PAPER • OPEN ACCESS

Electrification of the mechanical drive of vertical spindle cotton picker drums

To cite this article: M Shoumarova *et al* 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1231** 012003

View the article online for updates and enhancements.

You may also like

- Cotton harvesters for one-time cotton-picking
Anvar Rizaev, Rafik Matchanov, A T Yuldashev et al.
- Advance of spindle drum and frontality of active spindle surface
A Rizaev, A Yuldashev, D Kuldoshev et al.
- Epi-and hypo-cyclic spindle drives of a cotton harvester
A A Rizaev, D A Kuldoshev, N B Dzhuraeva et al.

This content was downloaded from IP address 213.230.109.7 on 16/11/2023 at 09:52

Electrification of the mechanical drive of vertical spindle cotton picker drums

M Shoumarova, T Abdillayev and Sh A Yusupov

Tashkent Institute of Irrigation and Agricultural Mechanization Engineers (National Research University), Tashkent, Uzbekistan

E-mail: sher_xxx89@mail.ru, sherzod-yusupov@tiiame.uz

Abstract. The article notes that the existing mechanical drive of the vertical spindle drums in the cotton harvester is complex, with uncovered multi-stage gear transmissions that create a strong noise, and engagements that do not occur throughout the height of the tooth. The drive of the first left drum is particularly complex, as the movement from the apparatus gearbox is transmitted through six gear engagements. Open gears quickly wear out, which disrupts the chessboard arrangement of spindles and reduces the completeness of cotton collection. It is believed that almost 80% of cotton is collected by the first pair of drums. Frequent disruptions in the chessboard arrangement of spindles of the first pair of drums, therefore, greatly affect the completeness of collection. Therefore, the authors propose to improve this drive by electrifying it. They recommend replacing the machine's distribution gearbox with a direct current generator. Electrification will make the spindle drum drive more compact. It will be possible to slightly vary the speeds of only the rear spindle drums for technological reasons.

1. Introduction

Nowadays, cotton harvesters are equipped with vertically spindle machines as well as "combined machines", which are equipped with a horizontal-spindle and, if necessary, a vertical-spindle apparatus and are prepared for serial production with a multi-gear drive for spindle drums. The drive starts with a transfer gearbox (Fig.1) installed on the rear PTO of the tractor[1]–[3]. The gearbox has three output shafts with separate engagement: one output shaft is connected to the cardan shaft, which transmits the movement to the harvester gearbox (Fig.2); the second output shaft transmits rotation to the fan for transporting the collected cotton to the hopper. The third shaft is for the water pump, which is only activated when washing the spindles.

From the harvester gearbox, the movement is transmitted to the spindle drums. The right drums receive movement directly from the harvester gearbox through two engagements, while the left drums operate in worse conditions. The open toothed engagements are installed horizontally, but the gears are located in planes that are slightly offset from each other by a height of 2-4 mm. Therefore, the teeth engage not over the entire height. Overall, the gears work under difficult conditions, causing the teeth to wear out intensively.

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

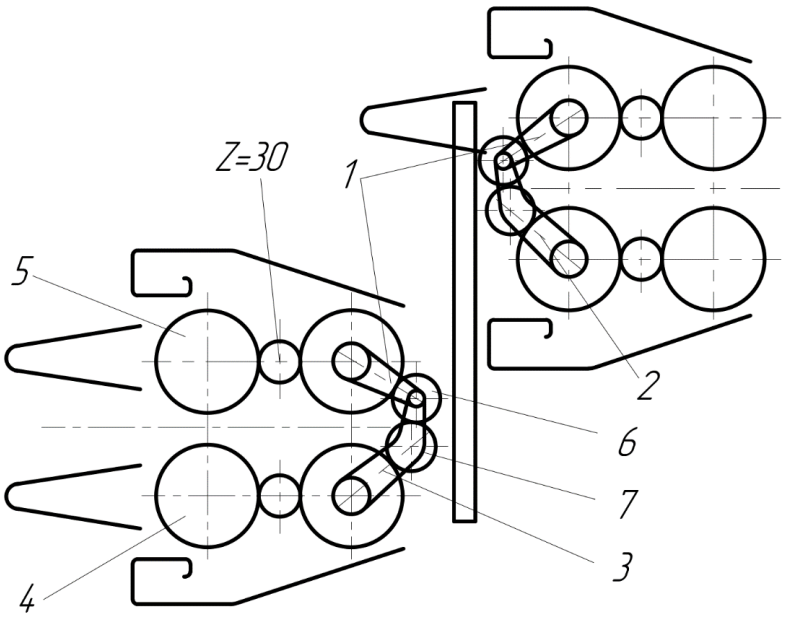

Figure 1. Diagram of the serial drive:
1- small drive shaft; 2,3- large drive shaft; 4- left spindle drum; 5- right spindle drum; 6,7- gears.

This leads to a violation of the chess placement of the spindles of the left and right drums. As a result, the completeness of cotton collection decreases[4], [5]. It should be noted that the first pair of drums collects up to 80% of the cotton entering the hopper. Therefore, frequent violations of the chess placement of the spindles are a significant problem[6]–[8].

In addition, it should be taken into account that each pair of gearings reduces the transmitted power by up to 3% [9]. This further emphasizes the need and relevance for improving the existing drum drive.

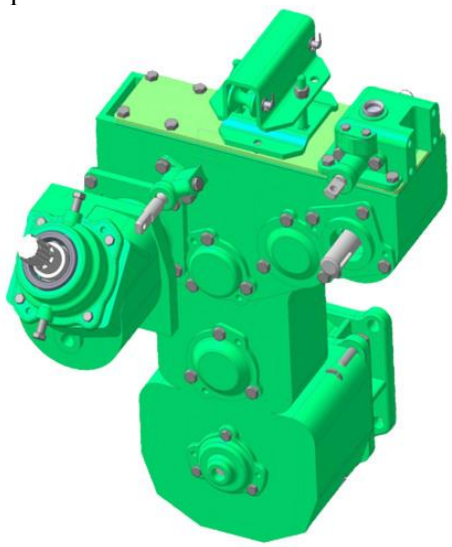

Figure 2. Distribution gearbox.

2. Method for improving the existing drive

Fig. 3 shows the kinematic diagram of the existing drum drive. As mentioned above, the apparatus reducer receives rotation from the distribution gearbox via a universal joint (Fig. 2). The apparatus reducer is a bevel gear type, so it turns the direction of rotation by 90°. It rotates the horizontal gear with Z=30 (Fig. 3), which directly rotates the gear on the shaft of the front and rear right drums. The gear of the rear left drum receives rotation from the gear of the rear right drum through two intermediate gears. The gear of this drum then transmits the movement to the gear on the shaft of the front left drum 4 through an intermediate gear. As can be seen, even small wear of the gear teeth, when summed up, negatively affects the chess position of the front left drum.

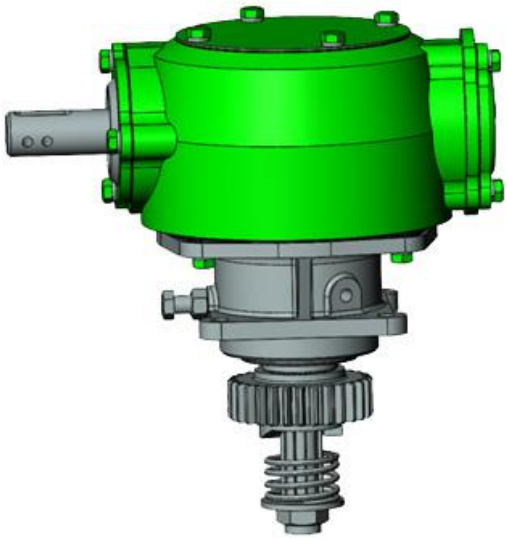

Figure 3. Apparatus reducer.

It is not possible to install it precisely in comparison with the right front drum, there will be deviations that will reduce the completeness of cotton collection.

3. Results and discussion

Taking into account what has already been said, the authors propose.

- Instead of a distribution gearbox for the rear PTO of the tractor, a permanent magnet generator will be installed.
- Instead of the apparatus gearbox, two low-power electric motors will be installed. The first motor will rotate the front pair of spindle drums, while the second motor will rotate the rear pair of drums.
- Separate electric motors of the required power will be installed on the fan of the cotton transport system to the hopper, as well as on the water pump for washing the spindles.

The diagram of the proposed technical solution is shown in Fig. 4. This diagram corresponds to the front pair of drums. The same drive design is recommended for the rear pair of drums, regardless of the front pair.

On the actual apparatus, the right drums are mounted on frame 4, rigidly connected to the frame of the entire apparatus (Fig. 4). Brackets with an electric motor are vertically attached to this frame, and a gear 2 is installed on the motor shaft, which is the driving gear and engages with gear 5 on the shaft of the right drum 3 and rotates it. The driving gear 2 is constantly connected to the intermediate gear 6, which rotates gear 8 on the shaft of the left drum. As can be seen from the diagram, the left drum 1 rotates in the opposite direction to the right drum. Therefore, the cotton bush, clamped between the left and right drums, is pulled into the working gap. Small-toothed gears are used, so by changing the engagement of the intermediate gear 6, the spindles of the drums can be more accurately set in a chessboard pattern.

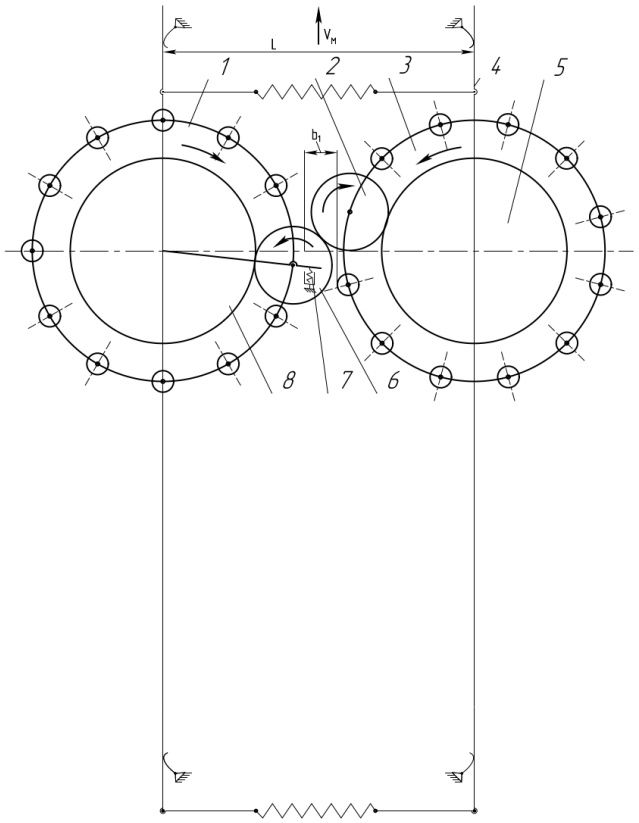

Figure 4. Diagram of the recommended drive for one pair of spindle drums: 1-left drum; 2-gear on the rotor of the vertical electric motor; 3-right drum; 4-fixed frame of the right drums; 5-gear of the right drum; 6-idler gear; 7-spring; 8-gear of the left drum.

When the size of the working gap between the left and right drums is changed, gear 6 changes its position. At the same time, spring 7 always ensures the necessary full engagement of the teeth of gears 2, 6, and 8.

The drive for the second pair of drums is the same. The gap between the drums of the second pair is set smaller than that between the front ones. This is achieved by mounting their rotation axes to the sliding frame using screw mechanisms, allowing the left drums to be independently positioned relative to the right drums at different distances.

The left drums are mounted on a single movable frame, which can be opened relative to the apparatus frame for technical maintenance. The stripper drive remains unchanged.

4. Conclusions

Installing a single electric motor to drive both the right and left spindle drums simplifies the drive system, making it less noisy and less energy-intensive. Such a solution allows for more accurate positioning of the spindles of the right and left drums in a chessboard pattern, improving the completeness of cotton collection.

References

[1] Sablikov M V 1985 *Cotton picking machines* (Moscow: Agropromizdat)
[2] Shoumarova M, et al. 2022 Vertical-spindle cotton picker drum drive Registration number of the application IAP 2022 0630

[3] 2017 Tashkent Tractor Plant Instructions *MX-1.8 Cotton picker* (Tashkent)
[4] Shoumarova M, et al. 2023 *E3S Web of Conferences* **365** 04022
[5] Shoumarova M et al. 2022 *IOP Conf Ser Earth Environ Sci* **1076** 012020
[6] Rizayev A A et al. 2022 *AIP Conference Proceedings* **2637** 060005.
[7] Matchanov R et al. 2021 *IOP Conf Ser Earth Environ Sci* **677** 052021
[8] Rizaev A A 2017 *Research and creation of working bodies of a cotton picker with high efficiency* (Tashkent: Publishing house "FAN" AS RUz)
[9] Berezovsky Yu N 1985 *Machine parts* (Moscow: Mechanical engineering)