The possibility to use Bandsaw Dynamic Tensioning in Bandsaw Machines

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Abstract. The authors considered the mechanism of motion transmission to wood-cutting band saws, using the effects of their dynamic tension during operation, within the general statements of the flexible link transmission theory.

1. Introduction
Bandsaw machines are widely used in the woodworking, light, food, and metalworking industries. Basic working principles of the cutting mechanisms in the bandsaw wood-cutting machines, the ways of their development, and physical processes during the main motion pulsion are considered in the linked articles [1-7].

One of the development possibilities of the cutting mechanisms in the bandsaw wood-cutting machines appeared quite recently (about 20-30 years ago). It is based on the wood locally stretched in the cutting area by a band saw and is worth viewing as it moves many tensions in the bandsaw away. You can see a typical scheme of this machine in Figure 1, [8]. The authors refuse a double-pulley cutting mechanism scheme and move to the scheme, where the mechanical frictional contacts transmit the motion.

Saw tension appears because of the difference in effort of the saw transmission and braking forces. This way of tensioning in a bandsaw is called dynamic tensioning. The main problem of this method of machine development is the unpredictability of the saw out of the cutting area when the cutting speed is high (30…35 m/s). Besides, the friction contact, as noted earlier [1-3], is unreliable and causes increased wear of the band saw.

2. Analytical review
For a more stable transmission of movement to the band saw, it is necessary to introduce several friction pairs into such schemes (Figure 1) that transmit motion (and torsion), or use traction elements based on tracks, or belts, as shown in the works [9-12]. Besides, in such systems, as in all non-pulley schemes of band saws, a system for adjusting the saw position and keeping it from shifting under the influence of the regular cutting force is not fully developed. The proposed solutions for holding the saw on friction support with the help of thrust rear rollers, as the development history of band-saw machines shows, do not reduce the existing problems.

Decreasing the essential stresses in band saws, this direction of cutting mechanisms development does not solve other problems.
Figure 1. A non-pulley bandsaw machine scheme with bandsaw tension only in the cutting area [8]: 1 – saw, 2, 3 – drive and brake rollers, 4 – log feeding and fastening system, 5, 6, 7 – elements of the friction brake, 8, 9, 10, 11 – frame with brake guide device.

They are related to the development of efficient support circuits for the saw outside the cutting area, as well as to providing stable support reactions for the band saw near the cutting area to counteract the feed force. In this regard, this direction of development of band saws with a locally stretched band saw only in the cutting area has not yet received practical application in the woodworking industry. Some analogues of such machines are used in light industry for cutting leather and fabrics and in the metalworking industry as cutting machines. At the same time, the cutting speed is 2 times less (10...15 m/min) than when sawing wood. Therefore, the saw outside the cutting area does not suffer from additional dynamic effects.

Despite many unresolved issues, these schemes help to develop theoretical models and laboratory samples for analytical and experimental research in the field of band sawing wood.

3. The concept model of development
The concept model of the band saw cutting mechanism must meet the following requirements:
– have tension for the band saw only in the cutting area between the guides,
– do not have additional centrifugal forces in the working branch of the saw,
– have reliable adjustments to give the band saw the desired position,
– create stable support reactions for the saw near the cutting zone to counteract the feed force based on relative rest friction.

In this case, the band saw will only be stretched in the cutting area due to the required pulling force $F_{\text{pul}}$ of the drive-guide device, which should be

$$F_{\text{pul}} \geq (F_{\text{br}} + P_z)C_t \quad (1)$$

where $P_z$ is a tangent component of cutting forces;
$F_{br}$ is a required braking force of the band saw;

$C_t \approx 2.5 \ldots 3$ is the coefficient of tractive effort reserve.

The effort $F_p$, required for tension of the band saw in the work area, will be as follows:

$$F_p \geq F_{pull} - F_{br} \geq 2F_0 - F_x$$ (2)

where $F_0$ stands for the pre-tensioning force of the band saw branch in static;
$F_x$ is tension force in the idle branch of the band saw during operation.

In general, the implementation of these conceptual schemes of guide devices and cutting mechanisms entails a complication of the existing band saw equipment [1] and is not yet fully justified, since little has been studied theoretically and practically, especially in terms of maintaining the band saw outside the cut. Therefore, it is necessary to limit yourself to simpler schemes that do not complicate band saws, while at the same time significantly increase the stability of band saws.

4. The main result

From a practical point of view, double-pulley systems with dynamic tension of a pre-"weakly stretched" saw (Figure 2) and a locally stretched section of it in the cutting area can be more efficient due to the Poncelet ratio [1]. At the same time, it is necessary to solve the issue of transmitting the traction force by a two-way drive-guide device and partially braking the saw movement by a brake-guide device.

**Figure 2.** Layout diagram of a horizontal band saw with dynamic tension of a pre-stretched band saw: 
1, 2 – master and slave pulleys, 3 – a band saw, 4 – electric drive motor, 5, 6 – brake and drive guide devices, 7 – a traction flexible intermediate working body, $yx$ – boom deflection of the idle branch of the band saw when working from the redistribution of the tension force in accordance with the Poncelet ratio.

In comparison with this scheme, the cutting mechanism of a traditional two-blade band saw with rubberized rollers placed on the driven and driving pulleys will be simpler (Figure 3). This will allow for a lower pre-tensioning force of the saw to increase the pulling force and achieve the effect of dynamic tension due to its weakening in the idle branch.

The effect of dynamic tension of the band saw is present in any conventional cutting mechanism scheme of a double-pulley band saw and is determined from the Poncelet ratio.

$$F_0 = \frac{F_p + F_x}{2}$$ (3)
Figure. 3. Recommended installation scheme for rubberized guide rollers in the cutting mechanisms of double-pulley band saws with the effect of the band saw dynamic tension. 1, 2 – master and slave pulleys; 3 – a band saw; 4 – electric drive motor; 5, 6 – guiding devices; 7 – sawn timber.

However, given that $F_p >> F_x$ due to the resistance to the saw movement from the pulleys and guides, as well as due to the action of cutting forces, for the full force compensation, the tension in the working branch of band saw blades should be subject to the following conditions (2)

$$F_{pu} - (F_{br} + P_z)c_t \geq 2F_0 - F_x$$

(4)

Thus, based on the theoretical studies of the conditions for transmitting movement to the band saw, there is a need to create a new direction in the development of cutting mechanisms for band saws. The direction should involve the establishment of reliable support reactions for the band saw in the cutting area, preventing its unauthorized transverse movement along the pulleys under the action of the feed force. One can achieve it by using rubberized rollers in the cutting mechanism of band saws to get the effect of the dynamic tension of the band saw.

This direction of cutting mechanisms development for woodworking band saw machinery allows you to combine the advantages of a traditional machine with a new way of their evolution. That is, to create double-pulley band saws with dynamic tension of a pre-"weakly stretched" band saw in the case of using some drive and brake guide devices following conditions (2) and (4).

The tangible advantages of this direction of band-saws development include the fact that they maintain continuity with traditional double-pulley schemes. This fact makes it possible to use technical engineering not only for creating new band saws but also for upgrading existing ones and those in operation.

5. Conclusions

1. One of the promising directions for the development of cutting mechanisms for band saws is the direction based on sawn wood locally stretched in the cutting area with a band saw using the effect of dynamic tension of the band saw.

2. To achieve the effect of the dynamic tension of the band saw, one can use rubberized pres-sure rollers in the systems of cutting mechanisms of traditional double-pulley band saws.
3. The tangible advantages of this direction of cutting mechanisms development for band saws are that they maintain continuity with traditional double-pulley schemes.

References

[1] Shilko V K 2005 Cutting Mechanisms of Band saw Machines Tomsk: TSUAB Press p 220
[2] Kondratyuk A A, Shilko V K and Rudnev V D 2004 Estimation of band mill traction performance 8th International Symposium on Science and Technology KORUS vol 1 pp 24–27
[3] Shilko V K 2004 Prospects of bandsaw development Woodworking industry vol 5 pp 6–11
[4] Druzhkov G F 1983 Band saws for sawing wood M: Forest industry p 72
[5] Kondratyuk A A, Shilko V K and Novoseltseva I V 2004 Modern trends in the development of cutting mechanisms for band saws The Int. Conf. on Mechanical Engineering and Modern Tech (Tomsk: TPU Press) pp 314–315
[6] Shilko V K 2004 Use of the friction of relative rest in cutting mechanisms of belt sawing machines. Friction and Wear vol 25 № 5 pp 512–518
[7] Rudnev V D, Kondratyuk A A and Shilko V K 2004 Band saw machines on the basis of long contact friction relative peace Current problems of the forest complex Proc Int Conf 5 NMRC “Les 2004” (Bryansk) pp 244–247
[8] A M Lopatin A M, Dolgopolova N A 2001 A Bandsaw Machine Patent 2162404 RF IPC 7B 27 B15/04 Inventions Useful Models vol 3 p 312
[9] Slepchenko I V, Kondratyuk A A and Shilko V K 2005 Influence of dynamic factors on the stability of band saws Modern Technic and Technologies Proc. Int. Conf. XI NMRC Modern Technic and Technologies Tomsk: TPU vol 1 pp 167–169
[10] Vlasov V P, Shilko V K, Slepchenko I V and Kondratjev M JU 2005 A Bandsaw Machine pat 45672 RF IPC 7B 27 B 15/00 13/00 Inventions. Useful Models vol 15 Part V p 972
[11] Shilko V K, Kondratjev M JU, Slepchenko I V and Stjepanov D E 2007 A Bandsaw Machine pat 64555 RF IPC 7B 27 B 13/00 15/00 15/04 Inventions. Useful Models vol 1 part II p 519
[12] Shilko V K, Kondratjev M JU, Slepchenko I V and Stjepanov D E 2008 A Bandsaw Machine pat 70480 RF IPC 7B 27 B 13/00 15/00 15/04 Inventions. Useful Models vol 3 part 5 p 1222