INVESTIGATION OF SMALL VIBRATIONS IN SEWING MACHINE NEEDLE MECHANISMS

Khudoyberdiyeva Makhliyo Abdukaxorovna,
Assistant,
Department of "Light Industry Machinery and Equipment"
Bukhara engineering technological institute, Uzbekistan
Raximov Dustmurod Otamurodovich,
Student,
Department of "Light Industry Machinery and Equipment"
Bukhara engineering technological institute, Uzbekistan
Anvarova Kamola Axtamjon qizi
Student,
Department of "Light Industry Machinery and Equipment"
Bukhara engineering technological institute, Uzbekistan

Abstract - This article gives sewing machine parameters and the scheme of experimental setup to determine small vibrations of needle mechanism of sewing machines.

Key words - Speed, thread, parameters, stitches, needle bar, crank, crank, main shaft, torque, vibration, mechanism, sewing machine.

Introduction.

Sewing machine mechanisms are characterised by high working speeds, high accelerations, inertial forces of movement, links, unstable process conditions and the predominant use of low kinematic pairs. Modern sewing machines perform up to 130-150 weave threads per second, kinematic cycles of such machines is 7-8 ms, and the duration of many process steps is less than 1 ms. The speeds of ms of working elements and threads are measured in tens of m/s, and the acceleration of threads is 600 m/s2. At the same time, the rotational speed of the driving links of the machines is 6000-8000 rpm. Many parameters c stitch lengths, thread tension, thickness, physical and mechanical properties, stitched parts and threads, and change for technological reasons, in machines with deflecting needles, in addition regulated by the magnitude of the needle deviation. As a consequence, changing the conditions of interaction between the working bodies of machinery.

In the design and calculation of mechanisms of interlacing threads - and other technological requirements-set structure of interlacing threads, type of stitching, thread tension, especially their movement and many dynamic and design conditions. Needle mechanisms allow the material to be heated and the threads to be threaded at the same time, the looping and deflection of the needles. Most needle mechanisms for the calcination of materials to be cross-linked are designed with low kinematic pairs which, at high link speeds, cause the individual links of the whole machine to oscillate.

When selecting the structure of the needle mechanism, it is useful to analyse the effect of the desaxial and arrangement of the crank on the movement of the needle and to establish a rational number of driver needle supports which is linked to the creation of different oscillation frequencies of individual links. The driver's needle rotation as a function of the crank angle from the correct vertical position is given by the formula:

$$Z_c = R\left[\frac{1}{\lambda}(1-\frac{\varepsilon^2}{2})\right]-\frac{\lambda}{4}-cos\varphi-\varepsilon sin\varphi+\frac{\lambda}{4}cos2\varphi$$

where, $\lambda = \frac{R}{l}$ $\varepsilon = \frac{E}{l}$; R, l, E crank radius, connecting rod lengths and desaxial. The graphs of the function $Z_c(+)$ make it possible to judge the influence of the mechanism structure on the duration of the needle stroke. Parameters c R, l, φ allows you to study the small vibrations of the links of the needle mechanism during operation.

One of the ways of increasing the reliability of sewing machines is to reduce vibrations in the joints of the needle mechanism, working at high speeds. Fig.1 shows a universal widely used type of needle mechanism of sewing machines sewing and footwear production of light industry.

The crank 1 rotates and drives crank 2 in a reciprocating motion together with the needle 4. At point A of the crank there is a device with a measuring device, in the rotary motion of the arrow 1. Each position of the driver's needle corresponds to a certain value of the measured value, which is indicated by the arrow on the scale of the device (1). This correspondence is broken if the crank stand vibrates. The arrow 1 then vibrates slightly in relation to the average position, which may not coincide with the position corresponding to static equilibrium.

Denote by α_0 the angle α which determines the position of pointer 1 when there is no stand vibration and by α_d the average angle α during crank vibration. The difference $\alpha_d - \alpha_0$ gives the dynamic error in the reading.

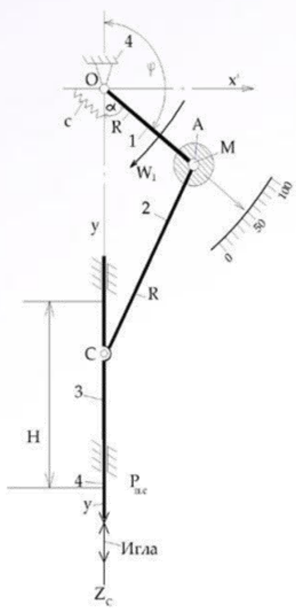

Fig. 1. Schematic of the experimental set-up for determining the small vibrations of a sewing machine needle mechanism: 1-crank, 2-crank, 3-needle bar, 4-pillar

The same error is produced when a periodically varying force $P_{п.с.}$ is applied to a needle driver in a static equilibrium position, resulting in a piercing force. The position of stable static equilibrium of the links of the needle mechanism corresponds to the minimum potential energy of the needle mechanism Pm, taking into account only the mass M concentrated at point A and the elasticity of the spring c placed between the prop and the crank 1:

$\Pi = \Pi_0 + M \cdot g \cdot l_{\text{крш}} \cdot cos\alpha + \frac{1}{2} \cdot c \cdot a^2$ (1)

where: α-generalised coordinate of the needle mechanism; Π_0 –constant value of potential energy determined by the origin; c-coefficient of angular (torsional) stiffness of the spring;

$l_{\text{крш}}$-lengths of crank and connecting rod.

By double differentiation of the expression of potential energy of the mechanism on the generalized coordinate we obtain:

$\frac{d\Pi_{\text{м}}}{d\alpha} = Mg \cdot l_{\text{крш}} sin\alpha + c \cdot a$ (2)

$\frac{d^2\Pi_{\text{м}}}{d^2\alpha} = Mg \cdot l_{\text{крш}} cos\alpha + c$ (3)

At conditions $c > Mg \cdot l_{\text{крш}} cos\alpha$ the position of stable equilibrium is characterised by the root of the equation.

$Mg \cdot l_{\text{крш}} sin\alpha + c \cdot \alpha_0 = 0$ (4)

In determining the kinematic energy of the needle mechanism $T_{\text{и}}$ and considering only the energy of the concentrated mass M:

$\text{T}_{\text{и}} = \frac{1}{2}\,\text{Ml}_{\text{крш}} \cdot \alpha^2$ (5)

Let us first investigate the free oscillations of the needle mechanism near the static equilibrium position, taking its generalised deflection coordinate

$q_{\text{c}} = \alpha_0 - \alpha$ (6)

Then the expression for the potential energy of the mechanism (1) takes the form

$\Pi_{\text{м}} = \Pi_0 + \; Mg \cdot l_{\text{крш}} \cos(\alpha_0 - q_c) + \frac{1}{2} c(\alpha_0 - q_c)^2$ (7)

From the Macleron series expansion around the value $q_c = 0$, we obtain an approximate expression for the potential energy of the mechanism.

$\Pi_{\text{м}} = \Pi(0) + \Pi'(0)q_{\text{c}} + \frac{1}{2}\Pi''(0)q_c^2$ (8)

Where the dashes denote the differentiation by qc in the further we assume $\Pi(0) = 0$, which corresponds to the change in the origin of the potential energy of the mechanism. The value Π' (0) is also zero by condition (4). Hence,

$\Pi = \frac{1}{2}(\text{-}Mg \cdot l_{\text{крш}} cos\alpha_0 + c)q_c^2$ (9)

i.e. quasi-elastic (generalised) stiffness coefficient $C_n$has the form:

$C_n = \text{-}Mg \cdot l_{\text{крш}} cos\alpha_0 + \text{c}$ (10)

The equation of motion of the needle mechanism during free oscillation is as follows:

$\frac{d}{dt} \cdot \frac{\partial T}{\partial \dot{q}_c} = -\frac{d\Pi}{d\ddot{q}_c}$ or $Mg \cdot l_{\text{крш}} \ddot{q}_c = -C_n \cdot q_c$ (11)

Consequently, the natural frequency of the needle mechanism

$K = \sqrt{\frac{Mg \cdot l_{\text{крш}} cos\alpha_0 + \text{c}}{M \cdot {l_{\text{крш}}}^2}}$ (12)

Depends on the position of static equilibrium. When investigating forced oscillations, let us represent the generalised coordinate as a sum:

$q = q_c + q_{\text{д}}$ (13)

Where: $q_{\text{д}}$ is the additional displacement caused by the periodically varying force $\text{P}_{\text{п.с.}}$ Substituting the value of q_c from relation (6), we obtain:

$q = \alpha_0 - \alpha + q_{\text{д}}$ (14)

For small fluctuations, the variable $\alpha_0 + q_{\text{д}}$ can be replaced by its mean value

$a_{д} = \frac{1}{T}\int_0^{-T}(\alpha_0 + q_{д})dt$ (15)

Where: T is the period of oscillation.

Then $q = \alpha_{д} - \alpha$, and the forced oscillations can be considered as oscillations relative to the position of dynamic equilibrium defined by the angle $\alpha_{д}$. The equation of motion of the needle mechanism in this case is as follows:

$\frac{d}{dt} \cdot \frac{\partial T}{\partial q} = \frac{d\Pi}{dq} + M_{пр}$ (16)

Where: $M_{пр}$-the torque applied to link 1 from the $P_{п.с}$ force.

If the lengths of crank and connecting rod are equal, the displacement of the driver needles is related to the rotation angle α by the relation

$H = 2l_{крш} - 2R_{крш} \cdot cos\alpha$ (17)

where: H -is the needle stroke, mm. Hence the transmission ratio

$$\frac{dH}{d\alpha} = 2l_{крш} sin\alpha$$

The reduced torque $M_{пр}$ is given by the condition

$\widetilde{M}_{пр} = \widetilde{P}_{пс} \cdot \frac{dH}{d\alpha}$ или $\widetilde{M}_{пр} = \widetilde{P}_{пс} \cdot 2l_{крш}\sin(\alpha_{д} - q)$ (18)

The power series expansion in the vicinity of q= 0 gives an approximate value of the applied momentum

$\widetilde{M}_{пр} = \widetilde{P}_{пс} \cdot 2l_{крш}(-\sin\alpha_{д} + q cos\alpha_{д})$ (19)

the approximate value of the potential energy of the mechanism is now found from a series expansion in the vicinity of q= 0 or that too $\alpha = \alpha_{д}$:

$\Pi = \left(-Mg \cdot l_{крш} sinд + c\alpha_{д}\right) + \frac{1}{2}(-Mg \cdot l_{крш} cos\alpha_{д} + c)q^2$ from here

$\frac{d\Pi}{dq} = -Mg \cdot l_{крш} sin\alpha д + c\alpha_{д} + (-Mg \cdot l_{крш} cos\alpha_{д} + c)q$ (20)

Substituting expressions for T, $M_к$ and $\frac{d\Pi}{dq}$ into equation (16) we obtain the equation of small oscillations of the needle mechanism under the action of a forcing force of useful resistance $P_{П.С.}$

$Mg \cdot l_{крш}{}^2 \ddot{q} + \left(c - Mg \cdot l_{крш} cos\alpha_{д} - 2l_{крш}\widetilde{P}_{пс} cos\alpha_{д}\right)q = Mg \cdot l_{крш}\sin\alpha_{д} - c\alpha_{д} - 2l_{крш}\widetilde{P}_{пс} sin\alpha_{д}$
(21)

the resulting linear equation with a periodic coefficient is reduced to an inhomogeneous Hill equation.

If the $P_{П.С.}$force varies according to a harmonic law: $\widetilde{P}_{пс} = P_0 cos\, pt$ then equation (21) is reduced to the inhomogeneous Mathieu equation

$$\ddot{q} + (a - 2d cospt)q = f(t) \qquad (22)$$

where:a,d are constants

Then $a = \frac{c}{M \cdot l_{крш}} - \frac{g cos\alpha_{д}}{l_{крш}}$; $d = \frac{P_0 cos\alpha_{д}}{M \cdot l_{крш}}$

$$f(t) = \frac{Mg \cdot l_{крш}\sin\alpha_{д} - c\alpha_{д} - 2l_{крш}P_0 \cdot \sin\alpha_{д} \cdot cospt}{M \cdot l_{крш}{}^2} \qquad (23)$$

Using equation (1.23), one can investigate the stability of motion using the properties of the coefficients of the Mathye equation. In this study, it is sufficient to assume that the dynamic equilibrium positions, i.e. the value of angle $\alpha_{д}$ is within the working range. To determine the value $\alpha_{д}$ itself, which characterizes the dynamic error of the needle mechanism, an approximate method based on the proximity of values α_0 and $\alpha_{д}$ can be used. Equation (1.23) is also considered for the influence of reciprocating vibration of the rack under the harmonic law in the direction of motion of the driver's needles on the sewing machine needle mechanism.

References:

1. Ganchini Shukhratzoda, A.Djuraev, M.A.Mansurova, S.Dj.Mukhamedjanova, "Design development and mathematical model of vibrations of plates of the tension regulator of the tension needle sewing machine"/ International Journal of Advanced Research in Science, Engineering and Technology. Vol. 6, Issue 7, July 2019, p.10208-10210.
2. Bozorova Farida, Mukhamedjanova Sabrina "Simulation Of Forced Vibrations Of The Elements Of A Sewing Machine's Compound Foot" *Acta of Turin Polytechnic University in Tashkent*: Vol. 10 : Iss. 3 , Article 5.p.22-25.
3. A.Djuraev , K.Yuldashev , C.Dj.Muxamedjanova "Calculation of the power of the undulating surface of the screw conveyor for cleaning lint" *Acta of Turin Polytechnic University in Tashkent*: Vol. 10 : Iss. 4 , Article 3.p. 59-64
4. Djurayev A., M.A.Mansurova, G.Sh.Tursunova, M.X. Shirinova "Effect of the Stitch Length on the Breaking Load of Stitches of Sewing Products" International Journal of Advanced Research in Science, Engineering and Technology Vol. 6, Issue 9 , September 2019.
5. Juraev Anvar and Rajabov Ozod, "Analysis of the interaction of Fibrous Material with a Multifaceted Grid of the cleaner", International Journal of Recent Technology and Engineering, Vol. 8, No. 1, (2019), pp. 2661-2666.
6. Djurayev A., Sh. Daliev, A. Zukhriddinov "Development of the resource-saving structure of the section of small purification of fiber material" International Journal of Advanced Research in Science, Engineering and Technology Vol. 6, Issue 2, February 2019 p.8080-8083.