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Vibration damping materials to reduce vibration in the garment industry

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ABSTRACT: By authors it is investigated reduction of vibration and noise of sewing machines by means of the vibrodamping materials.

KEYWORDS*:* the vibrodamping materials vibroextinguishing the bases, shock-absorbers, a pneumatic cylinder, an elastic element.

I.INTRODUCTION

The development of modern production technologies necessitates the creation of machines and mechanisms operating in conditions of significant speeds and accelerations. This leads to an increase in dynamic vibrational loads on machine parts and structural elements, as well as on individual components and devices of these machines. One of the methods for solving this problem is vibration damping - vibration reduction due to the dispersion of mechanical energy.

High-speed sewing machines are a fairly powerful source of noise and vibration. Experience shows that the effectiveness of measures to reduce the mechanical noise of existing equipment is very limited and is due to the possibility of structural changes of its components, therefore, the reduction of mechanical noise of machines should be achieved mainly at the design stage. In this case, without creating the appropriate dynamic and mathematical models, mathematical and software, allowing to analyze the developed design, achieving the goal is not possible.

For comparison, we give indicators of the sound pressure levels of different sound sources at a distance of one meter from the observer, taking the audibility threshold equal to zero: Increasing the speed parameters of modern sewing machines, their power and complexity of the mechanisms makes us look for new methods of dealing with noise and vibration.

With an increase, for example, in the frequency of rotation of the main shaft of a machine, the likelihood of resonance phenomena increases, and with an increase in inertia forces, their influence not only on the machine itself, its table, but also on the floor floors, especially when installing a large number of simultaneously working machines.

Vibration of machines can lead to a disorder of mechanisms, premature wear and destruction of parts, to a decrease in the reliability of machines and, in some cases, to disruption of the technological process.

Vibration is the kinetic energy transmitted to a machine or person. The reasons for its occurrence are unbalanced force effects, the sources of which are:

• reciprocating moving systems (crank mechanisms, vibro rammers, etc.);
• unbalanced rotating masses (for example, hand-held electric grinders).

In some cases, vibrations can also be generated by impacts of parts (gears, bearing assemblies).

Various methods are used to combat the vibration of machines and equipment and to protect workers from vibration. The fight against vibration in the source of its occurrence is associated with the establishment of the causes of the appearance of mechanical vibrations and their elimination.

To reduce vibration, the vibration damping effect is widely used - the conversion of the energy of mechanical vibrations into other types of energy, most often into thermal energy. They are applied at the stage of their operation.

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II. SIGNIFICANCE OF THE SYSTEM

The creation of new and improvement of existing sewing machines is associated with an inevitable increase in the intensity of the work of their parts, which significantly affects their performance and leads to a decrease in the reliability and durability of machines, and the more so, the higher their speed. Therefore, the issues of rational lubrication of mating pairs of mechanisms and units of sewing machines, and especially industrial machines, are gaining importance. This includes issues of the correct choice of systems, methods and modes of lubrication, as well as the type of oil during design, timely and rational periodicity of lubrication during operation, monitoring the operation of lubricating devices and oil quality.

Vibration damping is the process of reducing the level of vibration of a protected object by converting the energy of mechanical vibrations of the system into other types of energy. To this end, in the construction of parts through which vibration is transmitted, materials with high internal friction are used: special alloys, plastics, rubbers, vibration damping coatings. To prevent general vibration, use the installation of vibrating machines and equipment on independent anti-vibration foundations.

Vibration protection is a combination of methods and means that reduce the harmful effects of vibrations. The creation of vibration-protective devices that can effectively solve the tasks assigned to them with limited mass and geometric characteristics is a complex technical task, the solution of which is possible only with a comprehensive consideration of the nature of the disturbances and the dynamics of the created systems.

The main methods of vibration protection.

Reducing the intensity of oscillations of the object can be achieved in the following ways:

1. By reducing the levels of mechanical stresses excited by the source (this method of vibration protection is called reducing the vibration activity of the source).

2. A change in the design of the object, in which the specified mechanical effects will cause less intense vibrations of the object or its individual parts (this method is called the internal vibration protection of the object).

3. The addition of an additional dynamic system to the object, which changes the nature of its vibrations. Such a system is called a dynamic vibration damper, and the protection method based on its application is called dynamic vibration damping.

4. Installation between an object and a source of oscillations of an additional system that changes the nature of its oscillations.

This method of vibration protection is called vibration isolation, and devices installed between the source and the object - vibration isolators (vibration isolation devices)

III. LITERATURE SURVEY

The effect of vibration isolation is to weaken the bonds between the source and the object; this reduces the dynamic effects transmitted to the object.

The weakening of bonds is usually accompanied by the occurrence of some undesirable phenomena:

• an increase in the static displacements of the object relative to the source;

• an increase in the amplitudes of relative vibrations during low-frequency impacts;

Therefore, the use of vibration isolation as a method of vibration protection, in most cases, is associated with finding a compromise solution that satisfies the totality of requirements.

To weaken the transmission of vibration from sources of its occurrence to the floor, workplace, seat, handle, etc. vibration isolation methods are widely used in the form of vibration isolators made of rubber, cork, felt, asbestos, steel springs.

Vibration damping is called vibration damping due to active losses or the conversion of vibrational energy into its other forms, for example, into thermal, electric, electromagnetic.

Vibration damping can be implemented in cases when the design is made of materials with large internal losses; vibration-absorbing materials are applied to its surface; contact friction of two materials is used; structural elements are connected by cores of electromagnets with a closed winding, etc.

In relation to the source of vibration excitation, collective protection methods are divided into methods:

- reducing vibration parameters by acting on the excitation source;
- reducing vibration parameters along the paths of its propagation from the source excitement.

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The first includes such protective equipment as dynamic balancing, antiphase synchronization, changing the nature of disturbing influences, changing the structural elements of the excitation source, changing the frequency of oscillations, etc.

They are used, as a rule, at the stage of design and manufacture of equipment. Means of protection against vibration along the paths of its distribution can be incorporated into the designs of machines and equipment, and can be applied at the stage of their operation.

The most effective means of protecting a person from vibration is to eliminate direct contact with vibrating equipment. This is done through the use of remote control, industrial robots, automation and replacement of technological operations.

Reducing the adverse effects of vibration of manual mechanized devices on operators is achieved both by reducing the intensity of vibration directly in its source (due to structural improvements), and by means of external vibration protection, which are elastic-damping materials and devices placed between the vibration source and the hands of the operator [2] .

IV. METHODOLOGY

Unbalanced forces arise as a result of an imbalance, which may be caused by the heterogeneity of the material of the rotating body, the mismatch of the center of mass of the body and the axis of rotation, etc.

The basic concepts of vibration theory are:

1) vibration parameters: vibration displacement, vibration velocity and vibration acceleration;
2) mechanical;
3) natural frequency.

Vibrations encountered in technology, as a rule, have a character close to harmonic, and the periodic processes taking place in a number of cases can easily be represented as the imposition of harmonious oscillations, i.e. oscillations at which the oscillating quantity changes according to the law of sine (cosine).

For harmonic oscillations, the deviation of the oscillating point from the equilibrium position (vibration displacement) is determined by the formula:

$$x = x_т \sin(\omega t + \phi)$$

where:

$x_т$- vibration displacement amplitude;

φ - initial phase of oscillation at time, $t = 0$;

$\omega = 2\pi f$ - circular frequency;

f - oscillation frequency.

An elastic shock absorber (or elastic shock absorber) is installed between the base and the shock-absorbing object.An external force (F (t)) is applied to the shock-absorbing object. The task is to reduce the dynamic forces transmitted to the base by introducing elastic shock absorbers into the system.

In order to reduce the noise level and vibration of the sewing machine, we offer a device consisting of elastic devices located between the table and platform of the machine shock absorbers, one of which is rigidly connected to the table and platform, and others to the platform.

This device has a speed sensor for the main shaft of the machine, a signal amplifier and power cylinders, and the sensor is connected by means of a signal amplifier and power cylinder rods to the corresponding elastic shock absorber connected to the platform [3].

The elastic shock absorber is made in the form of an inflatable pillow made of rubber-like material, in the form of a pneumatic cylinder, in the form of a twisted or leaf spring. The device contains elastic shock absorbers 3 and 4 located between table 1 and platform 2 of the sewing machine, shock absorbers 3 are connected to table 1 and platform 2, and shock absorbers 4 are connected with platform 2.

The device also has a speed sensor 5 of the speed of the main shaft 6 of the machine mounted on the platform 2, a signal amplifier 7 and an actuator 8, which transmits the amplified signal from the sensor 5 to the power cylinders 9, and the sensor 5 is connected via a signal amplifier 7 and the rods of the power cylinders 9 to the corresponding elastic shock absorber 4, connected with the platform 2, shock absorbers 3 and 4 can be made in the form of an inflatable cushion of rubber-like material, shock absorbers can be made in the form of pneumatic cylinders s in the form of helical or leaf spring resting on a curved surface.

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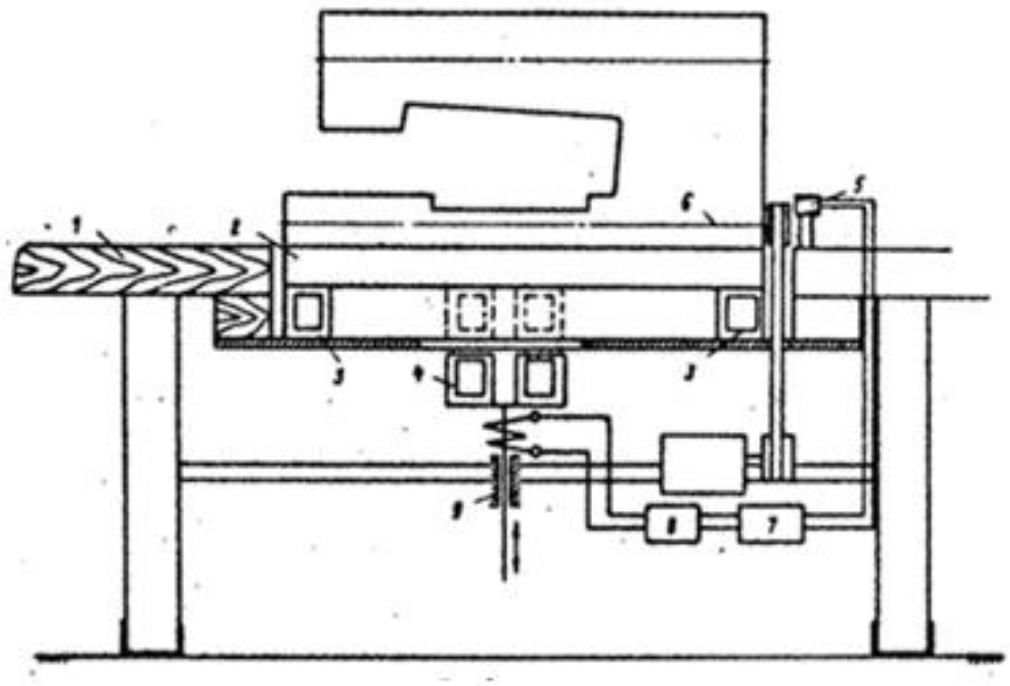

Fig. 1. General view of the device

The device operates as follows when the number of revolutions of the main shaft 6 of the sewing machine is reached, corresponding to one of the intermediate resonant frequencies of the sewing machine unit, the signal from the sensor 5 revolutions is fed to the signal amplifier 7, the actuating element 8 is equipped with power cylinders 9, which, interacting with intermediate elastic shock absorbers 4, takes the reduced rigidity of the platform support of the sewing machine. When passing through a section of the resonant frequency, the signal cylinders 9 leave the contact with shock absorbers 3 and 4 by a signal from the 5-speed sensor.

The machine relies only on shock absorbers 3 with a stiffness of 0, 6 10 Nm providing a minimum of 5 forces transferred to the table 1 In the case when the elements are made in the form of a non-linear spring resting on a curved surface, the non-linear leaf spring bends under the influence of the forces transmitted to its cantilever part from the side of the platform, in this case, the profile of the curved surface is selected so that the total stiffness of the shock absorbers changes nonlinearly according to the law corresponding to the change in resonance pilots at the sewing machine set.

When the shock absorbers 4 are made in the form of intermediate rubber-like pillows 10, when intermediate resonant frequencies are reached due to the interaction of the power cylinders 9 with pillows 10 of rubber-like or other elastic materials, the reduced rigidity of the elastic base of the platform changes, the system of inflatable pillows 10, due to which the resonance phenomena are excluded, when the intermediate resonance passes, the power cylinders 9 come out of contact with the pillows 10 fixed on one side to the table.

In the case when the elastic shock absorbers 4 are made in the form of pneumatic cylinders, when intermediate resonant frequencies are reached, the power cylinders 9 enter into interaction of the pneumatic cylinders with the platform 2, after the resonant frequency passes, the speed sensor 5 of the main shaft 6 of the machine sends a signal to the actuators 8 to the power cylinders 9 on withdrawal from contact of the pneumatic cylinders with the platform 2.

The device may contain several elastic elements (Fig. 2) as well as several power cylinders 9.

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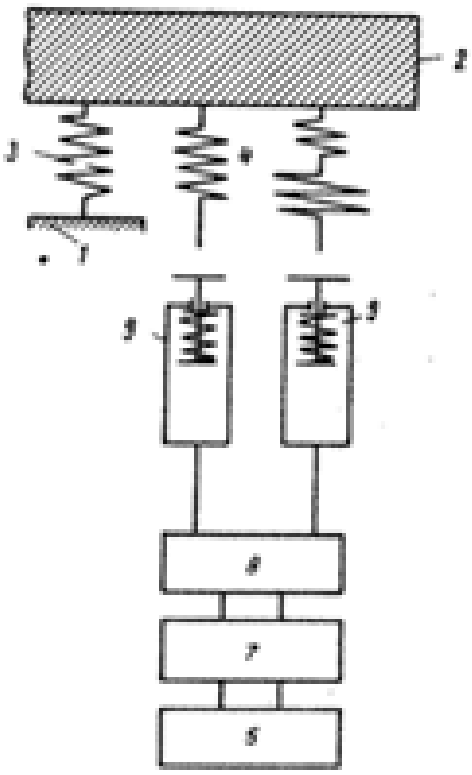

Fig. 2. Damping stiffness control scheme

The proposed device will significantly reduce noise and vibration levels of sewing machines in the area of the most dangerous frequencies for the operator. The vibration speed of the cover of an industrial table is reduced by 10-12 times in the entire range of operating speeds of the main shaft of the sewing machine.

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