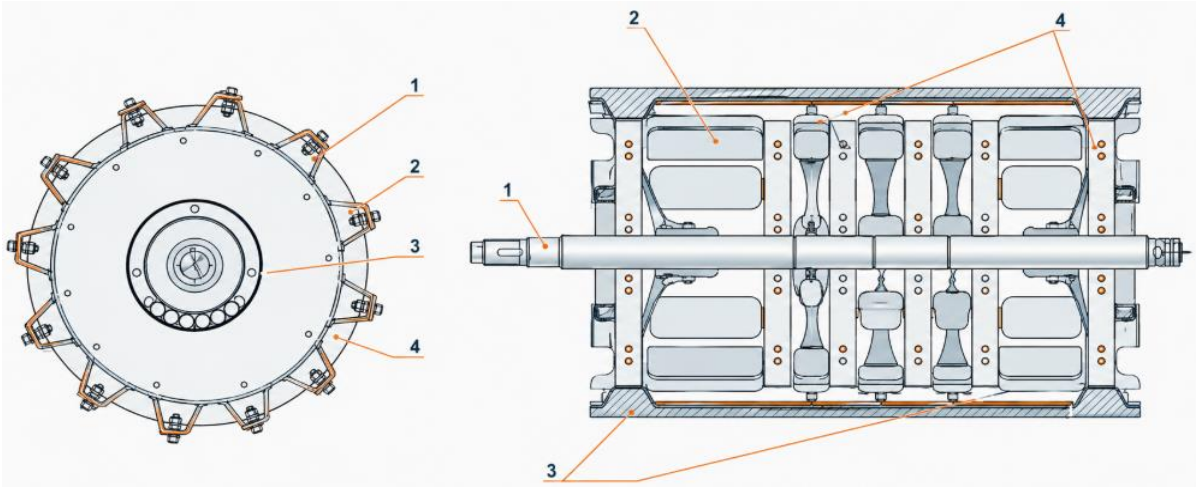


Fig. 1. Modernized combine harvester threshing unit:
1 – threshing drum shaft; 2 – threshing drum; 3 – supporting discs; 4 – balancing automatic balancers; 5 – beaters; 6 – side discs

The calculated operating parameters show that the modernization can be incorporated without a substantial increase in drive power. The total required drum-drive power is approximately 10.13 kW. The adopted diameter and speed correspond to an angular velocity of 70.59 s^{-1}, while the 0.94 m concave length provides a sufficient interaction zone for corn ears. The preliminary engineering justification indicates that stabilization of the drum can improve threshing quality by approximately 4–6%. This estimate is associated with lower vibration, more uniform action of the working elements and a reduction in excessive grain impacts. At the same time, reduced dynamic loading should decrease wear of bearings, shaft connections and supporting components. The proposed modification is therefore intended primarily to improve operational stability rather than to increase the

aggressiveness of threshing. An important advantage is retrofit compatibility: the modernization preserves the conventional shaft, drum, beaters, supporting discs and side discs and adds balancing elements to the existing assembly. Consequently, the general functional scheme of the combine harvester remains unchanged. A design improvement of the combine harvester threshing unit using balancing automatic balancers has been proposed. The main source of harmful vibration is variable mass imbalance of the threshing drum caused by non-uniform crop loading and material accumulation. The automatic balancers are installed on both sides of the drum and contain movable balancing bodies whose positions change under centrifugal forces. Their redistribution compensates part of the drum imbalance and stabilizes rotation without operator intervention. For the adopted operating conditions, the calculated drum diameter is 0.68 m, length 1.75 m, rotational speed 674.2 rpm, angular velocity 70.59 s^{-1} and total drive power 10.13 kW. The modernization retains the original threshing principle while aiming to reduce vibration, dynamic loading, grain damage and losses.

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ОБҐРУНТУВАННЯ РЕЖИМІВ РОБОТИ БАРАБАННОГО СЕПАРАТОРА НАСІННЄВОГО ВОРОХУ

Олександр ВІЛЬЧИНСЬКИЙ, Артем ЄРИКОВСЬКИЙ, Олексій ХАМРІЙ

Анотація. *У роботі висвітлено результати теоретичних та експериментальних досліджень технологічного процесу виділення та сепарації насіння огірків із соковитих плодів у циліндричному роторно-перфорованому сепараторі. Обґрунтовано актуальність механізації процесів овочевого насінництва та зниження частки ручної праці. Проаналізовано фізико-механічні й розмірно-масові характеристики вихідної сировини та насіння. На основі методології повного факторного експерименту (ПФЕ 23) розроблено математичні моделі у вигляді поліноміальних рівнянь регресії другого ступеня, які описують вплив кутової швидкості ротора, кута нахилу барабана та розміру отворів решета на втрати насіння й засміченість вороху. За результатами аналізу 3D-поверхонь відгуку визначено раціональні конструктивно-кінематичні параметри сепаратора, що забезпечують*