

# The use of a mobile unit for separating coniferous trees for rational nature management

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**Abstract.** The paper gives the analysis of the problem of rational nature management in the process of logging operations. An assessment of the formation of logging waste in the form of coniferous tree greenery, the expediency of separating needles directly in the places of their accumulation for further transportation and processing is substantiated. To solve the problem of separating needles from branches in logging conditions, the design of a mobile plant for needle separation was proposed. Analytical and mathematical methods were used, as well as modeling of the structures of units and assemblies. The results obtained can be widely used both at logging and wood processing enterprises. The use of the proposed design of a mobile device for separating needles in the process of logging operations will reduce the amount of logging waste by removing needles from the cutting area. This, in turn, will not only reduce the fire hazard of the logging process, but also expand the raw material base for the production of essential oils, bioactive preparations, vitamin flour and other products from coniferous trees.

## 1 Introduction

Coniferous tree greenery is a special type of forest raw material, the cells of which contain a large number of microelements that are necessary for the normal life of plants and animals [1]. As a result, coniferous tree greens are the main raw material for the production of essential oils, bioactive drugs and vitamin flour.

As the analysis of literary sources [2-4] showed, the demand for these products is only 10-15% satisfied. A feature of the harvesting and processing of coniferous tree greens is the limited time from the moment of separation of branches with needles from the tree to the production of finished commercial products [5-7]. As a result, it is most expedient when harvesting coniferous trees to separate the needles directly at the cutting area immediately after cutting the branches and send them for further processing.

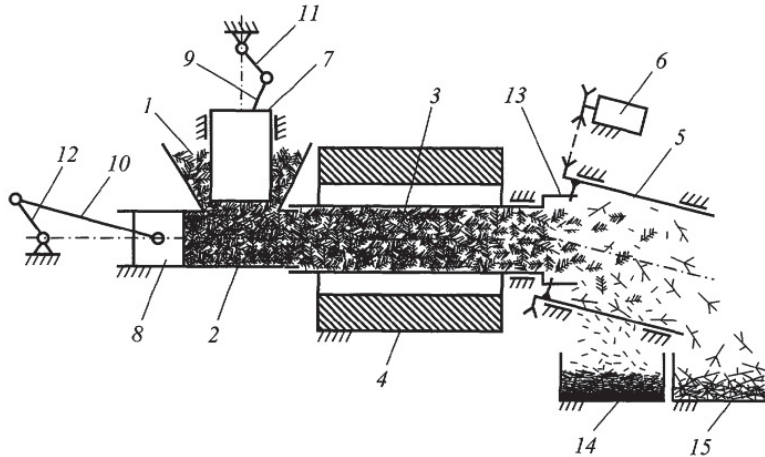
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## 2 Materials and methods

An analysis of modern designs of machines for separating needles showed that today devices that use both mechanical processing of raw materials and microwave heating are widely used.

Figure 1 presents a diagram of a machine for separating needles using microwave radiation.



1 - bunker; 2 - receiving chamber; 3 - drum; 4 - microwave heating chamber; 5 - separator; 6 - drive; 7 - piston; 8 - piston; 9 - connecting rod; 10 - connecting rod; 11 - crank; 12 - crank; 13 - lantern gear; 14 - a tray for needles; 15 - foot tray

**Fig. 1.** Scheme of installation for separation of needles by microwave heating [8].

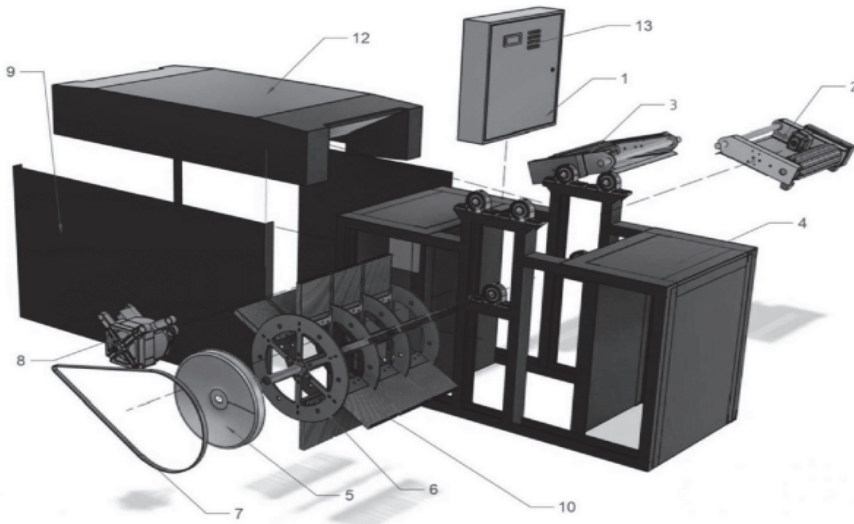
It is seen from the diagram that pre-prepared coniferous legs are loaded into the bunker, after which they are pushed into the receiving chamber using a feeder. Before batch feeding into the working chamber of the device, the feed mechanism compacts the feed material. Coniferous paws, pre-treated by microwave heating, go through the nozzle directly into the separator, where, as a result of continuous rotation, they contact each other and with the separator. On its peripheral part there are notches, the dimensions of which are 1.5 times larger than the size of the needles. In the separator, the process of separating the needles from the branch takes place. The needles through the notches of the separator, and the branches through the open part are distributed to the corresponding receiving trays [8].

The advantages of this machine include the preservation of the beneficial properties of the needles and a high percentage of its separation from the foot. The main disadvantages include the complexity of the design and, as a result, the high cost.

Figure 2 shows a diagram of the installation for separating the needles from the foot mechanically.

It can be seen from the diagram that the spring-loaded pressure roller of the feed unit with an emphasis on the support table of the frame pushes the branch into the working area with brushes fixed on the slats of the drum frame, which separate the greens from the branch and direct them to the greens removal chamber. As it passes through the working area, the bare branch is captured by the pressure spring-loaded roller of the output unit and pushes it out of the device. The impact force of the brushes is controlled by the speed of feeding branches into the working area of the separator and the speed of rotation of the drum, depending on the type of wood and the density of woody greenery on the branch [9].

The advantages of this equipment include high performance and simplicity of design in comparison with microwave heating. The main disadvantages include the ingress of bark and mineral impurities into the needles separated from the foot and increased wear of the brushes.



1 - shield; 2 - output block; 3 - falling block; 4 - support frame; 5 - drum pulley; 6 - frame drum; 7 - drive belt; 8 - drum engine; 9 - protective panel; 10 - brushes, brush cassettes; 11 - protective panel; 12 - protective cover; 13 - index input panel.

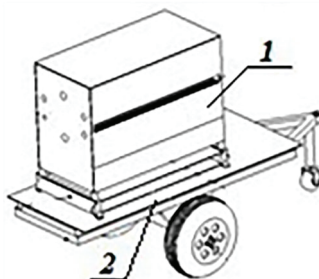
**Fig. 2.** Scheme of the installation for the separation of needles mechanically [9].

It is shown by the analysis of the design features of the existing equipment for the separation of needles that all machines can only be used stationary with the obligatory supply of electricity and are stationary.

### 3 Discussion and results

As a result, the purpose of this work was to develop the design of a mobile machine for separating needles from a foot in logging conditions.

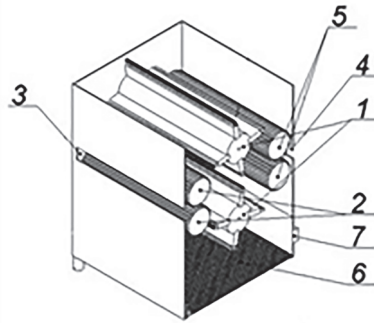
To achieve this goal, a model of a mobile car was developed in the Compass 3D system, shown in Figure 3.



1 - machine for separating coniferous greenery; 2 - wheelbase

**Fig. 3.** Scheme of a mobile machine for separating coniferous tree greens in logging conditions.

It can be seen from Figure 3, the mobile softwood cutting machine consists of a wheel base and an operating device, which is shown in Figure 4.

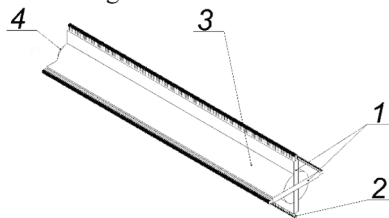


1 - working shaft; 2 - corrugated rollers for removing branches without needles from the device; 3 – exit window; 4 - entrance window; 5 - feeding corrugated rollers; 6 - separating mesh; 7 - pallet for mineral inclusions and bark

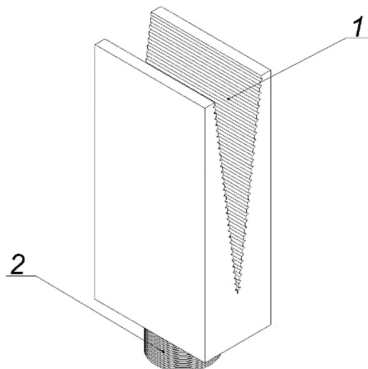
**Fig. 4.** Scheme of a machine for separating coniferous tree greens

It can be seen from Figure 4 that a branch with coniferous tree greens is manually fed into the input window (4), where two corrugated feed rollers rotating towards each other (5) pull it into the working area. In the working area, two rotating shafts (1), on which forks are installed, remove the needles from the branch. After that, the needles, under the action of gravity, enter the separating grid (6) and fall through the calibrated slots that separate the needles from the trapped mineral inclusions and bark. Branches without needles are removed from the device to the exit window (3) by corrugated rollers (2).

Figure 5 shows a diagram of the working shaft. It can be seen from the diagram that the shaft crosspiece includes two plates (1) located in perpendicular planes and installed in the shaft (3). On the blades there are elements for removing needles in the form of forks (2), a general view of which is shown in Figure 6.



**Fig. 5.** Working shaft: 1 - plates of the cross; 2 - element for removing needles; 3 - slotted shaft.



**Fig. 6.** Element for separating needles: 1 - working surfaces; 2 - thread for mounting on the cross of the working shaft.

It is shown in Figure 6 that the needles falling between the working surfaces (1) are clamped and cling to the fins. After that, due to the centrifugal force of the cross on the working shaft, the needles are torn off the foot.

## 4 Conclusion

Thus, in the course of the work, the expediency of processing coniferous tree greens was substantiated. An assessment is made of the design features of the existing designs of machines for separating needles from the foot. A 3D model of a mobile machine for separating needles from a foot in the conditions of logging operations has been developed and its effectiveness has been substantiated. The advantages of the proposed design include: mobility, small size and simplicity of design, high reliability, as well as low cost.

The study was financially supported by Krasnoyarsk Regional Fund of Science and Krasresurs 24 LLC within the framework of scientific project No. 2022052708731.

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