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(54) A method of reducing vibrations and forces in shed and other mechanisms of weaving looms

(57) A method of reducing vibrations and forces in shed and other mechanisms of weaving looms comprising a cam mechanism, consisting in modifying the stroke function of the cams of the mechanism in such a manner that the mechanism moves at a non-constant angular velocity of the drive shaft of the cam mechanism in the same manner as has been proposed for a constant angular velocity of the drive shaft of the cam mechanism.

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Description

Technical field

[0001] The invention relates to a method of reducing vibrations and forces in shed and other mechanisms of weaving looms comprising a cam mechanism.

Background art

[0002] In shed and other mechanisms of weaving looms, in particular of wide looms, currently arise vibrations which increase both the load the mechanism is exposed to and the play values existing in it, reduce its service life, and increase noise. A substantial cause of such vibrations is the non-uniform rotation of the main shaft of the weaving loom to which the shed or another mechanism of the weaving loom is connected. As a rule, the stroke interdependence conditions are suggested by modern methods with the aim to ensure as good dynamical behavior of the mechanism as possible. However, there has not been taken into consideration the fact that the angular velocity of the drive shaft of the mechanism is not constant.

[0003] The chief cause of the lack of uniformity of the main shaft rotation of weaving looms is the batten mechanism, and in needle machines the pick mechanism as well. The reduced inertia moments of these mechanisms as a function of the angular position of the main shaft are not constant. In peak values, the batten mechanism usually has the highest reduced inertia moment of all the machine mechanisms. Due to this, a part of the kinetic energy flows from the main shaft to the batten mechanism and back during one cycle of the loom. As a rule, the energy of the main shaft reaches its maximum at the beat-up and at the rear dead center, while it, and consequently its speed of rotation, are at their minimum in the interval of the maximum speed of the batten. These differences in the angular velocity of the main shaft are considerable in particular in wide looms with the dwell batten mechanism. Since the chief cause of the non-uniform main shaft rotation consists in the energy flow from the main shaft to the machine mechanisms and back and the flowing energy is proportional to the square power of the speed which has both a positive and a negative sign, the resulting effect is similar to the two-way rectification of an alternating signal and there are generated harmonic components of speed and acceleration with double frequency. These harmonic components of acceleration often have relevant amplitudes near the resonance frequency of the shed mechanism and thus generate shed mechanism oscillations with considerable amplitudes.

Principle of the invention

[0004] The principle of the invention consists in such a modification of the stroke interdependence of the shed mechanism or of another mechanism of the weaving loom resulting from the shape of the drive cam or double cam of the mechanism which eliminates the non-uniformity of the rotation of the drive shaft of the mechanism and thus makes the mechanism move in the manner proposed for the constant rotation speed of the drive shaft of the mechanism.

[0005] The advantage of the invention consists in substantial reduction of vibrations and forces of the shed mechanism or of another mechanism of the weaving loom, thus improving the function of the mechanism, increasing its service life, and reducing the noise level. However, in the application of the invention, the following limitations should be taken into consideration: a) the elimination of the influence of the non-uniform rotation is operative only in a given though relatively broad range of the operation speed, b) the angular position of the drive cam or double cam of the shed mechanism or of another mechanism of the weaving loom must be correctly set in relation to the main shaft of the machine.

Some basic examples of the embodiment of the machine

[0006] The calculation of the stroke interdependence of the shed mechanism or another mechanism of the weaving loom can be carried out with taking into account the influence factors of various relevance acting on the weaving loom and with the use of the calculation apparatus of various complexity available in the mechanism dynamics. The following examples are limited to simple solution methods only which do not take into consideration some influence factors but still achieve substantial advantages aimed at by the invention.

Example A:

[0007] The proposal for the modified stroke interdependence of the shed mechanism is based on the following assumptions:

- at the operation speed, with the weaving loom operating in a stabilized regime with an average main shaft angular speed ω_s there is measured the course of the angle of rotation of the main shaft φ in one cycle as a function of the time t

$$\varphi = \varphi(t) \qquad (1)$$

- the required stroke of the shed mechanism calculated for the main shaft angular velocity $\omega = \omega_s = const.$ is put in as the function

$$y = y(\bar{\varphi}), \qquad (2)$$

where the angle

$$\bar{\varphi} = \omega_s t. \quad (3)$$

[0008] The search object is such a function of the shed mechanism $z = z(\varphi)$ in which applies

$$z(t) = y(\omega_s t). \quad (4)$$

[0009] Under these conditions, the mechanism, when using the stroke function z, moves at a non-constant main shaft angular velocity ω in the same manner as the original mechanism with the stroke function y at a constant main shaft angular velocity ω_S. In the equation (4), the function z is set generally as a function of time. Assuming that

- the use of the modified stroke function of the shed mechanism does not change the course of the main shaft angular velocity ω, the angle φ of the main shaft angular position is defined by the equation (1) and it is possible to calculate the inverse function

$$t = t(\varphi). \quad (5)$$

[0010] Then

$$z(\varphi) = y(\bar{\varphi}), \quad (6)$$

where

$$\bar{\varphi} = \omega_s t(\varphi). \quad (7)$$

[0011] In this manner, the function $z(\varphi)$ for the required stroke of the shed mechanism is defined.

<u>Example B</u>:

[0012] This example is similar to the example A and is based on the same assumptions except that instead of the main shaft angular position as a function of time (Equation (1)) here is measured the main shaft angular velocity ω as a function of its angular position

$$\omega = \omega(\varphi). \quad (8)$$

[0013] Then

$$\frac{dy}{dt} = \frac{dy}{d\bar{\varphi}}\frac{d\bar{\varphi}}{dt} = \frac{dy}{d\bar{\varphi}}\omega_s \quad (9)$$

and

$$\frac{dz}{dt} = \frac{dz}{d\varphi}\frac{d\varphi}{dt} = \frac{dz}{d\varphi}\omega\ . \quad (10)$$

[0014] From the required relation of

$$\frac{dz}{dt} = \frac{dy}{dt},$$

expressing the fact that the mechanism with the stroke function z moves at a non-constant main shaft angular velocity ω in the same manner as the original mechanism with the stroke function y at a constant main shaft angular velocity ω_S, and from the equations (9) and (10) results the relation

$$\frac{dz}{d\varphi} = \frac{dy}{d\bar{\varphi}}\frac{\omega_s}{\omega}. \quad (11)$$

[0015] The equation (11) permits a very simple approximative calculation of the function z provided that the fluctuations in the main shaft angular velocity ω are not too great. Then can be set

$$\frac{dy}{d\bar{\varphi}} \cong \frac{dy}{d\varphi} \quad (12)$$

and the equation (11) gives the required function

$$z(\varphi) \cong \omega_s \int\frac{dy}{d\varphi}\frac{1}{\omega(\varphi)}d\varphi. \quad (13)$$

<u>Example C</u>:

[0016] The method of the invention can be used also for the calculation of the modified stroke function of the batten mechanism. The following example of embodiment gives a simple calculation of the modified stroke function. The stroke function of the batten mechanism $\bar{\psi}(\bar{\varphi})$ where $\bar{\psi}$ is the angular position of the batten is in analogy to the example A set for a constant main shaft angular velocity ω_S where the main shaft angular position $\bar{\varphi}$ is defined by the equation (3).Searched for is such a stroke function of the batten mechanism $\psi(\varphi)$ for a non-constant main shaft angular velocity ω in which applies

$$\psi(t) = \bar{\psi}(\omega_s t). \quad (14)$$

[0017] Under these conditions, the batten mechanism, when using the stroke function ψ, moves at a non-constant main shaft angular velocity ω in the same manner as the original mechanism with the stroke function $\bar{\psi}$ at a constant main shaft angular velocity ω_S. The calculation is based on the following assumptions:

- No account is taken of the variability of the reduced inertia moments of all weaving loom mechanisms except the batten mechanism.
- The drive electric motor supplies only the torque for

covering the passive resistance factors and losses and has no regulation effect.

- The passive resistance factors and losses are no function of the main shaft angular velocity.

[0018] Under these conditions, the main shaft angular velocity variations are due only to the batten mechanism. The equation describing the energy conservation can then be formulated as

$$\frac{1}{2}I_h\omega^2 + \frac{1}{2}I_b\dot{\psi}^2 = \frac{1}{2}I_s\omega_s^2 = konst., \qquad (15)$$

where I_h stands for the aggregate reduced inertia moment of the main shaft involving the drive system with the electric motor and average reduced moments of all the mechanisms except the batten one, ω is the main shaft angular velocity, not known beforehand, I_b is the inertia moment of the batten, $\dot{\psi}$ is the angular velocity of the batten (the point designating the derivative on time) I_s is the constant average reduced inertia moment of the whole weaving loom at the average main shaft angular velocity ω_s (the expression on the right side of Equation (15) denoting the aggregate kinetic energy of the weaving loom which is under the mentioned assumptions constant).

[0019] The funkction $\dot{\psi}$ is by Equation (14) equal to

$$\dot{\psi} = \frac{d\bar{\psi}}{dt} = \frac{d\bar{\psi}}{d\bar{\varphi}}\omega_s. \qquad (16)$$

[0020] By putting it into Equation (15), the main shaft angular velocity

$$\omega = \omega_s\sqrt{\frac{I_s}{I_h} - \frac{I_b}{I_h}\left(\frac{d\bar{\psi}}{d\bar{\varphi}}\right)^2}, \qquad (17)$$

can be calculated which permits, after setting $\bar{\varphi} = \omega_s t$, to calculate by integration the function $\varphi(t) = \int\omega\, dt$. The further procedure is the same as in Example A but for the fact that the modified function $\psi(\varphi)$ is searched for the given function $\bar{\psi}(\bar{\varphi})$.

Industrial application

[0021] The method of reducing vibrations and forces in shed mechanisms and other mechanisms of weaving looms can be used on all cam-driven types of weaving looms. Its application is particularly important in wide looms with dwell batten mechanisms where the natural frequency of the shed mechanism oscillations is relatively low whereas the exciting frequency due to the non-uniform main shaft rotation is relatively high and near the resonance frequency of the shed mechanism.

[0022] However, the method according to the invention cn be used in other machine types as well where cam mechanisms are used and the main shaft angular velocity fluctuations take place. As an example can be named the gear mechanism of internal combustion motors.

Claims

1. A method of reducing vibrations and forces in shed and other mechanisms of weaving looms comprising a cam mechanism, characterized by modifying the stroke function of the cams of the mechanism in such a manner that the mechanism moves at a non-constant angular velocity of the drive shaft of the cam mechanism in the same manner as has been proposed for a constant angular velocity of the drive shaft of the cam mechanism.