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MODERNIZATION OF ROLLERS IN ORDER TO IMPROVE THE QUALITY OF RUBBER PRODUCTS

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ABSTRACT

The study selected a technical solution to improve the quality of rubber products in rolls with roller modernization based on the addition of grooves. The essence of roller modernization is that the second of each pair of ring sections of rolls is equipped with small grooves, as well as the ring sections of each roll are made on removable ring sectors fixed on it. Such a proposed upgrade of rollers will help improve the quality of manufactured rubber products by rollers.

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Introduction.

One of the most common materials that are used in almost all industries and everyday life are polymers, plastics and rubbers [1].

In modern times, there is not a single branch of the national economy in which they would do without rubber or rubber-fabric products. And the primacy belongs to industry. This is explained by the fact that rubber has a complex of valuable operational properties: efficiency, gas tightness, electrically insulating properties, mechanical strength, etc.

Rubber (lat. resina — resin) is a product of vulcanization of rubber. It is a composite material - a rubber compound containing up to 15-20 ingredients that perform various functions. The main technical characteristics of all types of natural and synthetic rubber follow from their performance properties manifested in the process of manufacturing rubber products.

Rubber is produced by rolling. Rolling is the process of repeatedly pushing the molding mixture through the gap between two parallel counter-rotating rollers, which leads to its heating, mixing and homogenization [2].

Rollers is a mixing apparatus in which the material is mixed in the gap between parallel hollow cylinders (rolls) rotating towards each other [3].

The main advantages of rollers are high wear resistance, ease of use.

The main disadvantages include: a tape of rectangular cross-section of rolls with smooth surfaces requires careful submission.

In order to eliminate this lack of rollers, a literary and patent search for a modernization option was performed, which helped to choose the modernization of rollers.

The article is aimed at choosing a way to improve the quality of rubber materials in rollers based on roller modernization.

Features of the design and principle of operation of rollers for the production of rubber products.

Rollers for processing plastics and rubber compounds are characterized by the following working units: front and rear rolls 1, 2, roll bearings 9, 14 and their housings (not shown), roll thermal control systems, lubrication systems (oil cans 18), limiting booms 3, knives for cutting edges, emergency and safety devices 19, 20, bed 8, 12, foundation plate 11, drive gear 4, drive (electric motor is not shown), etc. (Fig.1) [1].

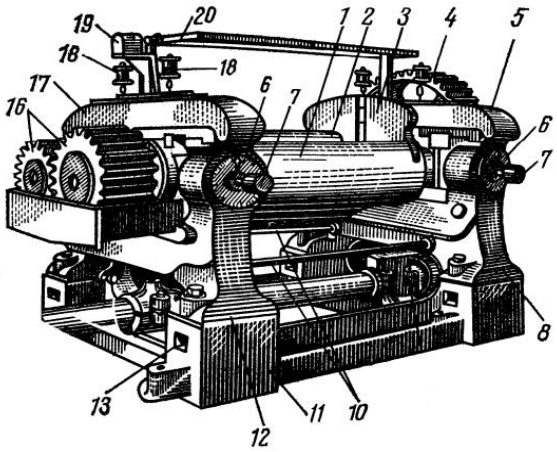

Fig. 1. Scheme of rollers for recycling rubber products:
1, 2 – front and rear rolls; 3 – limiting boom; 4 – drive gear; 5, 17 – traverses; 6 – dividing disks; 7 – adjusting screws; 8, 12 – elements of the bed; 9, 14 – bearings of the transmission shaft; 10 – thrust; 11 – foundation slab; 13 – mounting window; 15 – transmission shaft; 16 – friction gears; 18 – buttermilk; 19 – emergency switch; 20 – emergency bar.

In technological lines, the processing of rubber materials on batch rollers is usually replaced by a continuous process, in which the mixture is loaded onto the rollers from one end of the roll barrel, and selection from the other. In some cases, depending on the technological scheme of rubber material processing, the initial mixture is loaded onto the rolls from both ends of the roll, and selection – in the middle, or loading – in the center of the roll, and selection – from both its ends. Removal of the finished polymer composition in the form of a continuous tape, trimming of which is carried out with special knives, is most often carried out from a low-speed roll from the side of the mechanism for adjusting the size of the inter-roll gap. After leaving the inter-roll gap in the loading area, the material covers the front roll 1 and returns to the inter-roll gap, spreading evenly on one or both sides of the loading section (depending on the roller loading scheme). At each turn, the material gradually moves in a spiral to the place where it is removed from the rollers to an inclined conveyor.

In pic. Fig. 1 presents the classic design of continuous rollers, which work as follows: during continuous rolling of rubber materials, it sequentially passes through sections of the inter-roll gap, alternating with the contact zones of rubber materials with the roller heated to a certain temperature on one side and with the environment on the other. At the same time, the temperature of the material gradually increases, which leads to a decrease in power consumption along the length of the rolls. The effect of rolls on the rubber material consists in drawing it into the gap, compressing, intense shear and pushing the mixture to the exit from the inter-roll gap. Near the surface of the roll, the material moves

almost parallel to it, and the surface of the roll is the limit current line. At the entrance to the gap, the formation of a region of circulation of material with closed or periodically collapsing current lines, called rotating reserve, is observed. The surface of the rotating reserve of thermoplastic material in the zone of contact with the environment has a shape close to cylindrical, and on its surface emissions, ruptures and detachment of individual sections are observed. At the entrance to the inter-roll gap due to the presence of a rotating margin, a counterflow occurs. After passing the minimum inter-roll gap, the relaxation properties of the thermoplastic material and the excess pressure in the inter-roller gap cause the material to move in the direction of pressure reduction at a speed exceeding the linear speed of the roll surface. This zone is called the advance zone. After leaving the inter-roll gap, the material is either removed in the form of a belt from the roll and goes to the next stage of processing, or, together with the roll, makes the next turn and re-enters the gap. In pic. Fig. 1 shows a diagram of rollers for processing rubber compounds, which differ from rollers for processing plastics primarily by group roll drive, in which torque from the drive motor through the gearbox and a pair of drive gears is transmitted to the rear roller, and from it by means of a pair of friction gears – to the front roller, which rotates slower than the rear [1].

When processing on rolls, the material may shift in the reserve area along the rolls and at the same time go beyond their working part, which is unacceptable. To avoid this, the rolls are equipped with a limiting boom 3. The boom consists of two plates partially overlapping each other; The lower surface of each of them covers the upper part of its roll. The plates are fixed on bearing housings of movable and fixed rolls. When the rolls are moved apart together with the bearings, the plates shift, but the gap between them is not formed due to their overlapping each other.

To modernize the rollers, it was decided to modernize the roller, as one of the most important elements, the design of which most of all affects the efficiency of manufacturing rubber products.

Materials and research methods for choosing a roller roll modernization option for the manufacture of rubber products.

In order to obtain a continuous rubber belt with a surface that contributes to the reliable operation of the rollers and to improve the quality of rubber products manufacturing, a literary and patent review of roller modernization options was carried out.

As a result of literary and patent search and analysis of options for modernizing the roller design, several interesting technical solutions were selected. Let us consider them in more detail to select the most appropriate technical solution to improve the quality of profiled rubber products.

The source [4] proposes the design of rollers for processing plastics of rubber compounds containing a foundation slab, two frames, two rolls with a drive for their rotation. In this case, the rolls form an adjustable inter-roll gap, absent with fully erected rolls, and have cylindrical sections on the working surfaces located opposite each other, by performing sections on the working surfaces of the rolls in the form of coaxial cut cones. Thus, the bases of adjacent sections of each roll have the same diameter, which provides a variable geometry of the inter-roll gap and friction in it during the movement of the processed material from the place of its supply on the rolls to the shooting site. This design intensifies the mixing and heating of the recycled material. This design of rolls in the form of roll surfaces of sections in the form of coaxial cut cones reduces the time the material stays on the rollers, reducing the risk of thermal destruction, increases the productivity of rollers. During sequential movement from the place of supply to the place of shooting, this volume of material periodically falls into the inter-roll gap, where, due to its variable geometry (the diameter of the roll sections changes continuously) and, accordingly, the circular velocity of the working surfaces of the rolls in different sections along the barrels of rolls (at constant angular velocities of the rolls) is intensively mixed not only along the rolling direction, but also across the inter-roll gap, which is of great importance for the preparation of a homogeneous well-heated composition and which is almost impossible to achieve on traditional rollers without the use of special removable mixing devices. Despite most of the advantages of the proposed roller design, it will be difficult to implement the working surfaces of the rolls of the sections in the form of coaxial cut cones.

In [5], a new design of rollers is proposed, which provides the ability to adjust the clutch, which significantly expands the technological capabilities of the machine and contributes to the high-quality manufacture of products. The problem is solved by the fact that in the rollers containing the foundation slab, two frames, a drive motor, a gearbox, drive gears, as well as two rolls installed with

the possibility of rotation and equipped with friction gears, according to the proposed design, what is new is that they are equipped with at least one additional pair of friction gears with a different gear ratio, the friction gears of one of the rolls are fixed on it, and the second - with the possibility of rotation independently of it and interaction with the sliding key placed on the second roll with the possibility of movement along it. The execution of rollers with these distinctive features provides stepwise adjustment of the clutch: depending on the position of the sliding key on the corresponding roller, it is connected to one or another friction gear (while the rest of the friction gears rotate independently of the roller at this time), and therefore the desired value of the friction between the rolls is ensured. This proposed design will expand the technological capabilities of the rollers and, as a result, will contribute to improving the quality of rubber products.

The source [6] is tasked with improving rollers for processing rubber compounds, in which a new version of the ring sections of rolls would ensure the production of a continuous rubber tape with a surface that contributes to reliable feeding of the worm machine with the specified tape. The problem is solved by the fact that in rollers for processing rubber compounds containing front and rear rolls, each of which at the place of removal of the processed mixture in the form of a tape has at least one annular section with the formation between each pair of these sections of both rolls of the profiled gap, as well as a device for removing the processed mixture from the front roll. According to the prototype of the improved roller design [6], what is new is that on one of each pair of ring sections of the rolls are equipped with small grooves.

We propose to choose a technical solution based on a prototype of rolls with reefs at the end sections [6]. The completed drawing of the design of modernized rolls is shown in Fig.2. Fig. 2, A-A shows the cross section of the rollers. Fig. 2, B-B shows the cross section of rolls with small grooves of modernized rollers. Fig. 2, C shows small grooving of rollers on an enlarged scale.

Consider the principle of operation of modernized rollers. Hollow rolls; Their inner surface is cooled by water supplied through pipe 6. The waste water is freely drained through funnels 10, fixed at the right ends of the rolls, the receiving bath 11.

The rotation of the rolls from the electric motor 19 is transmitted through the gearbox 21. Between them installed band or shoe brake 20. All these elements are mounted on the foundation slab 13. There is a gear 15 on the output shaft of the reducer, which transmits rotation to wheel 1, fixed on it. On the right roll shanks are also motionlessly dressed gears 16 and 17; They are in mutual gearing and transmit rotation from the rear to the front roll. Gears 15, 1 and 16.17 are enclosed in casings, the lower part of which is an oil bath for lubricating steam.

On racks 9, two emergency stop cables of rollers 5 are stretched, connected to limit switches. When you press one of the cables, the limit switch gives a command to turn off the electric motor and activate the brake.

Adjustment of the size of the gap between the rolls is carried out using special mechanisms 18, equipped with safety devices. On each of the frames there are indicators of the gap value to eliminate the skew of the rolls. The rolls are made of hollow cast iron with a hardened surface of the working part and boring of the inner surface to which cooling water is supplied (using a special cooling system). To prevent the possibility of recycled material entering the roller bearings, protective sliding arrows 4 and 8 are installed on the rollers, one half of which is attached to the front and the other to the rear bearings of the rolls.

Rollers for processing rubber compounds contain front 7 and rear 24 rolls, each of which has at least one annular section at the point of removal of the recycled mixture in the form of a tape, respectively, with the formation of a profiled gap between them, as well as a device for removing the recycled mixture from the front roll 7 (Fig. 2).

The second of each pair of annular sections (respectively section C) can be equipped with small grooves (Fig. 2, C), and the ring sections of each roll 7 and 24 are made on fixed on the last removable ring sectors.

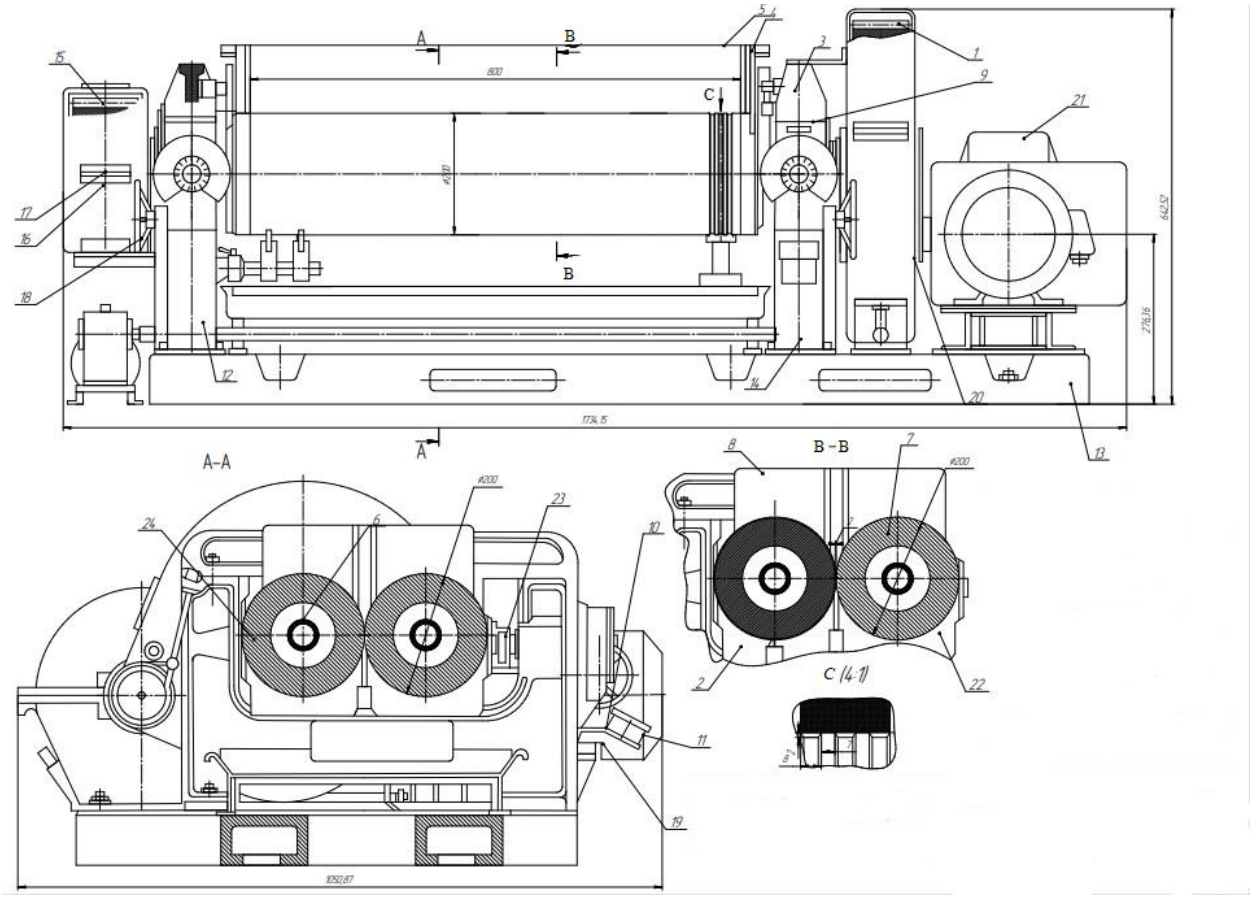

Fig. 2. Design of modernized rollers:

1 - gear; 2 - bearing housing; 3-traverse; 4 - arrow; 5 - cable emergency stop of rollers; 6 - roll cooling pipe; 7 - front roll; 8 - arrow; 9 - racks; 10 - funnel; 11 - reception bath; 12, 14 - frame of the bed; 13 - foundation slab; 15 - gear; 16.17 - toothed pairs; 18 - mechanisms for adjusting the inter-roll gap; 19 - electric motor; 20 - brake; 21 - gearbox; 22 - bearing housing; 23 - screw; 24 - rear roll.

The upgraded roller design works as follows: a pre-formed rubber compound or components are fed into the gap between rolls 7 and 24 in the place opposite to the place where the rubber belt is removed After repeatedly passing through the inter-roll gap mixture, it is gradually homogenized, heated and moved to the place where it is removed from the rolls. Having reached the annular sections of rolls 7 and 24, rubber fills the grooves and the space between the grooves (Fig. 2, C) and is formed at the exit of the profiled gap in the form of a corresponding profile, while due to the frictions in the inter-roll gap, as a rule, no more than 1.07, there is practically no "lubrication" of the grooves on the surface of the rubber band. Using device 10, rubber in the form of an endless rubber profiled tape is removed from the front roll 7 and then fed to the receiving bath 11 [6].

The technical result for the proposed design of rollers is that due to the formed profile surface due to small grooves, the rubber tape is reliably and evenly fed, which contributes to the production of high quality products.

The use of the proposed roller design makes it possible to achieve the goal, namely to improve the quality of the profiled rubber products obtained.

Conclusions.

Thus, the technical result of the proposed design for the modernization of roll rolls is that the second of each pair of ring sections of rolls is equipped with small grooves, as well as the ring sections of each roll are made on removable ring sectors fixed on it. This ensures the formation of appropriate grooves on the resulting rubber band, which increases the friction between it and the roll of the machine, and therefore also contributes to the movement of rubber rolls and improves the quality of the products obtained.

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