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Technology for Manufacturing New Elastic-Damping Elements

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Abstract

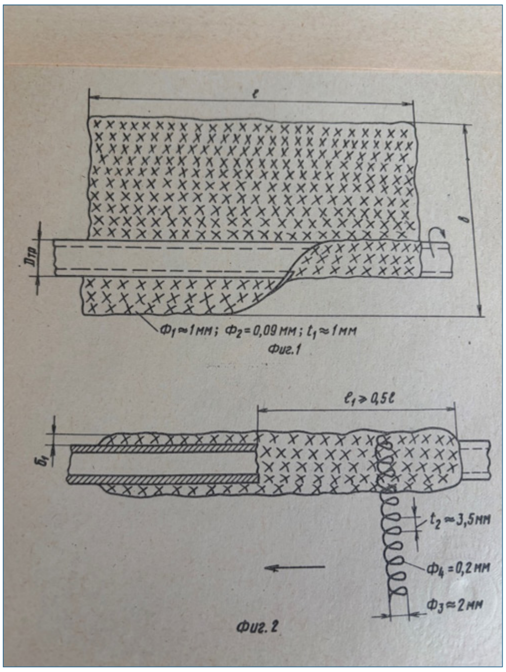
Technology has been developed by us for the use of elastic-damping elements (metallic rubber) under production conditions, determining their characteristics and main operating parameters, which makes it possible to increase the operational life and efficiency of elastic-damping elements (metallic rubber) by 40-50% under mandatory vibration conditions. The mentioned advantages of elastic-damping elements allow them to be accordingly used in spacecraft, heavy machinery, trains, airplanes, and various similar types of equipment, the vibration levels of which significantly exceed allowable sanitary-hygienic standards, especially when operating in difficult environmental conditions, for the manufacturing of effective vibration-damping means.

Keywords: New Elastic-Damping Elements, Technology, Metallic Rubber.

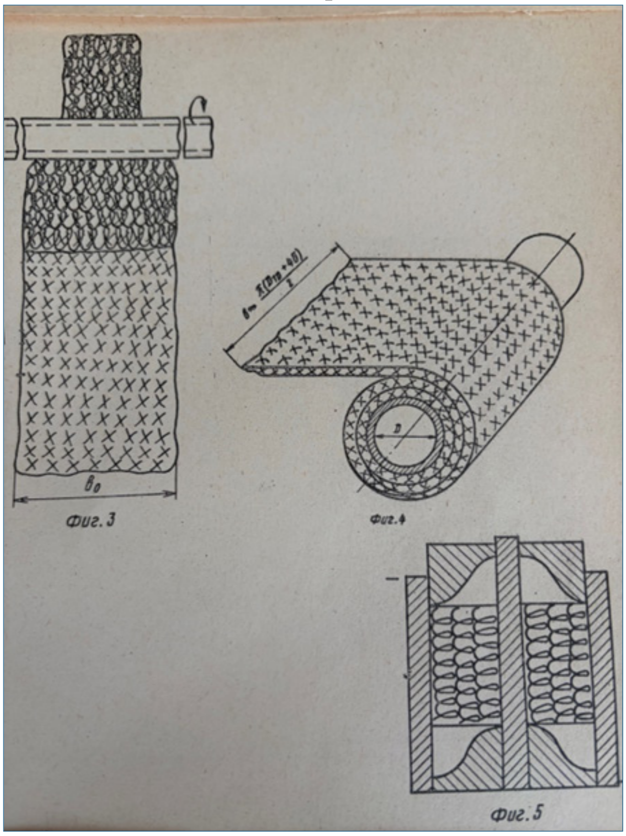
Introduction

Based on the theoretical research conducted by us, a technology for the production of new elastic-damping elements (metallic rubber) has been developed. These elastic-damping elements are characterized by an increased ability to absorb harmful energies and high resistance to cyclic loads, while the 'stress-displacement' behavior under static and dynamic loading in a cyclic load mode has a hysteretic characteristic in hyperbolic form. To achieve the increased ability to absorb harmful energies and high resistance to cyclic loads of flexible-damping elements (metallic rubber), we have developed new methods for manufacturing such elements [1]. To achieve this goal, it was used due to the oriented placement of spirals of various stiffness. with consecutively performed operations of laying coiled wire segments of spirals into a mat, twisting it into a roll followed by wrapping along its axis with spirals of a larger diameter, removing from the mandrel, rolling it into a ribbon-shaped blank and re-twisting into a roll, preliminary pressing in a mold of a given configuration, subsequent layering with segments of spirals and final pressing in the same direction, an increase in load-bearing and damping capacity of new elastic-damping elements (metallic rubber) by 40-50% is ensured. Figure 1 shows the operation of twisting the mat on the mandrel into a roll; Figure 2 shows the operation wrapping along the axis of the roll with segments of larger-diameter spirals; Figure 3 shows the operation rolling out the roll until a ribbon-shaped workpiece is obtained; Figure 4 shows the operation twisting on the mandrel of a strip-shaped workpiece; Figure 5 shows the operation pressing with punches of a given configuration [2]. A technology for the production of new elastic-damping elements (metallic rubber) has been developed consists in laying twisted wire segments of spirals with a ratio of their diameter to pitch of 1:(1.25-5) with mutual volumetric interweaving on a soft surface, for example, rubber, in the form of a mat; then the mat can be compacted by rolling it with a mandrel and the mat is twisted on the mandrel along its length in the form of a roll.

Figures 1,2 :Technology for the Production of New Elastic-Damping Elements (Metallic Rubber) has been Developed.



Figures 3,4,5: Technology for the Production of New Elastic-Damping Elements (Metallic Rubber) has been Developed.



Then they are wrapped along its axis with sections of larger-diameter spirals, having a diameter-to-pitch ratio of 1:(1.5-2) or one end for at least half the length, i.e., leaving a distance from the ends of the coil of 0.025–0.1 of its total length, with the turns tightly adjacent to each other with a gap. They lay them in a mat and wrap the roll along its axis with sections of spirals with a ratio of diameter to pitch to the diameter of the wire from which they are twisted, respectively equal to (10-12):1 and (15-18):1. The mat is wound on a mandrel into a roll until its wall thickness is greater than or equal to the diameter of the spiral segments with which the roll is wrapped along its axis. Next, the roll is freed from the mandrel and unrolled in the direction of its axis until a strip-shaped billet is obtained; the latter is twisted on the mandrel along its length and preliminarily pressed along the axis of the mandrel in a mold using punches of a given configuration to a value of 0.75-0.8 of the billet height, тhe workpiece is released from the mold, and the entire or specified part of its outer surface is covered with segments of coils at an angle of 40-50° to its longitudinal axis, with a ratio of the diameter of the wire from which they are wound to the diameter of the wire from which the coil segments laid in the mat are wound equal to 1:(1-2), and all of them are taken equal to (10-15)% of the weight of the workpiece. After that, the workpiece is repressed in the same direction until the final shape of the part is obtained [3].

One example of implementation technology for the production of new flexible-damping materials (metallic rubber) represents the performance of a cylindrical part with a diameter of 62 mm, a height of 45 mm, a nominal load of 240 N, and a maximum load of 300 N. The operating condition of the part is uniaxial compression along the vertical (longitudinal) axis, Segments of spiral with a diameter of 1 mm, weighing 60 g, wound on stainless steel wires with a diameter of 0.1 mm (grade EI-708) with a pitch of 1 mm, are laid on a soft surface (rubber or elastomer) with mutual spatial interweaving of the coils, The workpiece obtained, with a length of 500 mm and a width of 300 mm, is rolled using a mandrel in the form of a pipe with a diameter of 50 mm (figure. 1). The resulting mat is wound onto a mandrel along its length in the form of a roll, then sections of a spiral with a diameter of 2 mm and a pitch of 3.5 mm, wound from wire of grade 12Kh18N10T with a diameter of 0.2 mm, mass 7 g, are taken and these sections are wrapped around the roll over at least half of its length, Moreover, the coils are laid with an even gap between them (depending on the required load capacity), which is facilitated by the use of a mandrel (figure. 2). The thickness of the roll in this case must be at least 2 mm, which ensures the absence of contact between the wrapping spiral and the mandrel [4]. When choosing the ratio of 1mm and 3mm steps for both spirals, it is based on the fact that each turn of the wound spiral should enclose 3-4 turns of the spirals from which the reel is made. Wrapping the roll with spiral segments 1.5-5 times larger in diameter than the diameter of the wire from which the roll is made allows expanding the elastic properties of the final part while simultaneously increasing its resistance to impact loads with unilateral or all-around compression. Each turn of the wound coil, the pitch of which is 1.5-2 times its own diameter, replaces the turns of the roll in the corresponding direction of pressing, namely - along the longitudinal axis of symmetry of the cylindrical workpiece, thereby increasing the damping properties of the part. At the same time, the diameters of the wrapping coil and the diameter of the coil from which the roll is made are 10-12 times, and their pitch is 15-17 times greater than the diameters of the corresponding wires. Then the roll is released from the mandrel and unrolled in the lengthwise direction. The resulting ribbon-shaped blank, 80 mm wide (Figure. 3), is wound onto a thin mandrel with a diameter of 4 mm in a cylindrical shape from the end from which the spiral wire segments with a diameter of 0.2 mm were wound, which ensures a relatively uniform change in the isotropy of the blank and, consequently, of the final product along its radius. The cylindrical blank with a height of 80 mm (figure. 4) is placed in a mold with an internal diameter of 60 mm and preliminarily pressed to a height of 0.8 mm. After removing the cylindrical workpiece from the mold, it is wrapped with sections of spiral wire with a diameter of 0.2 mm, with a total weight of 3-4 g, while the projections of the axes of the spiral sections wrapped around the workpiece in the vertical plane form an angle of (40-50)° with its longitudinal axis (Figure. 5). Such layering of spiral segments ensures their good embedding on the lateral surfaces of the workpiece and, accordingly, prevents their bulging when placing the workpiece into the mold before final pressing.

After this, the final pressing is performed to the specified element height of up to 45 mm, stabilizing it with a load at least 5 times with a force equal to the pressing force of 12,000 N. Consequently, the specific pressing pressure is about 400 N/cm2. The roll can be wound not only halfway along its length, as shown in Figure. 2, but also fully. Subsequent operations remain unchanged; however, the product will have a higher load capacity.

Using the method we have developed, it is possible to manufacture elements of any shape and any diameter; this will depend on the mold we prepare. The characteristics of the elements, specifically their ductility, ability to absorb harmful energies, and resistance to cyclic loads, will be increased by 40-50% compared to elements made using conventional, well-known methods. Practically, we manufactured cylindrical-shaped elements in a special prismatic mold, the cross-sectional perimeter of which, Π was related to the diameter by the following empirical relationship: $\Pi > (1.5\text{-}2)\ nD$, where n is the number of twists of the ribbon-shaped workpiece, The height of the elements is 45 mm, and the nominal load capacity is 240 N. Cylindrical elements manufactured using this method can be used as a component of the elastic element of the shock-absorbing handle of jackhammers and rotary hammers, which allows a significant reduction in handle vibration velocity levels and, consequently, localized vibration on the miner's hands in the range of the main frequencies (8-31.5 Hz), and, in addition, increase performance by 40-45%. Based on the analysis of the experiments, we determined that in the investigated devices, the level of vibrations during the operation of vibration-damping devices decreased on average by 12-14 dB in each vibration band, while the resonance frequency of the vibration-damping devices varied in the range of 120-125 Hz.

In parallel, we have developed methodologies for determining the characteristics and main operating parameters of flexible-damping elements in production conditions, which allow for the assessment of the operational life and efficiency of flexible-damping elements under mandatory vibration conditions. The advantages of these flexible-damping elements enable them to be used, accordingly, in heavy machinery equipment, spacecraft, trains, airplanes, and other similar types of machinery, whose vibration levels significantly exceed permissible sanitary and hygienic standards, especially when working in particularly harsh environmental conditions, for the production of effective vibration-damping devices.

Conclusion

Thus, a method for manufacturing elastically damping parts from metallic rubber, including layering segments of spirals of different diameters cut from wires of various diameters with mutual volumetric intertwining into a given mold and pressing, characterized in that, in order to increase the load-bearing capacity and damping properties of metallic rubber parts, the segments of spirals with a diameter-to-pitch ratio of 1:(1.25-5) are laid out in the form of a mat, they twist it on a mandrel into a roll and wind along its axis with segments of spirals of larger diameter with a pitch of 1:(1.5-2), then twist the last one on the mandrel along its length and preliminarily press it along the axis of the mandrel in a mold using punches of a specified configuration.

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