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MECHANISM FOR DEBARKING LOGS WHEN PERFORMING LOGGING OPERATIONS USING A FOREST HARVESTER

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Abstract: The purpose of the proposed modernization was to create the possibility of harvesting assortments simultaneously with stripping the bark in longitudinal strips to accelerate the natural drying of wood without reducing the productivity of the device compared to its counterparts. The goal was achieved and the forest harvester equipped with the new device was able to harvest debarked logs.

KEYWORDS: harvester head, processor head, debarking, barking tools, debarking in strips, bark, feller-delimbing-cutting machine

1 Introduction

At present, some of the most functional forest machines, which are becoming more and more widespread, are machines such as harvesters and processors. The technological process of using these machines includes almost all the main operations of logging operations: felling, delimbing trees and cutting into assortments.

This circumstance allows us to conclude that the topic of development and improvement of the technological equipment of these high-performance modern machines is relevant and has scientific and practical significance.

This is confirmed by the works of scientists, V.S. Syunev, A. A. Seliverstov, [1], P.M. Mazurkin [2], F.V. Posharnikov [3], Tsarev, E. M. et. al. [4], Rukomojnikov, K. P. et al. [5] and other researchers who devoted their work to the development of the technical direction to improve the designs of the working bodies of forest machines. A fundamental development matrix [6] has been created, formulating ways to improve the harvester and processor heads based on functional and technological analysis, and other studies have been carried out to evaluate the most appropriate ways for further development in this area. And also to become the basis for further scientific research, which has been developed in this work.

2 Materials and Methods

To implement the proposed study, a patent search was carried out for constructive solutions for the working body of the feller-delimbing-cutting machines [7-20]. As a result of the analysis of these designs, a solution was found that made it possible to increase the functionality of the harvester and processor heads and improve the quality of the harvested assortments. The idea was to develop a new constructive solution that would make it possible to obtain not only assortments and waste in the form of branches and the top part of a tree, but also to carry out partial debarking of timber.

The purpose of the proposed modernization of the design of the working body of the harvester and processor heads was the possibility of harvesting assortments simultaneously with

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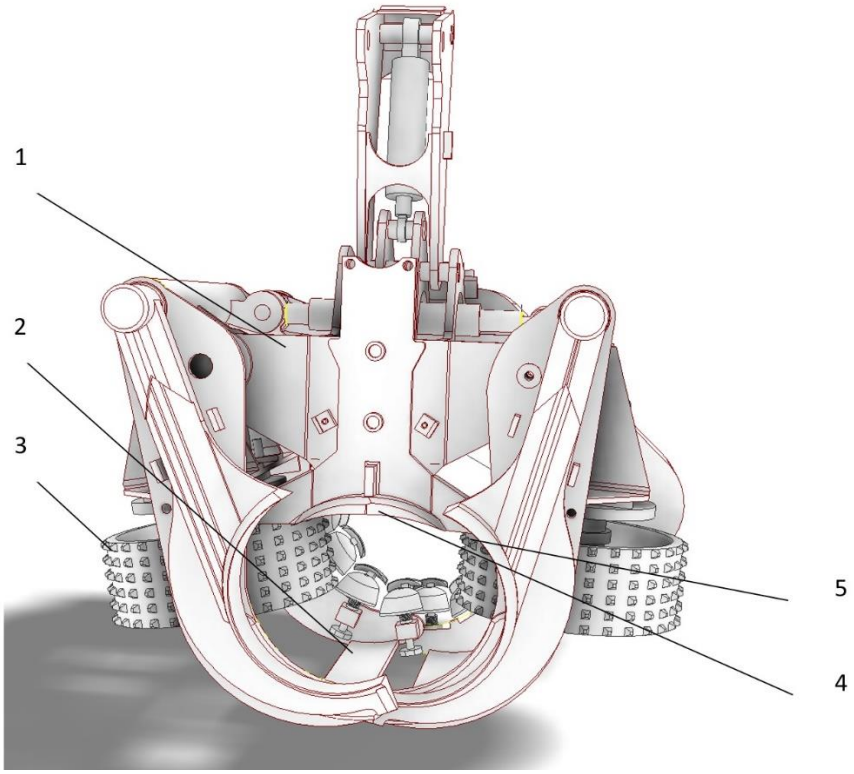
stripping the bark in longitudinal strips to accelerate the natural drying of wood without reducing the productivity of the mechanism.

The technical result is achieved by the fact that simultaneously with the operation of trimming branches, the bark is removed from the logs in longitudinal strips along the entire length of the whip.

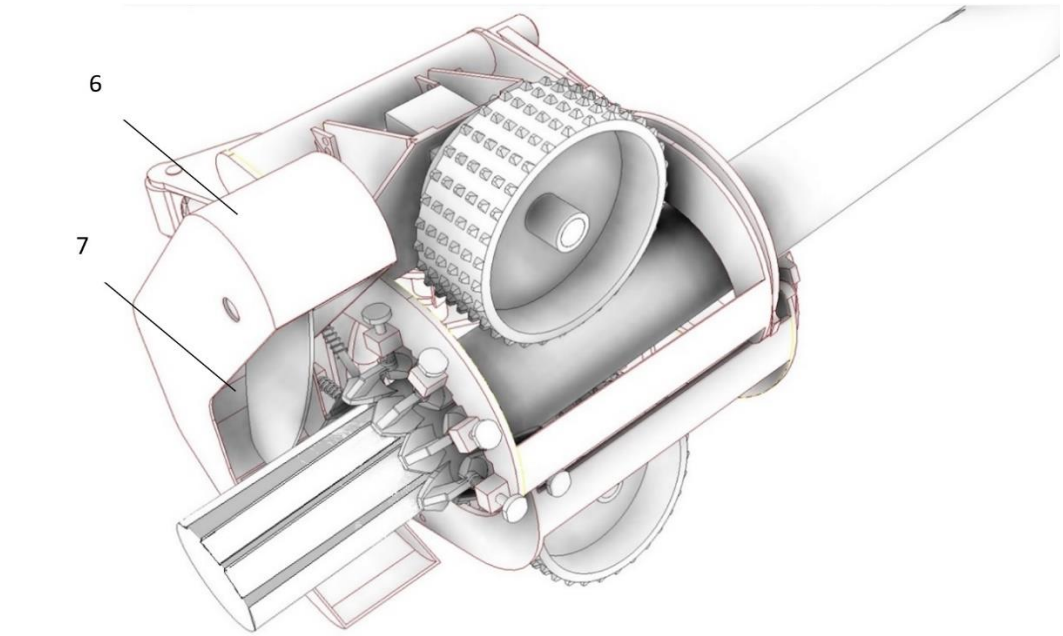
3 Results

The proposed design is illustrated by drawings, where in Fig. 1(a) shows a general view of the device from above; Fig. 1(b) shows the operation of the mechanism during the processing of the trunk; in Fig. 1(c) shows a schematic diagram of the operation of the wire removers.

The shortwood logging mechanism includes a body 1, on which movable grips 2 are mounted for gripping a tree trunk, pulling rollers 3 and a cut-to-length measuring mechanism. A conditionally fixed delimbing knife 4 and movable delimbing knives 5 are installed in the upper part of the body, and a saw mechanism 7 is installed in the lower part under the protective cover 6.



a)



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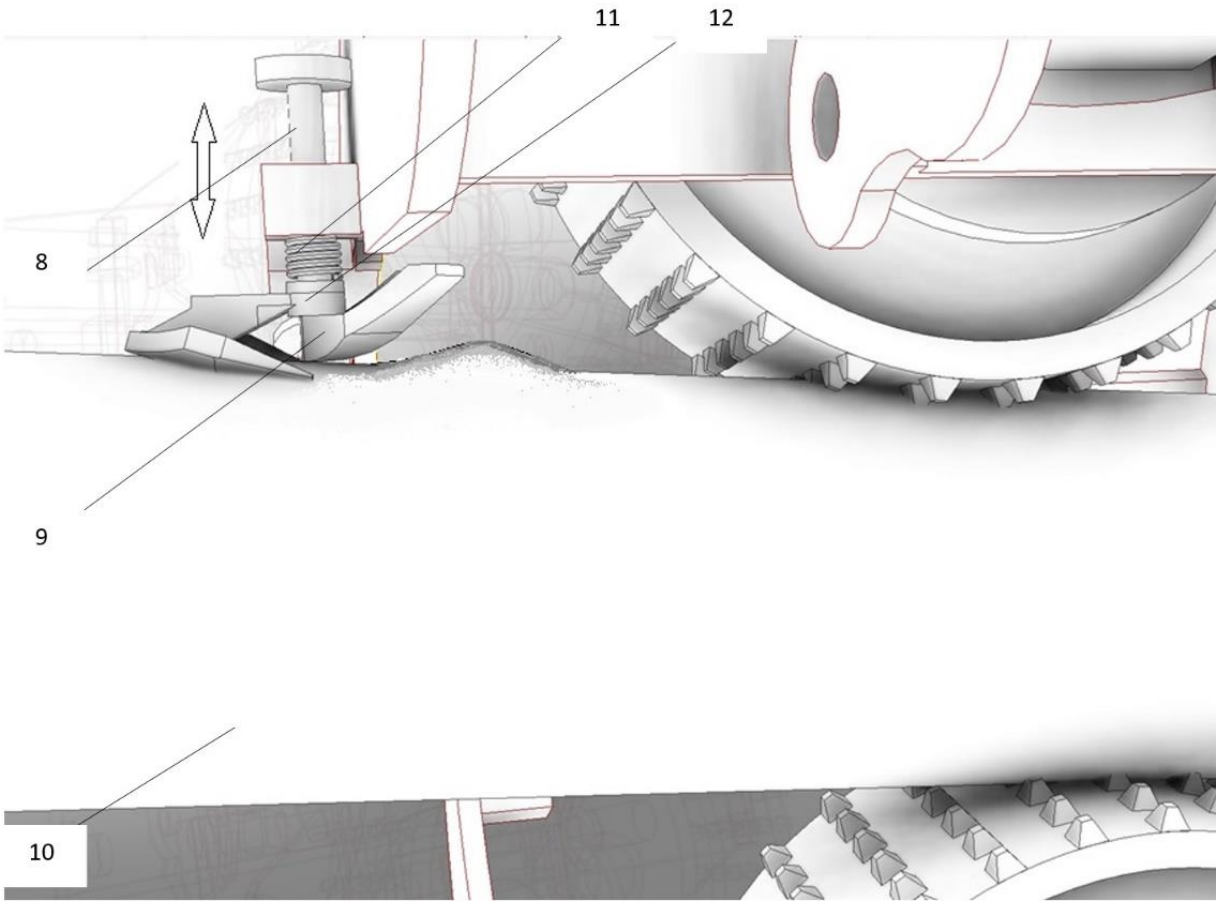

c)

Fig. 1. Harvester head: a - general view; b - view of the mechanism during the processing of the trunk; c - scheme of operation of the barking tools

In the lower parts of the grippers and the body of the mechanism, on spring-loaded axes 8 parallel to the cutting plane, guide blades 9 are installed with the possibility of wrapping them around the tree trunk with the formation of a closed loop around its perimeter, during the process of capturing the trunk 10 by the working body. In the process of pressing the blades guide to the trunk, they carry out the movement of the axes in directions perpendicular to the axis of the barrel. When the load is removed, they return to their original position under the action of the springs 11.

The barking tools 12 are hung on the axles between the springs and the guide blades with the ability to copy the reciprocating movements of axles. The cutting edges of the barking tools removers are arranged so that the distance between them and the rear parts of the guide blades corresponds to the thickness of the bark of the treated trees.

The work of the proposed working body of the felling-lopping-bucking machine is carried out by the operator, who directs the mechanism to a growing tree, captures, cuts down, and fells the tree. When gripping the barrel, the guide blades form a closed loop along its perimeter of the barrel. The axis of the guide blades move by compressing the springs in directions perpendicular to the axis of the barrel due to the force generated in the process of pressing the guide blades to the barrel. The scrapers copy the movement of the guide blades and the trunk of the tree being processed is inside the contour formed by the scrapers. When the trunk is moved by dragging rollers, reciprocating movements of the axes of the guide blades are carried out when they copy the irregularities of the tree trunk. The movement of the trunk is accompanied by cleaning the fallen tree from branches with delimbing knives and removing strips of tree bark with bark removers. When the required length of the assortment is reached, the saw mechanism is activated, which performs cross-cutting. Subsequent assortments are processed in the same way. At the end of the processing of the tree, the grips of the mechanism open the trunk, the load disappears, the springs open, and the guide blades and bark removers return to their original position.

4 Discussion

The analysis of the design of harvester heads made it possible to identify the presence of various similar technical solutions. In particular, the working body of the felling-lopping-bucking machine for producing assortments is known, which includes a housing on which the cutting-bucking mechanism is mounted, delimbing knives attached to the body by means of axes, a dragging mechanism in the form of a non-rotating roller and rotary rollers fixed coaxially to the axis of the rotary roller drive hydraulic motor. This option differs from the traditional design of the harvester head in that a cutting device for rounding assortments is mounted in the body of the working body. In this case, each rotary roller and its drive hydraulic motor are fixed on a rotary frame, which is mounted on an axis connecting it to the body of the working body and equipped with a mechanism for rotating the frame relative to the said axis. In this case, the non-driven roller of the pulling mechanism and the cutting device for rounding the assortments are connected to the body by means of hydraulic cylinders [21]. The technical result, which is directed by the claimed working body, is the ability to process stocky assortments with the help of a feller-delimbing-cutting machines in a cutting area.

The main disadvantage of this technical solution, in our opinion, is that the previously proposed method and the working body of the feller-delimbing-cutting machines is not intended for debarking assortments and provides for a two-stage processing of timber, which significantly limits its technical capabilities.

Also close in technical essence is the working body of the feller-delimbing-cutting machines for the production of debarked assortments [22].

This design is distinguished by the fact that in the lower part of the body there is a debarking device in the form of a stator inside which there is a rotor with barking tools connected through a rocker with pressure springs.

In this case, the stator is mounted on the housing with the possibility of rotation parallel to the plane of movement of the saw mechanism.

However, in our opinion, such a design does not provide sufficient impact of delimbing knives on branches, which leads to increased energy consumption, since the speed of the trunk is limited by the low speed of the debarking device, which significantly reduces the performance of the mechanism.

Method for the development of debarked assortments with the help of an improved working body of a feller-delimbing-cutting machines for its implementation makes it possible to concentrate most of the logging waste in the cutting area.

Another option for the effective use of the described working body may be its use when felling timber, when further rafting of logs on water is expected. The harvester head, which can remove bark, makes it possible to increase the buoyancy of coniferous small logs.

The next positive point that is realized when debarking logs in the forest is the reduction of damage to wood from the effects of bark beetles. This is a very big problem in the forests of Central Europe [23], Germany, the Czech Republic and Austria [24], Ministry of Agriculture of the Czech Republic [25, 26] where a significant part of the wood is harvested for the purpose of timely use of wood damaged by bark beetles. Under conditions of global warming, the resistance of trees to bark beetles is gradually decreasing [27, 28, 29, 30]

In this case, when harvesting assortments, the bark and bast (partially or completely) are subject to removal (debarking in strips) in longitudinal strips to accelerate the natural drying of wood.

In certain situations, the latter is left to protect the wood material from cracks.

Usually, sawlogs, wood that goes to building yard, logs used in a round form without antiseptic impregnations, and raw materials for the manufacture of wood chips are usually cleaned in this way.

The proposed mechanism can also be used when harvesting assortments for individual timber floating.

In this case, small-sized coniferous assortments of insufficient buoyancy must be subjected to debarking in strips and drying before being put into individual timber floating, which is fully consistent with the intended purpose of the proposed mechanism.

Another indicator that increases the interest of loggers in the development of the production of a new technical solution is the fact that, along with the widespread introduction of technology for harvesting and hauling assortments, their debarking is a widespread option for further processing in the timber warehouses of forest enterprises.

This process is accompanied by the receipt of a significant amount of waste in the form of bark in the warehouses of timber enterprises.

Utilization of these logging wastes, which is a serious task for manufacturers, can also be partially solved by introducing the proposed mechanism already at the stage of logging operations without transportation to the timber warehouses of enterprises.

CONCLUSION

The proposed modernization of the working body of the feller-delimbing-cutting machines, with insignificant additional financial costs for its improvement, will make it possible to capture, cut down, fell a tree, trim branches, cross-cutting and rough debarking of logs (debarking in strips) with longitudinal stripes along the entire length of the processed full-length log with no additional debarking drive mechanism, which makes it possible to carry out the development of roughly debarked assortments in the conditions of a cutting area and increase the efficiency of the production process.

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