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ROLLER MACHINE FOR FIBER MATERIAL PROCESSING

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Abstract– The article presents a new design of a roller machine for mechanical dewatering of wet fiber materials; it ensures uniform removal of excess moisture in all topographic sections of wet fibrous material of uneven thickness and surface. The proposed design of the roller machine can be used in various sectors of the economy, for example, in paper and cellulose production, leather and fur processing and light industry, where the moisture-containing materials are mechanically processed by uniform pressing of synchronously rotating working bodies. The machine is easy to operate and repair.

Key words– roller machine; fiber material; working shafts; mechanical dewatering; drive unit; thickness; speed; feed; quality; roll module.

I Introduction

The widespread use of roller machines and modern requirements contributed to the development of research to improve the roller technological machines and the technology for processing leather and fur semi-finished products.

In modern leather production, both new and outdated designs of technological machines are used for processing semi-finished leather products. In order to improve the roller machines, the authors have developed a new design of the roller machine for mechanical processing of semi-finished leather products.

II Literature review

The improvement of existing designs and the introduction of new technological equipment is one of the ways of innovative development of enterprises (manufacturers of finished products), which adapt to the modern requirements of consumers, ensure the competitiveness of leather products and the profitability of enterprises in the market. When solving these issues, it is necessary to try to improve the quality of treating leather raw materials during its mechanical processing.

In [1], the influence of internal stresses on the properties of the dermis during the process of semi-finished leather drying was investigated. Changes in limiting indices in the scouring and staking operations of leather and fur semi-finished product were investigated. It was established that at scouring, the strength of the leather fiber decreases and at staking it increases; this must be taken into account when setting the parameters for performing these technological operations.

The study in [2] is devoted to the properties and methods of processing raw hides and finished leather. The defects obtained after mechanical dewatering the leather semi-finished product are investigated in [3]; it also describes the methods for preventing technological defects. The importance of ensuring the required pressure of the pressing rollers and the feed rate of the semi-finished leather product during its mechanical dewatering is noted. The author of [4] in order to improve the quality of processing, considering the properties of the material, has developed models of roller machines for leather and fur, which allow determining the forces between the working and auxiliary shafts.

In [5], vibro-dynamic characteristics of dehairing, stripping and fleshing machines were investigated and a mathematical model was developed for the scientifically substantiated improvement of roller machines to improve the quality of processing of semi-finished leather products. In [6], the authors have analyzed the state of the leather industry and studied the prospects for the development of the leather processing industry. The methods of the most reliable assessment of the quality indices of the processed leather semi-finished product by reducing the vibration load of the working bodies of roller machines are described. The author of [7] investigated the operational properties of technological machines for dressing semi-finished leather products.

Thus, as a result of the analysis of research and literature sources [1-7], the main directions of improving mechanical processing of semi-finished leather and the development of the main units and mechanisms of roller technological machines, were determined.

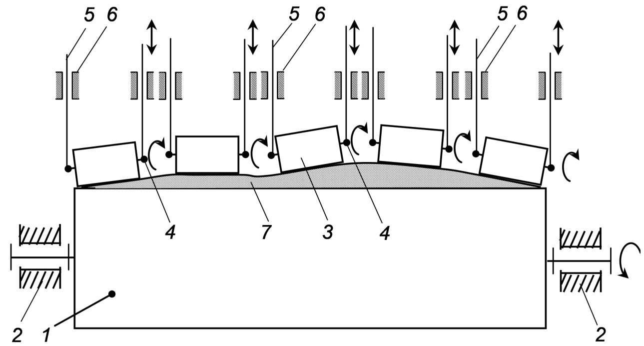

Fig. 1: Arrangement of the working rollers (front view) 1 - lower working roller, 2 – frame work, 3 - upper working roll, 4 - support of the upper working roller, 5 - rod, 6 - guide support, 7 - fibrous material

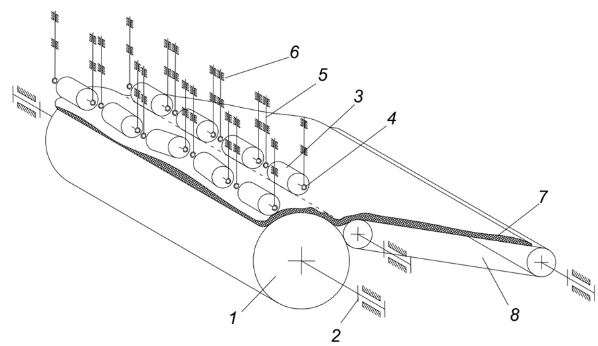

Fig. 2: General view of the roller machine (isometric view) 1 - lower working roller, 2 – frame work, 3 - upper working roller, 4 - support of the upper working roller, 5 - rod, 6 - guide support, 7 - fibrous material, 8 – conveyor

III Development of roller machine design

Providing highly efficient production of import-substituting products by organizing production based on innovative technological processes conducted by means of universal and multifunctional equipment helps manufacturers of finished products to ensure profitability and achieve high technical and economic indices. Existing technological machines for mechanical dewatering of fibrous materials do not always provide high-quality mechanical processing of wet fibrous materials of uneven surface and thickness since the rollers do not fully contact and do not copy all topographic sections of the wet fibrous material being processed. In most cases, to process wet fibrous material of uneven thickness and surface, the pressing rollers must have different angular velocities. The solution to this problem is the design of a roller machine developed by the authors of this article for the mechanical processing of wet fibrous materials of uneven thickness and surface [8–10].

Figure 1 shows the layout of the upper and lower rollers of a roller machine.

The roller machine for removing moisture from wet fibrous materials contains the upper and lower working rollers adjacent to each other; the upper roller is compound, it consists of several parts independent of each other, where the component parts are working rollers.

Figure 2 shows a general view of the roller machine. Figure 3 shows one of the possible options of drive 9 for the upper working roller, carried out by a driven sprocket rigidly fixed at the outlet end of the working roller 3 to which forced rotation is transmitted through an endless chain and a drive sprocket rotating from the common axis of all upper working rollers arranged in one row. The working rollers are made with the possibility of independent movement in the vertical plane while rotating about their axis, and they are mounted on supports.

The working rollers are arranged in two or more rows, and each subsequent working roller is staggered relative to the previous one to overlap the gaps of the previous row of working rollers.

The roller machine works as follows: the processed wet fibrous material 7 is fed to working rollers 1 and 3 by conveyor 8. When wet fibrous material 7 passes between lower working roller 1 and upper working rollers 3, the process of moisture removal takes place.

Compared to similar (VOPM-1800-K (Russia), Svit (Czech Republic), GJST4 320 (China), Ermaksan tannery machines (Turkey)) pressing roller machines, in the design of the roller machines proposed by the authors, the upper working rollers 3 are arranged in two or more rows. To overlap the gaps of the previous row, the subsequent rows are installed with an offset, in staggered order. The main difference from analogs is that the upper working rollers 3 are made with the possibility of rotation about their axis due to friction with the lower working roller 1 or with wet fibrous material 7. Each working roller 3 can additionally be supplied with a drive 9 for rotation about its own axis. Drive 9 can be implemented in the form of a chain or belt drive with a tension roller to compensate for the change in the center distance of the driven (in our case, roller 3) and driving (in our case, the source of rotational motion) wheels attached to the corresponding axles. In the general case, each roller 3 can receive independent rotation (from a servo motor, from bevel gears, etc.). The axes of rotation of working rollers mounted on support 4 have the ability to move in a vertical plane (reciprocate) while rotating about its axis due to the change in the thickness of the wet fibrous material 7 when copying its surface with all rotating working rollers 3.

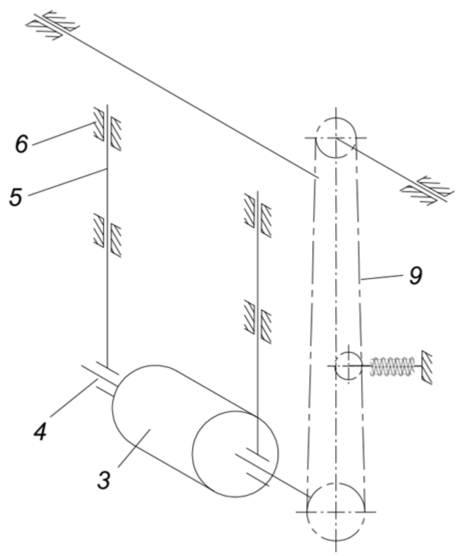

Fig. 3: Option of a drive for the upper working rollers 3 - upper working roller, 4 - support of the upper working roller, 5 - rod, 6 - guide support, 9 - drive of the upper working roller

During the removal of moisture, the working rollers 3 rotate about their axis at different angular velocities due to the uneven surface and thickness of the fibrous material 7. The rotating working rollers 3 completely copy the surface of wet fibrous material 7 and, depending on its thickness, they make a reciprocating motion, moving in the vertical plane. Uniform removal of moisture from the wet fibrous material occurs over its entire surface and thickness [11–14].

IV Conclusions

During the operation of the developed roller machine, the technical and economic result is achieved by ensuring the rotation of the working rollers of the upper working shaft with different angular velocity, caused by the uneven thickness and surface of the processed wet fibrous material. As a result, uniform moisture removal is ensured in all topographic sections of the wet fibrous material of uneven thickness and surface, which increases the quality of the yield leather.

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