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DUMYCH V. V., Chief of the Laboratory

Lviv branch of the UkrNDIPVT (Ukrainian Scientific and Research Institute for Prognosis and Testing of Machinery and Technologies for Agricultural Production) named after L. Pohorilyi

KURYLO V. L., Doctor of Agricultural Sciences, Professor

Institute of Bioenergy Crops and Sugar Beet

e-mail: Kurilo_V@ukr.net

ANALYSIS OF CONSTRUCTIONS OF WOOD CHIPPERS OF TREE SHREDDING MACHINES

There is the analysis of constructions of wood chippers devices of tree shredding machines.

Introduction. Production of wood fuel pellets and briquettes in Ukraine for the past 3-4 years is in the range from 260 thousand tons to 300 thousand tons per year. A large share of biofuels are made from solid wood. [1].

According to average annual data, State Forestry Enterprises of Ukraine harvested 15.0 million m³ of wood from which for production of solid biofuels was used less than 4.0 million m³ of wood. There was produced about 2 million m³ of logging wastes in the process of logging, which are burned or rotting off at the frame. [2].

In Ukraine 0.4 - 0.5 million m³ of wood waste are released, disposed of in landfills, incinerated or disposed of without the beneficial effect in fine woodworkers, wood residues in the home and utilities, urban horticulture and so on. Another reserve of wood for biofuel production is energy plants (willow, poplar, etc.) from which you can get about 3.5 - 4.0 million m³ of biomass. So, with effective public policy on the

issue of biofuels the total amount of wood for biofuel production in Ukraine will be about 12 million m³ [2].

For efficient use of potential of wood biomass we need to solve some problems. One of which is the technical support of the processing process of wood into chips with the help of wood chipper machines.

The aim of the research. Implementation of wood chippers in Ukrainian forest farms for increasing the use of forest wastes and increasing energy production from solid biofuels.

Results of the studies. Manufacturers offer different models of wood chippers: compact, low-power, medium-power, high-performance and large-sized, mobile and stationary, driven by independent internal combustion engines, GDP energy means and electric engines, with both manual and mechanical wood feed etc.

The main components of machines are frame, nutritious, cutting, transporting, cast-device, support-chassis, hydraulic and electrical systems, the mechanisms of power means joining the drive and working groups. Derevopodribnyuvachi completing different types of cutting devices - disk, drum, rotary and combined disk-hammer and rotary hammer.

Wood chippers technical characteristics are shown in table 1.

Table 1

Brief technical characteristics of wood chippers

Trade mark of a wood chipper	Producer	Type of a shredding device	Thickness of shredding wood, CM	Drive	The required power, kW	Productivity, tons / hr.	Weight, kg
1	2	3	4	5	6	7	8
Miniature wood chippers							
GSE 15	BGU Maschinen, (Germany)	hammer	to 5	electromotor	2,2	0,4	86
Bio 50	Caravaggi, (Italy)	disc	to 4	carburetor engine	3,7	0,4	55
Bio 80	Caravaggi, (Italy)	disk-hammer	to 7	carburetor engine	6,6	0,5	80
OL 2500 T	Oehler Maschinen (Germany)	rotary	to 12	GDP of the power mean	25-40	3-4	490
PZ 110	Pezzolato (Italy)	disk	to 11	diesel engine	18	0,5	365
HJ-4 M	Junkkari (Finland)	disk	to 10	GDP of the power mean	10-35	0,5-1,5	172
CIP 800-H9	Green Technic (Італія)	drum	to 6	carburetor engine	6,6	0,5	150
Low-power wood chippers							
HH 520/30D	BGU Maschinen (Germany)	drum	to 30	diesel engine	52	4-7	3500
TV 27-40	Vandaele (Germany)	disc	to 27	diesel engine	68	5-8	2750
Cippo 25	Caravaggi, (Italy)	disc	to 25	diesel engine	59	3,5	1660
DP 660T	Олно́ва (Ukraine)	disc	to 16	GDP of the power mean	24	2-4	760

OL 2600 D	Oehler Maschinen (Germany)	disc	to 25	carburetor engine	36	5-7	1500
PZ 210	Pezzolato (Italy)	disc	to 21	diesel engine	38	4,5	1180
HJ-260 G	Junkkari (Finland)	disc	to 25	GDP of the power mean	30-75	1,7-5	740
NHS 840	EIFO Forsttechnik	disc	to 21,5	GDP of the power mean	36	3-5	900
Coromat 160	Rabaud (France)	rotary	to 16	diesel engine	40	3-4	1200
RM 800.5	Хеммель-Україна (Ukraine)	disc	to 15	GDP of the power mean	50	4-5	665
Middle-power wood chippers							
PTH 700/660	Pezzolato (Italy)	drum	30-40	diesel engine	169	10-12	5300
Natura 350	Rabaud (France)	disc	to 35	carburetor engine	160	13-17	3100
NHS 960	EIFO Forsttechnik	disc	to 30	GDP of the power mean	80	7-9	1050
Biber 7	Eschbock Maschintnfabric (Germany)	disc	to 35	GDP of the power mean	44-125	8-12	5000
TV 40-52	Vandaele (Germany)	disc	to 40	diesel engine	120	9-13	2750
HJ-350	Junkkari (Finland)	disc	to 35	GDP of the power mean	75-140	5-12	2200
High-power wood chippers							
HJ-500 C	Junkkari (Finland)	disc	to 45	GDP of the power mean	80-150	8-25	2500
Hacker modell PTH 900/820	Pezzolato (Italy)	drum	45-50	diesel engine	169	25-30	12300
NHS 1400	EIFO Forsttechnik	disc	to 45	GDP of the power mean	188	25-30	4500
Biber 92	Eschbock Maschintnfabric (Germany)	drum	to 75	diesel engine	397	35-40	26000
Chippo 510 C	Komptech	drum	to 75	diesel engine	370	45	18000

Drum machine with cutting device consists of a cutting drum (9) with knife (1), anvil (3) mesh sieve of a cutting device (12), tail fan (2), feeder throwing chips into the throw zone (4), tail pipe (11) with visor (10), feed unit (conveyor (6), lower (7) and upper rollers (8), outfeed table (5) (Fig. 1).

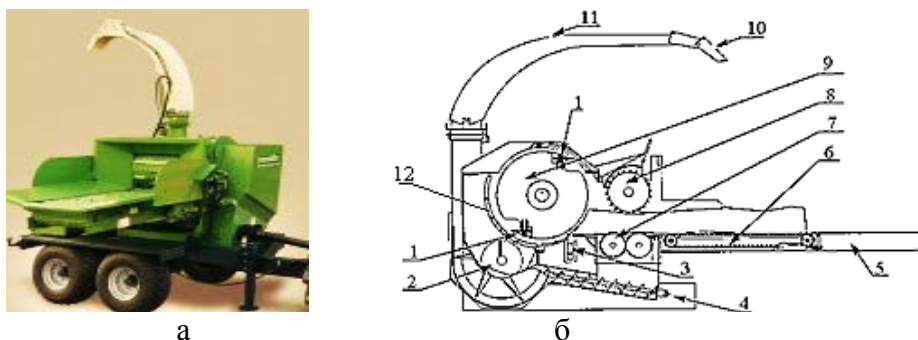


Fig. 1. Wood chipper with drum cutting device:

a –general view; б –structural diegram.

Drum cutting device consists of a drum with attachedknives, anvils and replacable mesh sieve. Manufacturers of wood chippers set drums in various models: with complete knives, semi-knives and quick replaceable blades (Fig. 2a , 2b , 2c , 2d). Wood chippers of drum types are equipped with sieve: with longitudinal holes and openings in the form of a cell, diamond etc. (fig. 2e, 2f; 2g). At the bottom of the sieves of crush camera a throw zone feeder is mounted in single or twin-screw feeder (fig. 2h) [3-5].

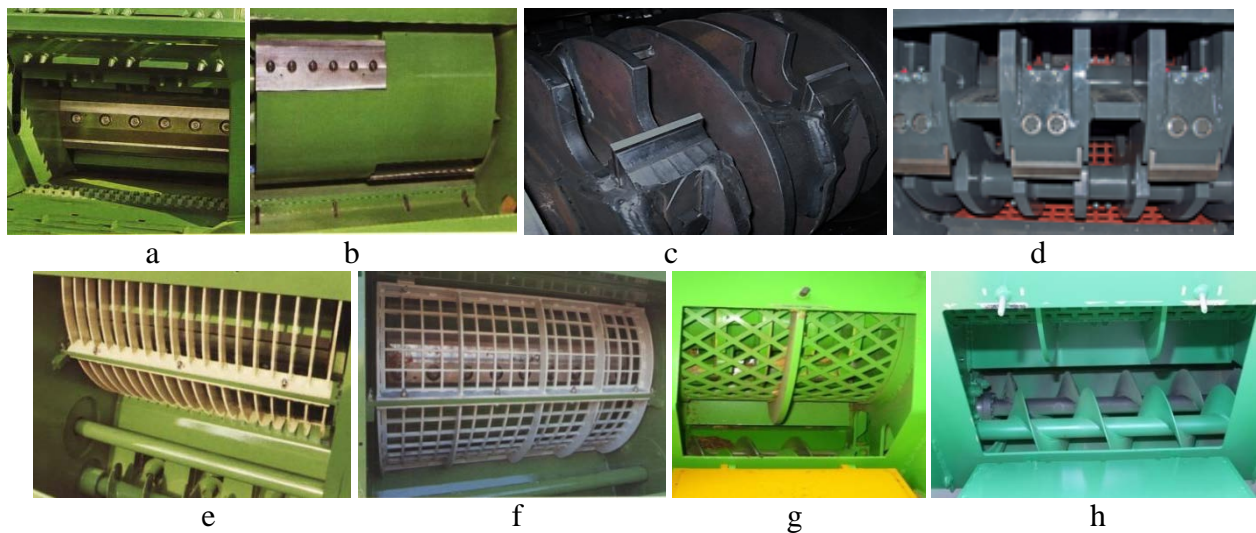


Fig.2. Cutting drums and sieves of drum type wood chippers

a – with complete knives; b – semi-knives; c,d – with quick replacable knives;
 e – with longitudinal wholes; f – with rectangular wholes; g – with rhombus wholes;
 h – screw-type throw zone feeder.

During the execution of the process a conveyor of a feeding device delivers wood between the upper and lower rollers that hold and guide it to the cutting drum. Drum knives rotate, slowly crush wood chips and dump them on the net-sieve. Chips spill through holes of a sieve and get to screw mechanism that transports them to miscarriage device. Further airflow, which is created by fan, chips go into the body or in a transport heap through tail pipe. A large fraction of chips, which do not pass through the sieve openings, shall be submitted for re-grinding.

Disk type wood chippers usually include a combination of cutting bodies. There is no principal difference in the construction of nutrient wood chippers with different types of cutting devices. However, the structural performance of cutting and transporting the junk-devices have significant differences.

Disc type cutting devices are divided into several types by ways of chopping wood into chips: single-phase and two-phase decomposition of wood. Machines with single-phase cutting device grind wood into 12 cm chips. Two-phase disk cutting devices, provide (depending on a design) wood chip fraction from 0.5 cm to 2.5 cm or from 0.5 cm to 12.0 cm.

The main quantity of wood chippers models with disc cutting device for two-phase wood chopping consists of crushing chamber, reception table (2), horizontal tank (3), clamping rolls (1, 2), tail pipe (8). The components of the grinding chamber: housing, hinged lid with secondary knife (9), disc (5) with attached blades (6) and ejection blades with cutted grooves (7) (Fig. 3) [6].

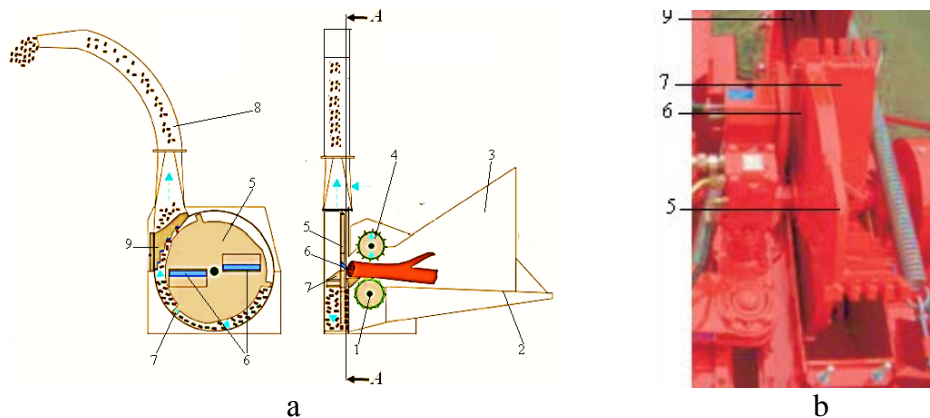


Fig. 3. Wood chipper with disk cutting device:

a - the functional and structural diagram; b - general view of the cutting device.

Wood chippers with rotary cutting device for performing two-phase chopping wood process execute the technological process in the following way: pinch rollers direct trunks and branches of trees to the cutting disc blades which grind them into chips. Cod goes to the blade ejection ththrough intervals between knife and drive, which move it to the second knife. Interacting with the second segment of the knife, wood chips ground to set fractions and is move to clamp or body of the vehicle using the air flow.

The construction of wood chipper for one phase chopping does not provides additional second knife and form of the ejection blade is modified. At the cutting blades such machines are usually installed with a solid blade loose.

Manufacturers of tree-shredding machines set several types of blade depending on the model (Fig. 4a, 4b, 4c, 4d, 4e), which are equipped with smooth or ribbed blades cutters and combination consisting of a main knife and plate vertical mini blades (Fig. 4 f, 4 g, 4 h) [3, 6, 7].

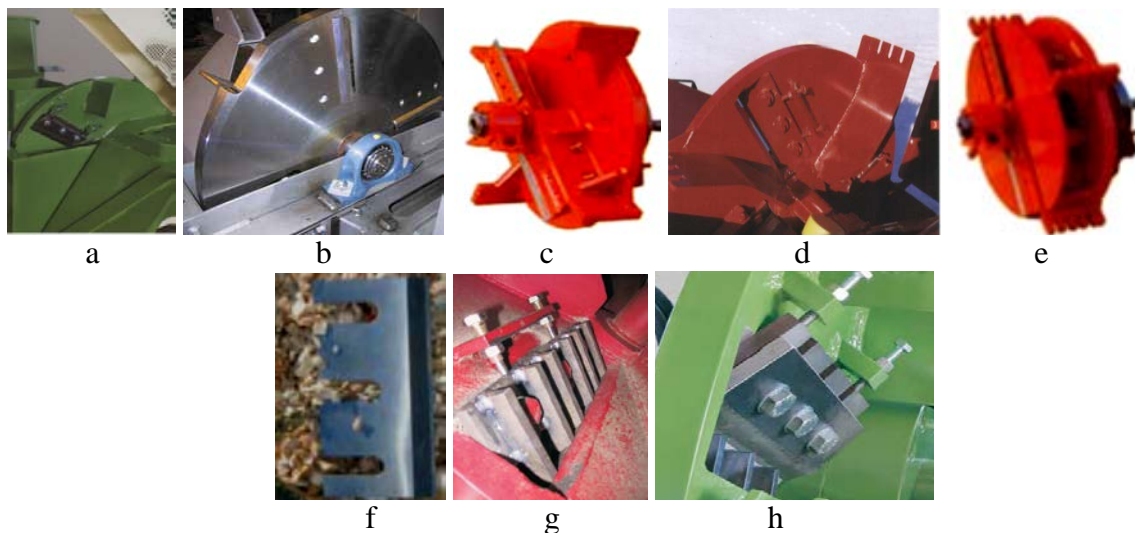


Fig. 4. Cutting discs and blades:

a, b, c - blade grinding machines for single-phase chopping,
 d, e - blade grinding machines for two-phase chopping,
 f, g, h – smooth and ribbed blades and cutter combo drive

For production of calibrated chips with a size on the OL 2700 NT wood chipper (Oehler Maschinen, Germany), for cutting H wood series of the Italian firm Pezzolato and some other manufacturers are installed cameras that are equipped with a sieve and re-grinding system (Fig. 5) [3 , 8].



Fig. 5. Wood chippers with rotary cutting devices for production of calibrated chips:

a –OL 2700 NT wood chipper; b – shredding chamber of the H Series wood chippers produced by Pezzolato

The technological process of wood chipping of these machines consists of the following operations: supply wood material, cutting and re-grinding and sizing wood chips in a sieve and remove it on the outside.

Some manufacturers of machinery for cutting wood also offer machines with horizontal disc cutter (Fig. 6). Major structural components are structurally similar to machines, which are equipped with vertical disc cutter. However, the spatial arrangement of major components (tank , cutting and bargain units are turned to 90° vertically with respect to similar mechanisms with vertical wood shredder blade. Structures in machines with horizontal blade does not provide mechanisms for delaying enforcement wood (wood material is fed from the top down under its own weight).

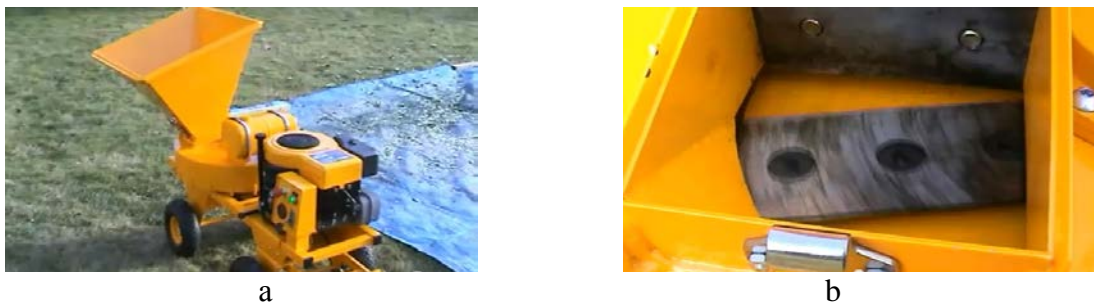


Fig. 6. Machine with horizontal cutting disc tools:

a - general view, b - cutting blade.

The global market of machines for cutting wood has also models of vehicles with medium and low productivity, as well as small machines, equipped with hammer and rotary cutting devices. So the firm Pezzolato (Italy) produces hook machine of S series (S4000, S7000, etc.), the firm VECOPLAN Maschinenfabrik GmbH (Austria) produces fixed VAZ 90/ 55 wood chippers, which are equipped with hammer cutting device. The Oehler Maschinen (Germany) produces universal wood chippers: OL 2500 T, OL 3000 T, OL 2500 D, which include rotary cutting devices. (Fig. 7) [3, 9 , 10]. These machines can also be used for making compost with tree-leaf-grass mixtures for grinding various types of plant material (leaves, grass, trunks and branches of trees and wood waste, used furniture and other products).

A hammer cutting device consists of a rotor, to which is attached three or four rows of plate hammers and counter hammers and a sieve. The main components of the rotary cutting device are drum with mounted on it axes. Self-acting lathes from high-alloy steel are installed in axes. [4, 8, 9].

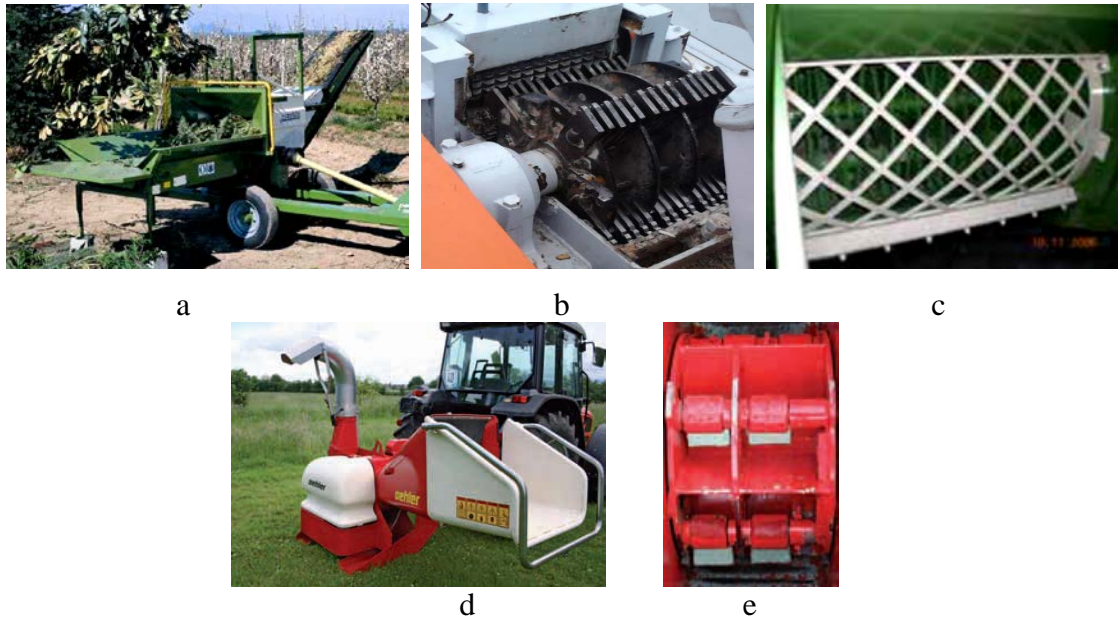


Fig. 7. Wood crushing machines with hammer and rotary cutting device:
a – the S7000 wood crusher with drum cutting device; b - hammer cutting device of the VAZ 90/55 tree shredder; c - sieve of the S7000 wood chipper; d – wood chipper of the OL 2500 D rotary cutting device; e - rotary cutting device.

Engineering firms also produce small and inefficient machines that are equipped with combined (usually disk-hammer) cutting devices for the production of wood chips and compost from the tree-leaf-grass mixture [3, 10] (Fig. 8).

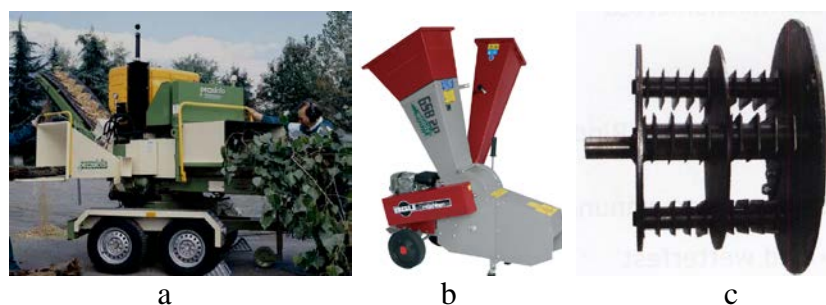


Fig. 8. Wood chippers combined with the cutting device:
a – the K 5500 wood chipper (Pezzolato, Italy);
b – the GSE 20 wood chipper (BGU Maschinen, Germany);
c – combined (disc-hammer) cutting device.

These machines are equipped with two independent mechanisms of feeding technological material to the working bodies: a wood is crushed by disk cutting device; leaves, small twigs, grasses are crushed by hammer cutting device.

For the purpose of processing chips and not oversized wood wastes of irregular geometric shape such as stumps, logs, etc. are used large double drum wood chippers Crambo 5000 (Komptech, USA), BA 965 D Titan (Jenz, Germany) and others. The cutting drum is made in the form of screw to windings of which are attached different types of teeth (sickle, hooks, dubs, sickle with interchangeable tips) [5] (Fig. 9).

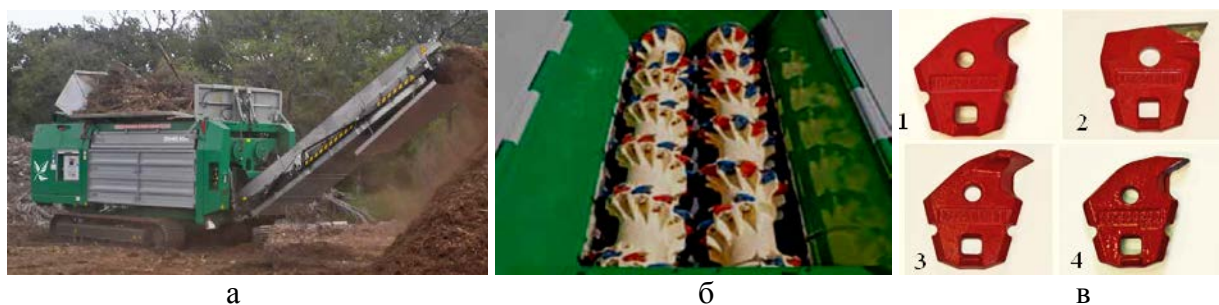


Fig. 9. Large wood crushing machine Crambo 5000:

a - general view, б – double drum cutting device; c - types of teeth:

1 - sickle teeth; 2 – hooks; 3 – dubs; 4 - sickle teeth with replaceable tips.

Conclusions. There are presented wood crushing machines on the world market, cutting operational bodies of which can process wood into chips of various sizes and shapes. Introduction of wood chippers to Ukrainian forest farms will increase the degree of forest waste and raise energy production from solid biofuels.

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Анотація

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Проведено аналіз конструкцій різальних пристроїв деревоподрібноувальних машин.

Ключові слова: *аналіз, конструкція, різальний пристрій, щепорез, деревина*

Аннотация

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