

UDC 621.935

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IMPROVEMENT OF BAND SAWING MACHINES USING AEROSTATIC BEARINGS

Ways to improve band sawing machines using aerostatic bearings are considered. The efficiency of this development direction is demonstrated.

Keywords: band sawing machine, aerostatic bearings, guides.

The widespread application of band sawing machines in the industry is hampered by low cutting accuracy at high feed speeds and insufficient saw durability. The large size and high metal intensity of band sawing machines make it difficult to create flexible automated sawmill lines on their basis.

Sawing accuracy depends on the forces acting on the saw during the sawing process, as well as the ability of the saw to counteract these forces. Consequently, measures are required to increase the rigidity and stability of the saw and reduce the cutting resistance forces [3] acting on the saw.

To increase the rigidity and stability of the band saw, guides are used, which reduce the free length of the saw l on the plane of its lowest stiffness. Guides can be of double-sided (retaining) type, installed with a gap δ on both sides of the saw (Fig. 1, *a*), or of single-sided (non-retaining) contact type, which deflect the saw by a certain amount (Fig. 1, *b*). Double-sided guides are simple in design and their manufacture does not require heat-resistant or wear-resistant materials. Even so, when the guides are installed with a gap, the stability of the saws is not affected, while the rigidity is slightly increased. Guides of this type mainly serve as limiters to the maximum deviations of the saw.

Single-sided deflecting guides are more effective. They reduce the free length of the saw l on the plane its lowest stiffness and, owing to this increase, its rigidity and stability, enhance the accuracy of movement of the saw within the cutting zone and eliminate oscillations of the saw. This type of guide is increasingly used in band sawing machines.

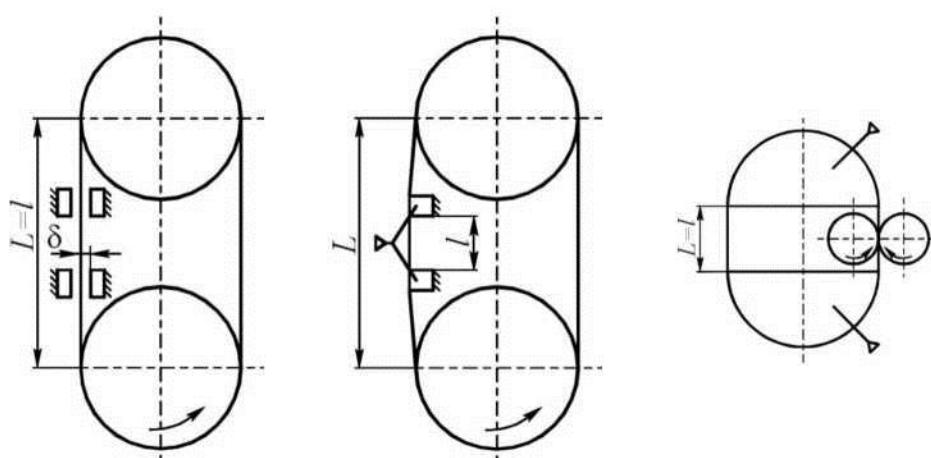


Figure 1. Schematic diagrams of band sawing machines: a – traditional design (with limiters to the maximum deviations of the saw); b – with deflecting aerostatic guides; c – with curvilinear aerostatic bearings

The friction of the saw on the guides can be significantly reduced if their working surfaces are made in the form of aerostatic bearings. The advantages of deflecting aerostatic guides are that the friction of the saw on the guides is reduced as much as possible, the saw is cooled by air, there is no wear on the guides, and no expensive heat-resistant and wear-resistant materials are required.

In [6], theoretical studies of the initial stiffness of band and frame saws were performed. Calculations of initial stiffness showed that installation of deflecting guides ensures a four-fold increase in the rigidity of the band saw compared with when the saw is used without any guides. In the event that double-sided guides installed with a gap of 0.3 mm are used instead of deflecting guides, the rigidity of the band saw is decreased two-fold [3].

The stability of the saw is characterised by the magnitude of the critical force P_{cr} . The calculations of the critical force according to the formulae given in [4] show that installation of deflecting guides ensures an increase in the stability of the saw by 39-44%.

To increase the stability of the saw further, measures are required to reduce the free length of the saw on the plane of its highest rigidity L . This can be achieved by using a band sawing machine with a saw moving along curvilinear aerostatic guides* [3]. In this type of machine, the free length of the saw l is reduced 4-6 times and its stability is significantly increased.

Fig. 1, *c* shows a schematic diagram of a band sawing machine with a saw moving along curvilinear aerostatic bearings, while Fig. 2 shows a general view of a band sawing machine of the new type.

Prototype band sawing machines with curvilinear aerostatic guides have been created [3, 5]. The results of tests have confirmed the prospects for the selected direction for improving band sawing machines. A band sawing machine with a saw moving along curvilinear aerostatic guides can be classified as resource-saving sawing equipment, since its use increases the volume output of sawn timber by 1-3%, reduces energy consumption by 10-15% and reduces the size and metal intensity of equipment by 30-50%, increases the durability of saws 15-20 times, provides an opportunity to use hard-alloy band saw blades, simplifies the technology for manufacturing the machine and eliminates such a source of noise as saw pulleys.

*The design of a band sawing machine with a saw moving along curvilinear aerostatic guides was proposed, scientifically substantiated and technically developed by Prof. G.F. Prokofiev.

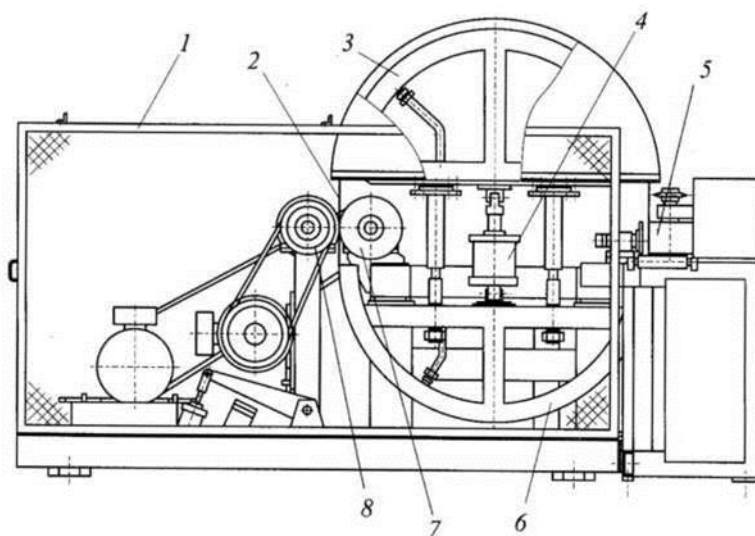


Figure 2. Band sawing machine with a saw moving along curvilinear aerostatic guides: 1 – enclosure; 2 – band saw; 3, 6 – upper and lower curvilinear aerostatic guides; 4 – saw tension mechanism; 5 – feed mechanism; 7, 8 – driving friction wheels

High durability of band saws of band sawing machines with curvilinear aerostatic guides is ensured: by increasing the radius of curvilinear guides (reducing bending stress), wherein free length L remains constant; by reducing the tension force of the saw, as there is a large stability margin due to the reduction in the free length of the saw L several times; due to the exclusion of inertia and pulley runout. Calculations of the durability of band saws of band sawing machines with curvilinear aerostatic guides and their verification are provided in [2].

The lateral component of the cutting force depends on the cutting force, as well as on the precision of preparation, installation, movement of the saw and the accuracy with which the sawn material is fed. The precision of saw movement depends on how accurately the cutting unit is manufactured and calibrated. Installation of deflecting aerostatic guides allows the precision of saw movement to be improved.

The design of the feed mechanism has a great impact on feed accuracy. In dividing band sawing machines, the highest feed accuracy can be achieved using a feed mechanism with a drive feed belt moving along a guide bar, whose working surface is made in the form of an aerostatic bearing [1]. The feed mechanism is shown in Fig. 3. Application of the proposed design ensures reliable and accurate feeding of processed material.

It is possible to increase the efficiency of sawmill production significantly through creation of automated sawmill lines on the basis of band sawing machines.

Use of these lines not only solves the issues of obtaining high quality lumber with minimum consumption of raw materials and energy but also simplifies and reduces the cost of operating raw materials and lumber warehouses.

An automated sawmill line constitutes a complex system of sawing and milling equipment, consisting of modules with devices for their positioning, auxiliary process equipment, devices for determining the size and quality characteristics of incoming raw materials, their positioning and feeding to processing equipment, automated systems for assessing the quality of received lumber and control systems for the elements of the line.

Aerostatic bearings can be used for fast and accurate positioning of band sawing modules depending on the cutting pattern determined by the size and quality characteristics of the raw materials. The scheme of a multi-saw band sawing machine is shown in Fig. 4.

Compressed air is supplied from the compressor to the working surfaces of the sliders of the band sawing module, thus forming aerostatic bearings. Minimal friction of the sliders on the guides allows a significant reduction in energy consumption for moving the band sawing module and improved positioning accuracy.

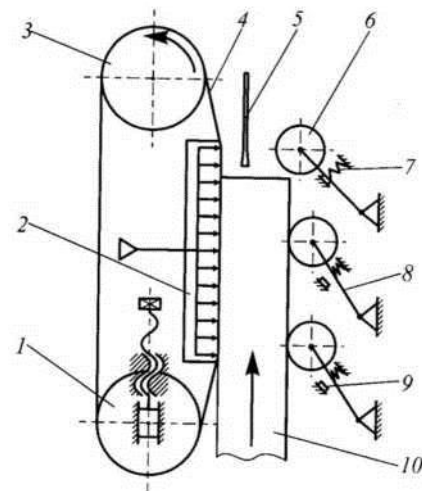
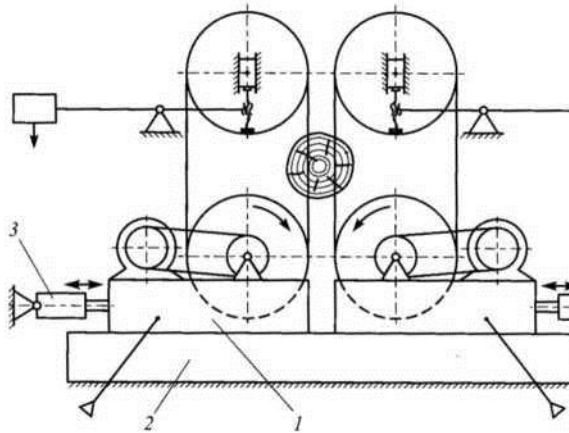


Figure 3. Feed mechanism of dividing band sawing machine: 1, 3 – driving and driven pulleys; 2 – guide bar with a working surface made in the form of an aerostatic bearing; 4 – drive feed belt; 5 – band saw; 6 – pressure rollers; 7 – springs; 8 – supports; 9 – stops; 10 – processed material

Figure 4. Scheme of a multi-saw band sawing machine with single-blade modules positioned along aerostatic guides:
 1 – band sawing module with sliders with working surfaces made in the form of aerostatic bearings;
 2 – base frame of the band sawing machine with guides for the sliders of band sawing modules;
 3 – positioning mechanism



Theoretical and experimental studies have been performed in order to select a rational design for aerostatic bearings. The results of the studies and recommendations on use of aerostatic bearings in machinery are given in [5].

Conclusions

1. Use of deflecting guides for band saws allows the rigidity of the saws to be increased several-fold and their stability partially enhanced. It is expedient to make the working surfaces of the guides in the form of aerostatic bearings. This is an important direction for modernising existing band sawing machines.
2. Use of band sawing machines with curvilinear aerostatic guides offers the greatest effect in increasing the durability, rigidity and stability of band saws. This is a promising direction for creating a new type of band sawing machine.
3. In order to improve the accuracy of feeding of sawn material in dividing band sawing machines, it is advisable to use a feed mechanism with a feed belt moving along an aerostatic guide bar.
4. It is advisable to use aerostatic bearings to reduce energy consumption and improve the accuracy of positioning within the slider-guide kinematic pair of band sawing modules in flexible automated sawing lines.
5. The theoretical and experimental studies of aerostatic bearings performed can be used for improving band sawing machines.

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Received 13/09/2005

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Improvement of Band Sawing Machines Using Aerostatic Bearings

Ways to improve band sawing machines by using aerostatic bearings are considered. The efficiency of this development direction is demonstrated.

