TO‘QUV DASTGOHLARIDA TARKIBLI ROLIKLAR BILAN JIHOZLANGAN MUSHTUMCHALI BATAN MEXANIZMLARINING KINEMATIK TADQIQI

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Annotatsiya. Mazkur maqolada to‘quv dastgohi batan mexanizmini tarkibiy roliklar va rezinali qayishqoq vtulka bilan jihozlangan mushtumchali mexanizm asosida kinematik tahlil qilish masalasi yoritilgan. Tadqiqotda matoni shakllantirish jarayonida koromislo uchi, ya’ni berdo harakatining talab etiladigan qonuniyatini ta’minlash uchun rolik rezina elementining deformatsiyalanishi hisobga olinadi. Yopiq vektorlar uslubi va yuqori kinematik juftliklar qonuniyatlariga tayangan holda shatun va koromislo uzunliklari, burilish burchaklari hamda ularning o‘zgarish xususiyatlari aniqlanadi. Olingan natijalar rezinali vtulkaning maksimal siqilish va cho‘zilish deformatsiyasi koromislo burchak siljishining amplitudasi va shakliga sezilarli ta’sir ko‘rsatishini ko‘rsatadi. Grafik tahlil asosida elastik element deformatsiyasi ortishi urilish zonasida burchak siljishining chiziqli bo‘lmagan tarzda ko‘payishiga olib kelishi aniqlangan. Natijalar to‘quv dastgohida matoni shakllantirish sifatini oshirish uchun batan mexanizmi parametrlarini asosli tanlash imkonini beradi.

Kalit so‘zlar: to‘quv dastgohi, batan mexanizmi, mushtumchali mexanizm, tarkibiy rolik, rezinali vtulka, qayishqoq element, kinematik tahlil, koromislo, berdo, burchak siljishi.

Аннотация. В данной статье рассматривается кинематический анализ батанного механизма ткацкого станка, оснащенного кулачковым механизмом с составными роликами и резиновой упругой втулкой. В исследовании учитывается деформация резинового элемента ролика, обеспечивающая требуемый закон движения конца коромысла, то есть берда, в процессе формирования ткани. На основе метода замкнутых векторов и закономерностей высших кинематических пар определены длины шатуна и коромысла, угловые перемещения и особенности их изменения. Полученные результаты показывают, что максимальная деформация резиновой втулки при сжатии и растяжении существенно влияет на амплитуду и форму углового перемещения коромысла. Графический анализ подтверждает, что увеличение деформации упругого элемента приводит к нелинейному росту углового перемещения в зоне удара. Результаты исследования позволяют обоснованно выбирать

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параметры батанного механизма для повышения качества процесса формирования ткани на ткацком станке.
Ключевые слова: ткацкий станок, батанный механизм, кулачковый механизм, составной ролик, резиновая втулка, упругий элемент, кинематический анализ, коромысло, бердо, угловое перемещение.
Annotation. This article presents a kinematic analysis of the loom beat-up mechanism equipped with a cam mechanism, composite rollers, and a rubber elastic bushing. The study considers the deformation of the rubber element of the roller, which ensures the required motion law of the rocker end, namely the reed, during the fabric formation process. Based on the closed-vector method and the regularities of higher kinematic pairs, the lengths of the connecting rod and rocker, angular displacements, and their variation characteristics are determined. The obtained results show that the maximum compression and extension deformation of the rubber bushing has a significant effect on the amplitude and shape of the rocker angular displacement. Graphical analysis confirms that an increase in the deformation of the elastic element causes a nonlinear increase in angular displacement in the impact zone. The findings make it possible to justify the selection of beat-up mechanism parameters in order to improve the quality of fabric formation in a loom.
Keywords: loom, beat-up mechanism, cam mechanism, composite roller, rubber bushing, elastic element, kinematic analysis, rocker, reed, angular displacement.

KIRISH.

Batan mexanizmlarida to‘qimani shakllantirish jarayonlariga kormislo oxirining ba’zi balandlikli tebranishi talab etiladi. Mushtumchali batan mexanizmi harakatining bunday qonuniyatini ta’minlash uchun rolik tarkibiy qayishqoq vtulka bilan tayyorlangan. Bunda mushtumchali mexanizmning tarkibiy roligi rezinalarining deformasiyalanishi hisobiga koromsloning uchi (berdo) kerakli harakat qonuniyatini bajaradi.

ADABIYOTLAR TAHLILI. Bunday holda rolikning rezina vtulkalarini maksimal deformasiyasi (siqilish va cho‘zilish) ni hisobga olgan holda kormislo harakatining tavsiflarini aniqlash muhimdir. Ushbu mushtumchali mexanizmning kinematikasini ko‘rib chiqamiz. Buning uchun beshinchi avloddagi aylanuvchi kinematik juftlikka ega bo‘lgan mushtumchali mexanizmning yuqori kinematik juftliklarining qonuniyatlari uslubidan foydalanamiz [2]. Rolikni rezinali vtulkasining deformasiyasida mexanizmdagi beshinchi avloddagi kinematik juftliklardan birini almashtirish hisobga oldik). Mexanizmning hisobiy sxemasi 1-rasmda ko‘rsatilgan.

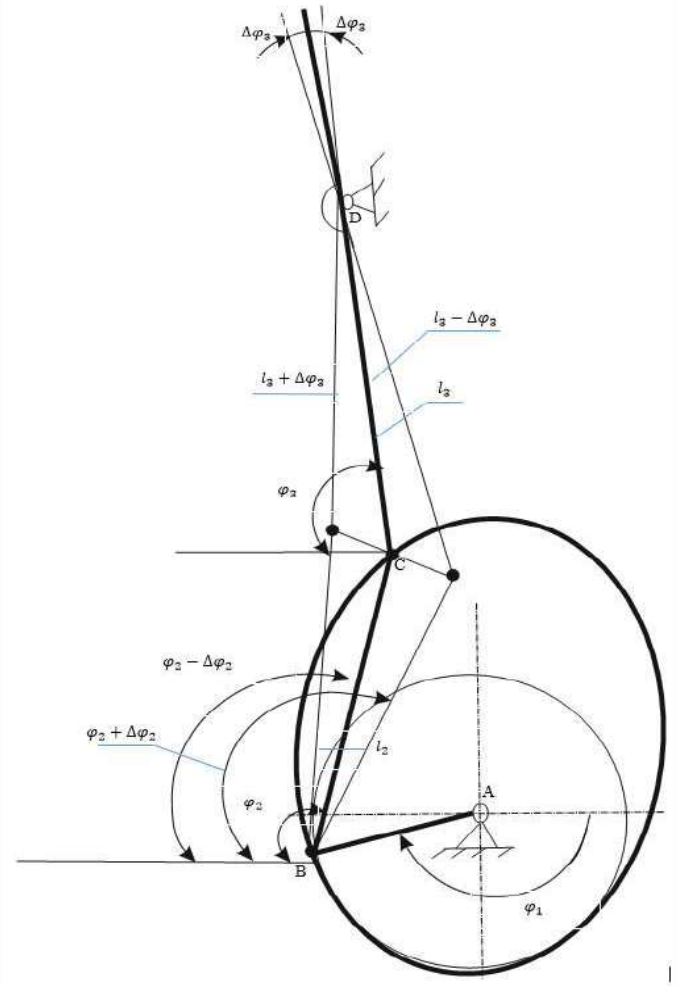
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TADQIQOT METODOLOGIYASI. 1-rasmda tavsiya etilayotgan mushtumchali mexanizm ko‘rsatilgan, ma’lum bo‘lgan yopiq vektorlar uslubini [3] qo‘llab, burchak siljishlar φ_2 va φ_3 larni aniqlash uchun ifodaga ega bo‘ldik.

Ko‘rilayotgan mexanizmda *ABD* va *BCD* konturlar uchun vektor tenglamasini tuzamiz:

ABD kontur uchun:

$$\bar{l}_4 + \bar{q} - \bar{e}_1 = 0 \qquad (1)$$



1-rasm. To‘quv dastgohi batanini mexanizmining mushtumchali mexanizmini almashtirish sxemasi

BC ABD kontur uchun:

$$\bar{q} + \bar{l}_2 + \Delta\bar{l}_2 - \bar{l}_3 - \Delta\bar{l}_3 = 0\,; \qquad \bar{q} + \bar{l}_2 - \bar{l}_3 = 0\,;$$

$$\bar{q} + \bar{l}_2 - \Delta\bar{l}_2 - \bar{l}_3 - \Delta\bar{l}_3 = 0 \qquad (2)$$

Bu holda (2) tenglama vektorlarini koordinataning x va u o‘qlariga proeksiyalab (3) ga ega bo‘lamiz:

$$l_4 + q\cos\varphi_q - l_1\cos\varphi_1 = 0$$

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$$q\sin\varphi_q+l_1\sin\varphi_1=0 \qquad (3)$$

Keltirilgan uslubga asosan (3) dan quyidagiga ega bo‘lamiz:

$$tg\varphi_q=\frac{l_1\sin\varphi_1}{l_4-l_1\cos\varphi_1};\qquad q=-l_1\frac{\sin\varphi_1}{\sin\varphi_q} \qquad (4)$$

Δl_2 va Δl_3 larning qiymatlarini BCD burchak uchun hisobga olgan holda kosinuslar teoremasini qo‘llab quyidagiga ega bo‘lamiz:

$$\begin{gathered} l_2^2=q^2+l_3^2-2ql_3\cos\varphi_{3q};\\ l_3^2=q^2+l_3^2-2ql_2\cos\varphi_{2q}; \end{gathered} \qquad (5)$$

$$(l_2+\Delta l_2)^2=q^2+(l_3+\Delta l_3)^2-2q(l_3+\Delta l_3)\cos(\varphi_{3q}+\Delta\varphi_3);$$

$$(l_3+\Delta l_3)^2=q^2+(l_2+\Delta l_2)^2-2q(l_2+\Delta l_2)\cos(\varphi_{2q}+\Delta\varphi_2);$$

$$(l_2-\Delta l_2)^2=q^2+(l_3-\Delta l_3)^2-2q(l_3-\Delta l_3)\cos(\varphi_{3q}-\Delta\varphi_3);$$

$$(l_3-\Delta l_3)^2=q^2+(l_2-\Delta l_2)^2-2q(l_2-\Delta l_2)\cos(\varphi_{2q}-\Delta\varphi_2);$$

Bunda:

$$\varphi_{3q}=\arccos\frac{q^2+l_3^2-l_2^2}{2ql_3};\qquad \varphi_{2q}=\arccos\frac{q^2+l_2^2-l_3^2}{2ql_2};$$

$$\varphi_{3q}+\Delta\varphi_3=\arccos\frac{q^2+(l_3+\Delta l_3)^2-(l_2+\Delta l_2)^2}{2q(l_3+\Delta l_3)};$$

$$\varphi_{2q}+\Delta\varphi_2=\arccos\frac{q^2+(l_2+\Delta l_2)^2-(l_3+\Delta l_3)^2}{2q(l_2+\Delta l_2)}; \qquad (6)$$

$$\varphi_{3q}-\Delta\varphi_3=\arccos\frac{q^2+(l_3-\Delta l_3)^2-(l_2-\Delta l_2)^2}{2q(l_3-\Delta l_3)};$$

$$\varphi_{2q}-\Delta\varphi_2=\arccos\frac{q^2+(l_2-\Delta l_2)^2-(l_3-\Delta l_3)^2}{2q(l_2-\Delta l_2)};$$

Burchak siljishlarning qonuniyatlarini quyidagi ko‘rinishda olamiz:

$$\varphi_3=\arccos\frac{l_1^2-l_2^2+l_3^2+l_4^2-2l_1l_4\cos\varphi_1}{2l_3\sqrt{l_1^2+l_4^2-2l_1l_4\cos\varphi_1}}+arctg\frac{l_1\sin\varphi_1}{l_4-l_1\cos\varphi_1}$$

$$\varphi_2=\arccos\frac{l_1^2+l_2^2-l_3^2+l_4^2-2l_1l_4\cos\varphi_1}{2l_2\sqrt{l_1^2+l_4^2-2l_1l_4\cos\varphi_1}}+arctg\frac{l_1\sin\varphi_1}{l_4-l_1\cos\varphi_1}$$

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Qayishqoq elementning deformasiyasini hisobga olgan holda to‘quv dastgohi batan mexanizmining povodok (shatun) va parrak (koromislo) larining uzunligi $\Delta\varphi_2$ va $\Delta\varphi_3$ larning qiymatlarini aniqlash davriy ko‘rinishda bo‘ladi deb hisoblanadi. Bunda birinchi tenglama (6) dan uchinchi tenglamani ayirib va ikkiga bo‘lib, hamda ikkinchi tenglamadan ayirib va ikkiga bo‘lib quyidagi ifodaga ega bo‘lamiz:

$$\Delta\varphi_3 = \frac{1}{2}\left[\begin{array}{l}\arccos\dfrac{l_1^2+l_4^2-2l_1l_4\cos\varphi_1+(l_3+\Delta l_3)^2-(l_2+\Delta l_2)^2}{2(l_3+\Delta l_3)\sqrt{l_1^2+l_4^2-2l_1l_4\cos\varphi_1}}- \\ -\arccos\dfrac{l_1^2+l_4^2-2l_1l_4\cos\varphi_1+(l_3-\Delta l_3)^2-(l_2-\Delta l_2)}{2(l_3+\Delta l_3)\sqrt{l_1^2+l_4^2-2l_1l_4\cos\varphi_1}}\end{array}\right] \quad (7)$$

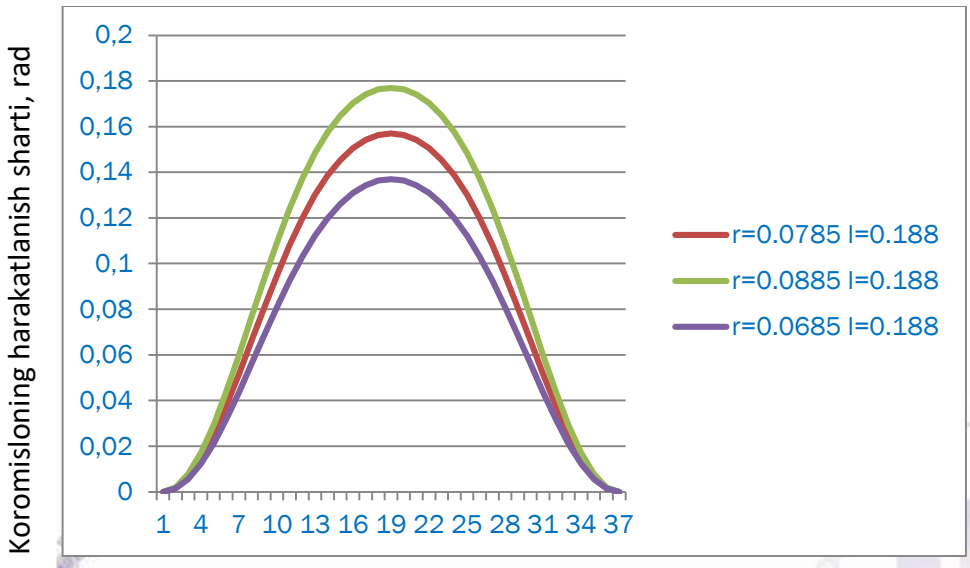
$$\Delta\varphi_2 = \frac{1}{2}\left[\begin{array}{l}\arccos\dfrac{l_1^2+l_4^2-2l_1l_4\cos\varphi_1+(l_2+\Delta l_2)^2-(l_3+\Delta l_3)^2}{2(l_3+\Delta l_3)\sqrt{l_1^2+l_4^2-2l_1l_4\cos\varphi_1}}- \\ -\arccos\dfrac{l_1^2+l_4^2-2l_1l_4\cos\varphi_1+(l_2-\Delta l_2)^2-(l_3-\Delta l_3)}{2(l_2-\Delta l_3)\sqrt{l_1^2+l_4^2-2l_1l_4\cos\varphi_1}}\end{array}\right]$$

3-rasmdagi sxemaga asosan quyidagicha ifodalash mumkin:

$$\varphi_{3\max}=\varphi_3+\Delta\varphi_3; \qquad \varphi_{3\min}=\varphi_3-\Delta\varphi_3;$$

$$\varphi_{2\max}=\varphi_2+\Delta\varphi_2; \qquad \varphi_{2\min}=\varphi_2-\Delta\varphi_2$$

3-rasmda qayishqoq element bilan ta’minlanmagan koromisloning, (batan mexanizmining mavjud varianti uchun) harakat qonuniyati keltirilgan.



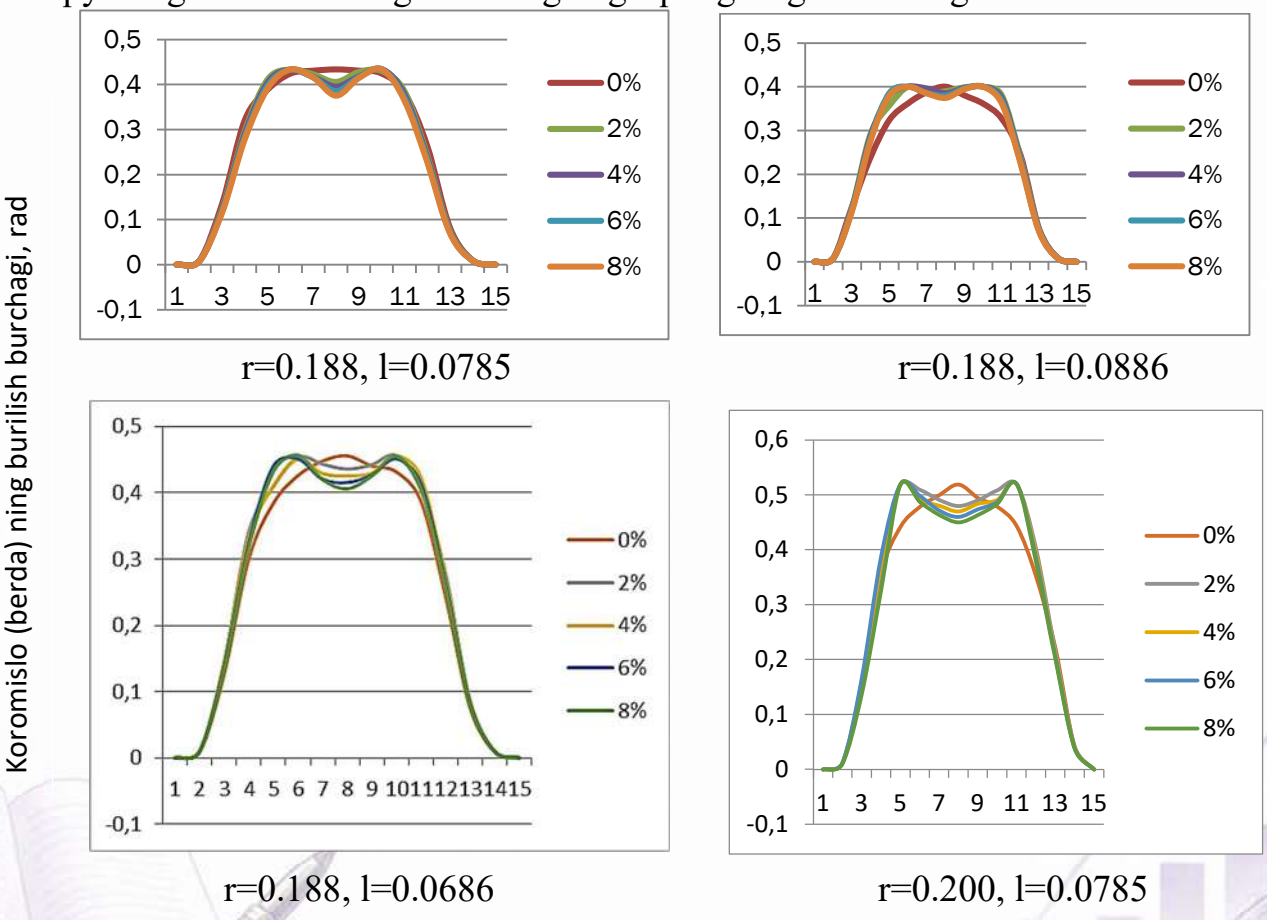
3-rasm. Batan mexanizmi kormislo (berda) ni mushtumchaning aylanish holatidan burchak siljishi

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4-rasmdagi grafikni tahlili *r* va *l* uzunliklar kormisloning tebranish amplitudasi va shakliga sezilarli darajada ta'sir qilishini qo'rsatdi. Kormisloning tebranish amplitudasiga, *r* ning qiymati ta'sir ko'rsatadi. Bunda krivoship mexanizmining radiusi (mushtumcha profilining minimal radiusi) 0,0685 m.da kormisloning burchak siljishi 0,34 rad.ga etadi, r=0,0885 м bo'lganida koromisloning burchak siljishi 0,44 rad.ga ortadi.

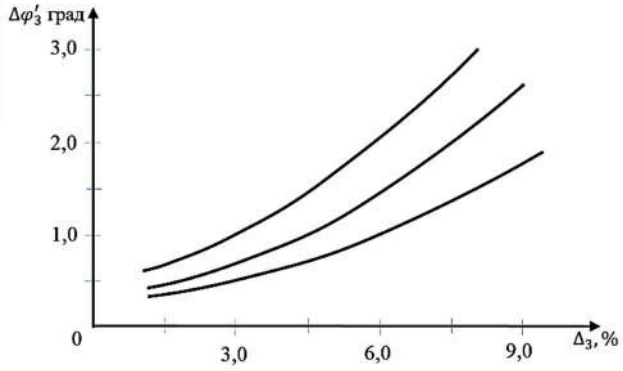
Kinematik juftliklardagi (tarkibiy rolikdagi) qayishqoq elementning shatun va koromislo (almashtirilayotgan mexanizmda) larning orasida deformasyalanishining maksimal qiymatini hisobga olganda koromisloning (berda) burchak siljish xarakteri o'zgaradi (3-rasmga qaralsin).

MUHOKAMA VA NATIJALAR. To'quv dastgohi batan mexanizmi roliginining rezinali vtulkasining maksimal deformasiyalanishidan berdoning burchak siljishi qonuniyatlarini ishlashini olingan natijalariga asosan quyidagilarga ega bo'lamiz. 4-rasmda urilish zonasida koromisloning burchak siljish miqyosi qiymatining mushtumchali mexanizm rezinali vtulkasining deformasiyalanish qiymatiga nisbatan o'zgarishining bog'iqlik grafigi ko'rsatilgan.



4-rasm. Qayishqoq elementning deformasiyalanishini hisobga olgan holda koromislo burchak siljishining qonuniyatlari

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5-rasm. Urilish zonasida koromisloning burchak siljish miqyosi qiymatining mushtumchali mexanizm rezinali vtulkasining deformasiyalanish qiymatiga nisbatan o‘zgarishining bog‘iqliqligining grafigi

XULOSA. Grafiklarni tahlili, rezinali vtulkaning deformasiyalanish qiymatini oshirish, koromisloning kichik holatida chiziqli bo‘lmagan qonuniyat asosida siljishning ortishiga olib kelishini ko‘rsatdi. Bunda $\Delta\varphi_3'$ ning qiymati $\Delta_3 = 9{,}0\%$ bo‘lganida 3,1° ga etadi.

$\Delta\varphi_3' \leq (1,0^0 \div 1,5^0)$ zonada koromisloning kerakli turg‘unlik va tebranishining tavsiya etiladigan qiymati $\Delta_3 = (5.5 \div 6{,}5)\%$ ga teng bo‘ladi.

Ushbu holatda to‘quv dastgohida to‘qimani shakllantirish jarayonining sifati ta’minlanadi.

FOYDALANILGAN ADABIYOTLAR RO‘YXATI

1. O‘zR Patenti, №IAP 7977 To‘qimachilik dastgohining batan mexanizmi / Xudayberdiyeva M.A., Djurayev A., Madraximov Sh.X. // B.I. -2025. Byul. №4 (289).

2. Xudayberdiyeva M.A., Djurayev A. Mushtumchali mexanizmlarning konstruktiv xususiyatlari va ularni tikomillashtirish bo‘yicha tadqiqotlar tahlili // Fan va texnologiyalar taraqqiyoti ilmiy-texnikaviy jurnal. – Buxoro, 2024. -№3.- B. 278-286. (05.00.00 №24).

3. Xudayberdiyeva M.A., Djurayev A. Qayishqoq elementli mushtumchali mexanizmlarning samarali sxemalarini ishlab chiqish // Fan va texnologiyalar taraqqiyoti ilmiy-texnikaviy jurnal. – Buxoro, 2024. -№4 -B. 261-266. (05.00.00№24).

4. Xudayberdiyeva M.A., Djurayev A., Urmanov N.T. Kinematic analysis of a cam mechanism with elastic elements of paired cams of a boel mechanism of a weaving loom // Scientific And Technical Journal Namangan Institute of Engineering And Technology Volume 7 Issue 3, Namangan, 2022. - P: 33-38. (05.00.00 №33).

5. Xudayberdiyeva M.A, Djurayev A. Improvement of the loom batan mechanism// “Paxta tozalash, to‘qimachilik va yengil sanoat sohalarining texnologiyasini takomillashtirish” mavzusidagi xalqaro ilmiy-amaliy

anjumani maqolalar to‘plami. Termiz, 2023. - B. 32-34.
6. Худайбердиева М.А Кулачковый батанный механизм с составными роликами и пружинным накопителем энергии // International conference on advance and technology.Volume 01 Issue 07,U.K London, 2024. - P. 25-28.

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