G. UALIYEV, A.A. JOMARTOV

(Institute of Mechanics & Mechanical Engineering, Almaty)

OPTIMIZATION OF TIMING DIAGRAM OF DEVICE FOR AUTOMATIC REMOVAL OF FAULTY WEFT OF LOOM STB

Annotation

In this paper, we consider optimization of timing diagram of device for automatic removal of the faulty weft of projectile loom STB in order to improve the reliability and performance. Timing diagram for this device is presented in vector form. Equations of mathematic model of timing diagram of device for automatic removal of the faulty weft are composed. Optimization of timing diagram of device is made, the time of removal defect thread is founded, optimal timing diagram of device for automatic removal of the faulty weft of loom STB is got.

Ключевые слова: ткацкий станок, циклограмма устройства, вектор, автоматическая ликвидация.

Кілт сөздер: тоқыма станогы, құрылғының циклограммасы, вектор, автоматты түрде жою.

Keywords: loom, patterns devices, vector, automatic elimination.

It is now widely used variety of device for automatic removal of faulty weft of looms [1-5]. Device for automatic removal of the faulty weft of loom can improve the efficiency of weaver. Device management is carried out in automatic mode, the signal due to the shutdown of loom weft breakage.

In the production of fabric on looms such as russian projectile loom STB (stanok tkatzki beschelnonyi), projectile with the weft thread flies from the left (fighting) the box to the right (receiving). The thread which is carried away of projectile, can be missed of projectile or is extended by the compensator from weft end gripper.

Necessary to determine where is broken weft. We define a zone break weft loom STB, (See fig 1.): 1-zone is the area between bobbin and left weft end gripper; 2-zone is the area more to the right of left weft end gripper; 3-zone is the area of braking of projectile.

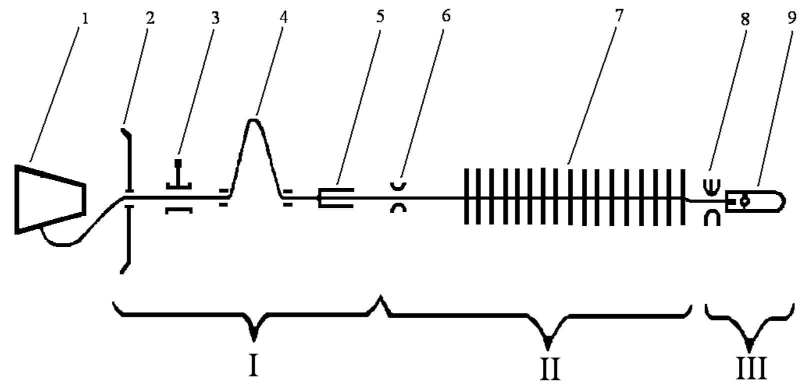

Fig.1 – The zones of break weft loom STB

Figure 1 shows: 1 - reel, 2 – eye for thread, 3 - weft brake, 4 - eye of the compensator, 5- mechanism of return weft, 7 - sley mechanism, 8 - right weft end gripper, 9 - projectile .

The analysis of the statistical data on breakage weft (fig. 2), shows that breakages in the first and second zones are approximately equal probability.

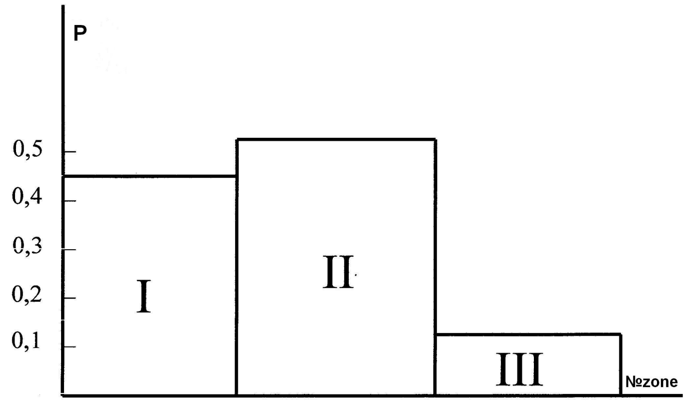

Fig. 2 – The statistical data on breakage weft on looms STB, $p = {h_i}/{n}$,

where p - arithmetic average of the weft yarn breakages,

n - the number of weft yarn breakages, h_i - the number of breakages weft in i -th zone

Figure 3 shows the scheme of loom STB with device for automatic removal of faulty weft, where: 1 (1 ') – bobbin of thread, 2 (2') - electronic weft brake, 3(3') - compensator of the electromagnetic latch, 4 (4 ') - compensator, 5 - electronic weft controller, 6 - nozzle for supplying yarns, 7 – the left operator for removal of faulty weft, 8 - centering plate, 9 - projectile, 10 – the right operator for removal of faulty weft, 11 - gauge of projectiles arrival, 12 - the control unit.

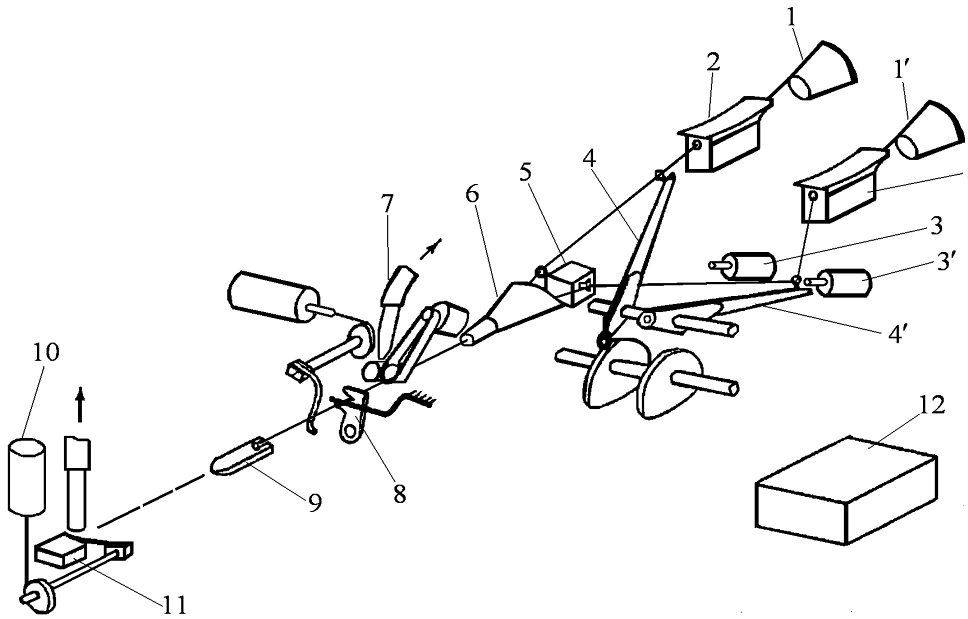

Fig. 3 – The scheme of loom STB with device for automatic removal of faulty weft

The algorithm of device for automatic removal of faulty weft depends on breakage zone of wefts (Fig. 2). The algorithm of device for automatic removal of faulty weft is shown in Figure 4.

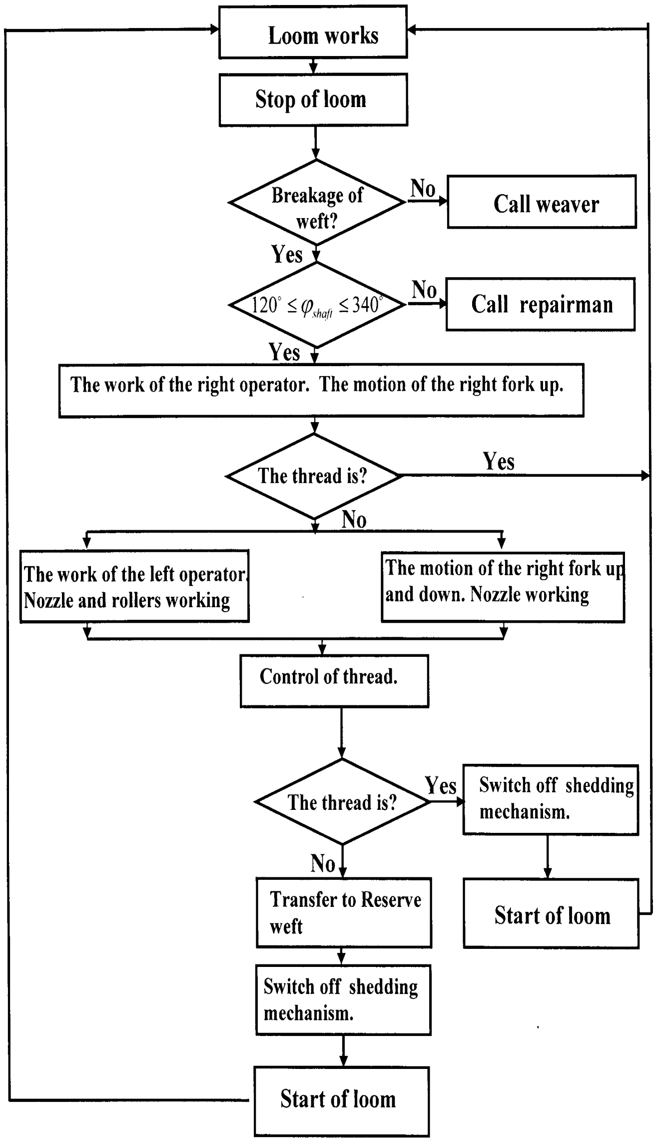

Fig. 4 – Algorithm of device for automatic removal of faulty weft of loom STB

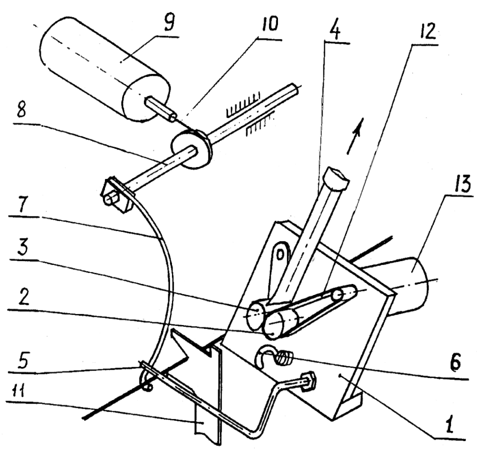

Fig. 5 – The left operator of removal faulty weft

Figure 5 shows a scheme of the left of operator of removal faulty weft, where: 1 - bracket, 2 and 3 - rollers, 4 - left ejector, 5 - limiting angle of weft yarn, 6 - guide, 7 - the left fork, 8 - roller, 9 - pneumatic cylinder, 10 - rod, 11 - centering plate, 12 – tape, 13 - engine.

The left of operator of removal faulty weft works as follows: when the machine is stopped because of the weft yarn breakage voltage is applied to the motor 13 is rotated by exhaust tape 12 rollers 2 and 3, and the air cylinder air is supplied. Through traction rod 10 turns roller 8 attached to it feed left fork 7. Feeder left fork 7 moves from the starting position, suitable for the weft yarn and carries it to form a loop, the extreme points of which are centering plate 11 and limiting angle weft 5. The plane, which moves the feed left fork 7 crosses exhaust rollers 2 and 3. Weft yarn pickup rollers and suction is applied to the nozzle 4.

We determined the design parameters of the left operator of removal faulty weft of loom STB. Developed working model sample of the operator.

Consider timing diagram of device for automatic removal of faulty weft. We form the vector timing diagram of device removal weft and related mechanisms and components of loom STB [6]. We enumerate mechanisms and components involved in the removal of weft: 1 - the left fork, 2 – right ejector, 3 - the right fork, 4 - rollers, 5 - left ejector, 6 - thread movement, 7 - movement of a thread from bobbin, 8 - the controller of movement of a thread, 9 - the lever of switching-off shedding mechanism, 10 - a cross-section shaft of shedding mechanism, 11 - the mechanism of start-up of loom.

Conditions of joint work of mechanisms and components:

1. The inclusion of the right ejector, left ejector and rollers must be after checking for false stops the machine, due to breakage weft.

2. The process of movement from the weft bobbin should be carried out in raising the left fork.

3. Capture of thread rolls should be carried out during the transition left fork up.

4. The thread starting up should be done after the lowering of the left fork.

5. Monitoring the availability of the threads should be carried out after the start of its movement from the bobbin.

6. The shedding mechanism into operation after pulling the threads.

7. Turning loom is at the end work of shedding mechanism.

According to the conditions of the vector timing diagram of device for automatic removal of faulty weft of loom STB is composed [6], as shown in Fig. 6.

Let's make system of vector equations describing work of the device (fig. 6.):

$$\sum_{j=1}^{m_i} \vec{l}_{ij} = \vec{P}, \qquad i = \overline{1,11}, \tag{1}$$

Values of m_i are resulted in table 1.

Table 1 – Values of m_i

i	1	2	3	4	5	6	7	8	9	10	11
m_i	7	5	5	5	4	4	5	5	4	4	3

We form the vector equation for the vectors of connection (fig. 6.)

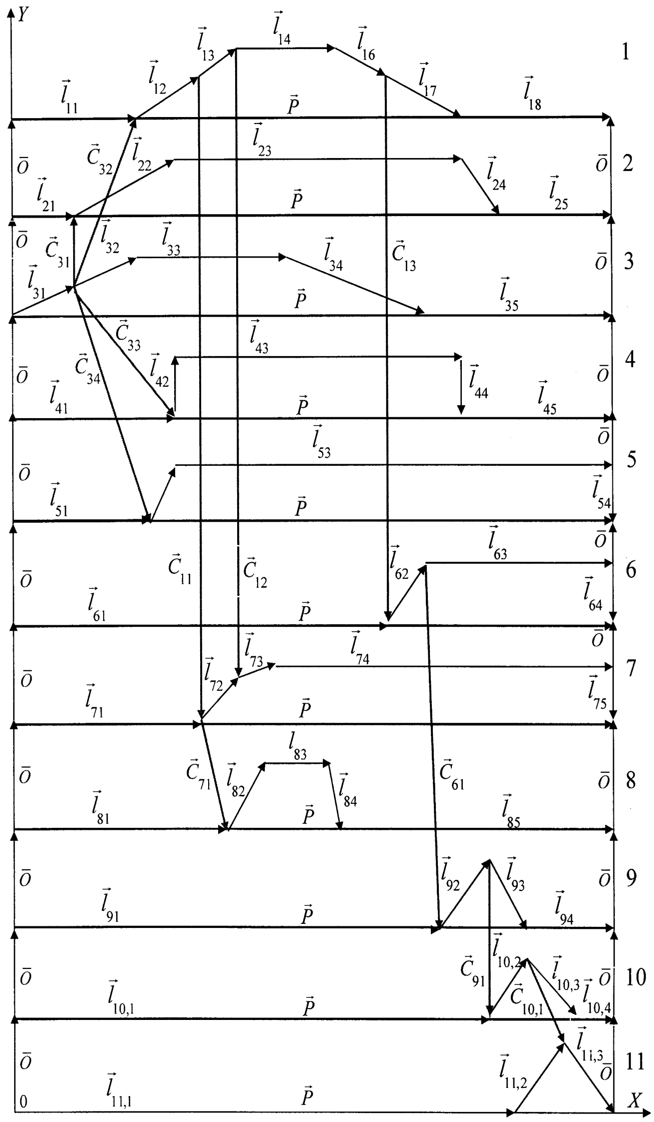

Fig. 6 – The vector timing diagram of device for automatic removal of faulty weft of loom STB

$$\left.\begin{aligned}
\vec{C}_{31} &= \vec{l}_{21} - \vec{l}_{31} + \vec{0},\\
\vec{C}_{32} &= \vec{l}_{11} - \vec{l}_{31} + \vec{0},\\
\vec{C}_{33} &= \vec{l}_{41} - \vec{l}_{31} + \vec{0},\\
\vec{C}_{34} &= \vec{l}_{51} - \vec{l}_{31} + \vec{0},\\
\vec{C}_{11} &= \vec{l}_{71} - \vec{l}_{11} - \vec{l}_{12} + \vec{0},\\
\vec{C}_{12} &= \vec{l}_{71} + \vec{l}_{72} - \vec{l}_{11} - \vec{l}_{12} - \vec{l}_{13} + \vec{0},\\
\vec{C}_{13} &= \vec{l}_{61} - \vec{l}_{12} - \vec{l}_{13} - \vec{l}_{14} - \vec{l}_{15} + \vec{0},\\
\vec{C}_{71} &= \vec{l}_{81} - \vec{l}_{71} + \vec{0},\\
\vec{C}_{61} &= \vec{l}_{91} - \vec{l}_{61} - \vec{l}_{62} + \vec{0},\\
\vec{C}_{91} &= \vec{l}_{10,1} - \vec{l}_{91} - \vec{l}_{92} + \vec{0},\\
\vec{C}_{10,1} &= \vec{l}_{11,1} + \vec{l}_{11,2} - \vec{l}_{10,1} - \vec{l}_{10,2} + \vec{0}.
\end{aligned}\right\} \tag{2}$$

We project the equation (1, 2) on X axis:

$$\sum_{j=1}^{m_i} t_{ij} = T, \tag{3}$$

where, i = 1,2, ..., 11; T - time operation of the device t_{ij} - the projection of vectors $\vec{l}_{ij}$ on the axis X is the actuation time of mechanisms [6].

$$\left.\begin{aligned}
C_{31}^{x} &= t_{21} - t_{31,}\\
C_{32}^{x} &= t_{11} - t_{31,}\\
C_{33}^{x} &= t_{41} - t_{31,}\\
C_{34}^{x} &= t_{51} - t_{31,}\\
C_{11}^{x} &= t_{71} - t_{11} - t_{12},\\
C_{12}^{x} &= t_{71} + t_{72} - t_{11} - t_{12} - t_{13},\\
C_{13}^{x} &= t_{61} - t_{11} - t_{12} - t_{13} - t_{14} - t_{15},\\
C_{71}^{x} &= t_{81} - t_{71},\\
C_{61}^{x} &= t_{91} - t_{61} - t_{62},\\
C_{91}^{x} &= t_{10,1} - t_{91} - t_{92},\\
C_{10,2}^{x} &= t_{11,1} + t_{11,2} - t_{10,1} - t_{10,2}.
\end{aligned}\right\} \tag{4}$$

Let's impose constraints on times of actuation of mechanisms

$$t_{ij} \geq t_{ij}^{\min} \tag{5}$$

Where $t_{ij}^{\min}$ - a minimally acceptable time of actuation mechanisms $i = 1,2,...,11;\ j = \overline{1, m_i}$.

Let's impose constraints on projections of vectors of connection:

$$\left.\begin{array}{l}
t_{21}-t_{31} \geq 0, \\
t_{11}-t_{31} \geq 0, \\
t_{41}-t_{31} \geq 0, \\
t_{51}-t_{31} \geq 0, \\
t_{71}-t_{11}-t_{12} \geq 0, \\
t_{71}+t_{72}-t_{11}-t_{12}-t_{13} \geq 0, \\
t_{61}-t_{11}-t_{12}-t_{13}-t_{14}-t_{15} \geq 0, \\
t_{81}-t_{71} \geq 0, \\
t_{91}-t_{61}-t_{62} \geq 0, \\
t_{10,1}-t_{91}-t_{92} \geq 0, \\
t_{11,1}+t_{11,2}-t_{10,1}-t_{10,2} \geq 0,
\end{array}\right\} \qquad (6)$$

Equations (3) with constraints (5, 6) describe timing diagram of works of device for automatic removal of faulty weft of loom STB.

Solve the following optimization problem by method of Hooke -Jeeves [7]:

$$T \to \min, \qquad (7)$$

with equations (3, 4) and constraints (5,6).

As a result of the solution of a problem (9), operating time of device for automatic removal of faulty weft of loom STB has made 18 seconds at norm 30 seconds for the weaver.

Conclusion

Device for automatic removal of faulty weft of loom STB is developed.

Vector timing diagram of device for automatic removal of faulty weft of loom STB is made and optimum parameters of timing diagram of devices are received.

REFERENCES

1 Improper weft removing device for air jet loom. US patent # 5,046,532. Sep.10, 1991.

2 Device for cleaning the weft insertion area of a weaving machine. US patent # 4,546,799. Oct.15, 1985

3 Clearing a weft yarn break in loom. US patent # 5,158,120. Oct.27, 1992.

4 Device for automatic removal of faulty weft. US patent # 5,060,699. Oct.29, 1991.

5 Weft yarn clearing device. US patent # 5,199,468. Apr.6, 1993.

6 Jomartov A.A., Ualiev G. Model of timing diagram of machine-automaton, Bulletin of MGTU of Bauman. "Mechanical engineering", Russia, 2010, №2, pp. 59-70.
7 Kelley C. T. Iterative methods for optimization, 180 p

ЛИТЕРАТУРА

1 Improper weft removing device for air jet loom. US patent # 5,046,532. Sep.10, 1991.
2 Device for cleaning the weft insertion area of a weaving machine. US patent # 4,546,799. Oct.15, 1985
3 Clearing a weft yarn break in loom. US patent # 5,158,120. Oct.27, 1992.
4 Device for automatic removal of faulty weft. US patent # 5,060,699. Oct.29, 1991.
5 Weft yarn clearing device. US patent # 5,199,468. Apr.6, 1993.
6 Jomartov A.A., Ualiev G. Model of timing diagram of machine-automaton, Bulletin of MGTU of Bauman. "Mechanical engineering", Russia, 2010, №2, pp. 59-70.
7 Kelley C. T. Iterative methods for optimization, 180 p

Резюме

Г. Уәлиев, А.А. Жомартов

(Механика және машинатану институты, Алматы қ.)

СТБ ТОҚЫМА МАШИНАСЫНДАҒЫ ЖІПТІҢ ҮЗІЛУІН АВТОМАТТЫ ТҮРДЕ ЖОЯТЫН ҚҰРЫЛҒЫНЫҢ ЦИКЛОГРАММАСЫН ОҢТАЙЛАНДЫРУ

Өнімділік пен сенімділікті арттыру мақсатында СТБ тоқыма станогының жіпті үзуін автоматты түрде жоюға арналған құрылғының циклограммасын оңтайландырылу қарастырылған. Бұл құрылғы үшін циклограмма вектор түрінде келтірілген. Жіптің үзілуін автоматты түрде жоятын циклограмманың математикалық үлгісі жасалды. Құрылғының циклограммасы оңтайландырылды, СТБ тоқыма станогының жіпті үзуін автоматты түрде жою үшін құрылғының тиімді циклограммасы алынды.

Кілт сөздер: тоқыма станогы, құрылғының циклограммасы, вектор, автоматты түрде жою.

Резюме

Г. Уалиев, А.А. Джомартов

(Институт механики и машиноведения, г. Алматы)

ОПТИМИЗАЦИЯ ЦИКЛОГРАММЫ УСТРОЙСТВА АВТОМАТИЧЕСКОЙ ЛИКВИДАЦИИ ОБРЫВА УТОЧНОЙ НИТИ НА ТКАЦКОМ СТАНКЕ СТБ

Рассматривается оптимизация циклограммы устройства для автоматической ликвидации обрыва уточной нити ткацкого станка СТБ в целях повышения надежности и производительности. Циклограмма для этого устройства представлена в векторном виде. Разработана математическая модель циклограммы автоматической ликвидации обрыва уточной нити. Проведена оптимизация циклограммы устройства, получена оптимальная циклограмма устройства для автоматической ликвидации обрыва уточной нити ткацкого станка СТБ.

Ключевые слова: ткацкий станок, циклограмма устройства, вектор, автоматическая ликвидация.

Поступила 02.01.2013 г.