REDUCTION OF WARP BREAKS ON WEAVING LOOMS BY MODIFICATION OF THE MODE OF BEAT-UP

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Summary

A novel device is described which loosens the fabric in the moment of beating up the weft and thereby reducing warp tension. Its utilization lowers the number of warp breaks, i.e. the value basically controlling loom efficiency and the number of looms assignable to one weaver. Tension peaks in the warp decrease by 30–66% allowing to raise the number of looms per weaver — at a time utilization factor of 70% of the weaver — by 50–100% with a simultaneous rise by 5–7% in loom efficiency. Another advantage is that fabrics with high densities can be woven in cases when — owing to insufficient tensile strength of the warp yarn — it would be impossible without the device.

Continuity of weaving is repeatedly interrupted by yarn breaks, warp breaks being of highest importance, particularly so in the case of broad (multiple-width) fabrics, partly because the average standstill time is high (1–3 min) and also because the frequency of standstills caused by warp breaks is very high even at apparently low specific values. For example, if the number of warp threads per loom is 6000 and the number of warp breaks is 0.2 per 10^3 warp threads per 10^4 picks, a loom with 210 rpm will stop 1.2 times per hour owing to warp breaks. Due to well-known reasons the best specific warp break values in Hungary cannot be reduced below 0.3–0.5, that is, with the above warp setting the loom will stop 1.8–3 times per hour owing to warp breaks.

Warp breaks affect weaving cost, the time utilization factor of the weaver, efficiency of weaving and the number of looms that can be assigned to one weaver.

Effect of warp breaks on loom assignment and loom efficiency

The weaving costs for work-cloth fabrics were analyzed by Egbers [1]. His data indicate that in modern Western European weaving mills the cost of reparing one warp break — including energy and labour cost and production loss — amounts to DM 0.5885 (about Ft 9.42). Some domestic estimates also yield around Ft 10.— for the repair of one warp break in weaving mills [2].

Other weaving characteristics are also affected to a high extent by the number of warp breaks.

Mándoky, considering the system weaver-looms as a one-channel line-up system, established relationships between the time utilization factor T of the weaver and the assignable number of looms N, depending on the ratio Ψ between manual time T_k and machine time T_g for unit product and on the rpm value of the loom. In Fig. 1 the relationship of time utilization factor *vs.* ratio of

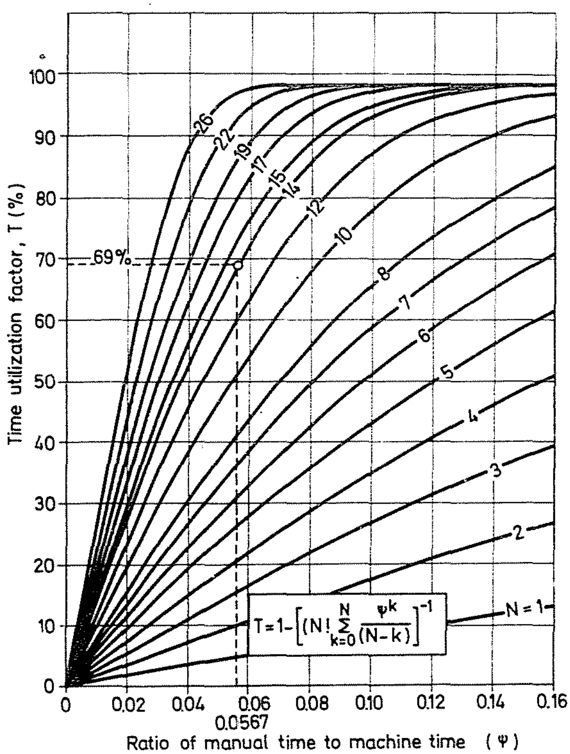

Fig. 1. Time utilization factor T% of weaver *versus* ratio of manual time to machine time Ψ for 1 to 26 looms per weaver

manual time to machine time is plotted for 1 to 26 looms assigned to the weaver; Fig. 2 presents the analogous curves of efficiency. The relationships are suited to estimate the effect of warp break frequency.

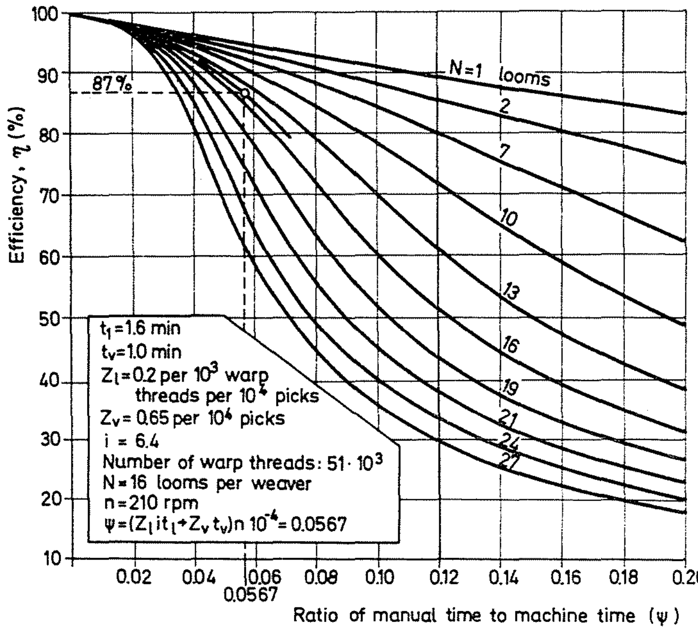

Fig. 2. Loom efficiency η *versus* ratio of manual time to machine time Ψ for 1 to 27 looms

Let us consider, e.g., the operational parameters of the loom assumed to be constant, the value Z_l of specific warp break equal to 0.2 per 10^3 warp threads per 10^4 picks, the specific weft break value Z_v equal to 0.65 per 10^4 picks, the number of warp threads $B=i\cdot 10^3=6400$, average standstill caused by warp break $t_l=1.6$ min, average standstill caused by weft break $t_v=1$ min. These values yield a value $\Psi\cong 0.1$. Then, for a time utilization factor of the weaver amounting to 69%, one will find from Fig. 1 that the number of looms to be assigned to the weaver is 14, and from Fig. 2, that at such conditions a loom efficiency of 87% is to be expected.

Figure 3 presents machine efficiency η and number of looms per weaver N *versus* frequency of warp breaks Z_l as calculated by means of the discussed relationships, assuming that the value of weft breaks is constant. The figure demonstrates that a higher number of looms can be assigned to the weaver only at specific warp break values below 0.4, and 16–20 looms per weaver can be reached only at specific warp breaks of 0.1–0.2. A rise of the value of specific warp breaks in this range by 0.1 will reduce the number of looms attended by one worker by 5–7 looms and machine efficiency by about 5%.

Figure 2 also demonstrates that machine efficiency, corresponding to ~70% time utilization factor of the weaver steeply falls at specific warp break

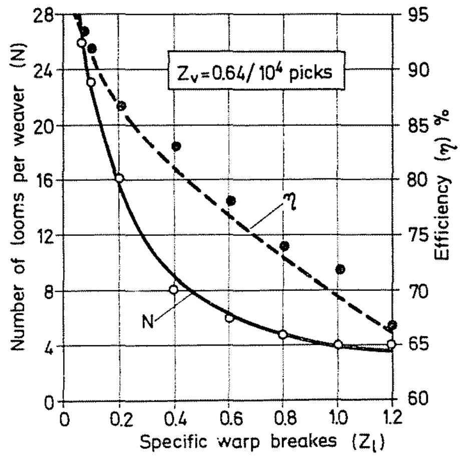

Fig. 3. Number of looms per weaver N and efficiency η *versus* specific warp breaks Z_l

values exceeding 0.2; in this range a rise of 0.1% in specific number of warp breaks reduces machine efficiency by about 2.5%.

The high importance of all technological or design innovations directly reducing warp breaks or warp tension which indirectly causes warp breaks is hence clearly demonstrated by the relationships discussed.

Warp stresses during the weaving operation depending on the mode of beat-up

Warp stresses during weaving can be judged by the tensile force generated in the warp threads. It is known that these stresses are established by the superposition of the forces generated in shedding and in beat-up (Fig. 4).

The tensile force acting on the warp thread in shedding depends on the type of shedding device and shed dimensions, that is, it is defined by design characteristics of the loom. The tensile force at beat-up, the beat-up peak F_B in Fig. 4, however, is of technological origin and depends on the conditions of beat-up.

With the development of weaving technology several new beat-up modes were introduced besides the mode adopted from hand weaving. Among them, the method in which the fabric is loosened at beat-up shall be analyzed in the followings.

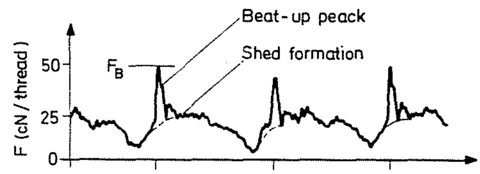

Fig. 4. Tensile force generated in the warp during beat-up

The force generated in the warp thread at beat-up originates above all in the friction resistance between warp and weft. The ideal model for conditions at traditional beat-up are shown in Fig. 5. From the vector polygon shown in the

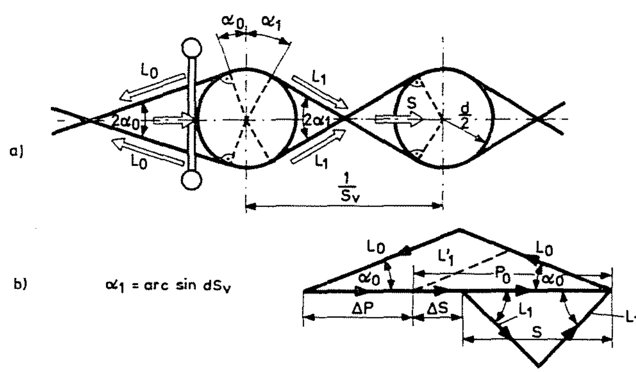

Fig. 5. Schematic representation of forces in the traditional mode of beat-up

figure, the tensile force L_0 arising in the warp threads when the weft slips forward between the warp threads can be calculated on the basis of rope friction. Using the symbols in Fig. 5

$$L_0 = L_1 \cdot \exp \mu(\alpha + \alpha_1) = \frac{S}{2 \cos \alpha_1} \exp \mu(\alpha + \alpha_1) \tag{1}$$

and

$$\frac{L_0}{S} = \frac{\exp \mu(\alpha + \alpha_1)}{2 \cos \alpha_1}, \tag{2}$$

that is, the weft beat-up into a fabric with the given density S_v (characterized by the warp crossing angle α_1 increasing proportionally to density) will occur at a defined ratio of warp force L_0 and the force S generated in the fabric.

With the traditional mode of beat-up this ratio of forces will be established by the selvedge displacement in beat-up: the initial tension L_0 of the warp is increased by ΔP, and the tension in the fabric will decrease — proportionally to the displacement of the selvedge — by ΔS. For this reason the traditional beat-up mode — particularly at high fabric densities — will result in high beat-up warp forces, causing warp breaks directly or indirectly.

Force conditions when fabric tension is reduced at beat-up are shown in Fig. 6. By this mode of beat-up the ratio L_0/S expressed in Eq. (2) will be

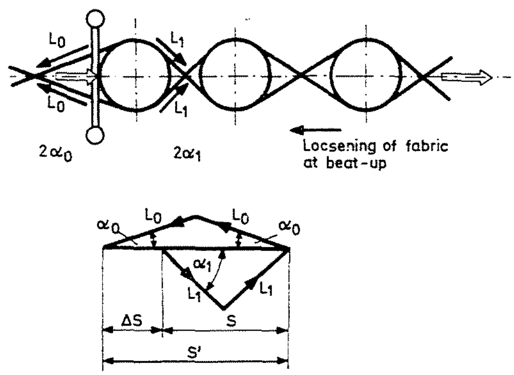

Fig. 6. Schematic representation of forces when the fabric is loosened in the moment of beat-up

established at ideal conditions, at $L_0 = \text{constant}$, since the initial fabric tension S' will decrease — by loosening the fabric during beat-up — by the value ΔS to the required value S. Thus, in the ideal case, beat-up is performed without a beat-up peak.

A novel device was developed and patented for SZTB looms to reduce fabric tension at beat-up.

Design and operation of the device reducing fabric tension at beat-up

The device JE-MHL-SZTB reduces fabric tension during beat-up by means of a fabric guide element which moves towards the reed during the beat-up. In this manner, the ratio of warp tension to fabric tension required to beat up the weft thread is established, and the tension peak of the warp at beat-up is significantly reduced.

The design of the device which can be mounted on any SZTB loom type is shown in Fig. 7. It operates in the following manner:

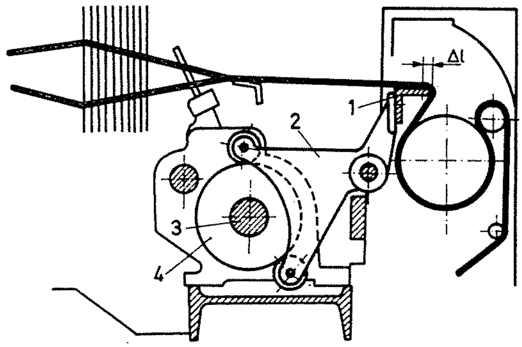

Fig. 7. The device JE-MHL-SZTB reducing warp tension in the moment of beat-up

The fabric guide element *1*, at beat-up, moves towards the reed by a distance of *Δl*. It is actuated by the swinging arm *2* controlled by the high-precision cam *4* which is wedged on the main shaft of the loom *3*.

For the looms SZTB-175 and SZTB-216 two units are needed, for SZTB-250 three and for SZTB-350 four units.

The advantages of the tension-reducing device are:

— decrease of the warp tension peak at beat-up,
— significant decrease in the number of warp breaks, and
— higher weft density being achieved.

In Fig. 8 oscillograms demonstrating warp tension peak decrease by means of the device are presented. The oscillograms were recorded for the

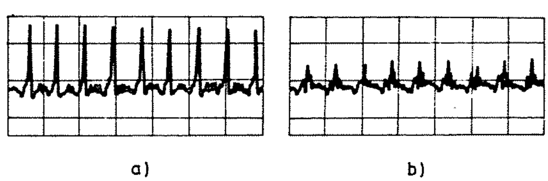

Fig. 8. Oscillograms presenting the tension peak at beat-up: a) with the traditional mode; b) utilizing the device JE-MHL-SZTB

following fabric: warp 20 × 2 tex cotton, weft 66 tex line, warp/weft density 210/136, plain weave. In this case the beat-up peak was reduced by 67% by using the device.

Peak decrease values for some experimental fabrics are presented in Table 1, indicating values between 31 and 66%.

Table 1

Decrease in warp tension peak at beat-up by the device JE-MHL on SZTB looms

Count, tex and material warp	Count, tex and material weft	Number of threads/10 cm warp	Number of threads/10 cm weft	Weave	Decrease in warp tension at beat-up, %
20 × 2 Cotton	50 cotton	232	170	plain	66
	100 line		126	plain	31 – 50
	50 cotton		450	satin 8/3	34
	100 line		250	satin 8/3	38
	66 line		228	twill 3/3	41
			250	twill 3/3	41
			270	twill 3/3	44
30 Cotton	30 cotton	390	135	plain	25
			154	plain	31
			224	twill 2/2	45
			345	satin 8/3	40
			370	satin 8/3	42

By virtue of reducing warp tension at beat-up, the device significantly lowers the number of warp breaks.

Table 2 summarizes the results obtained in a longer experimental period, indicating a decrease of 51 to 67% in the number of warp breaks, its extent, in average, being equal to the decrease in tension peak at beat-up.

Significant results are achieved by the lower number of warp breaks both in the number of looms assigned to one weaver and in machine efficiency. These data are also presented in Table 2; they were calculated by the relationships shown in Fig. 3, presuming identical conditions of loom operation and weft breaks. The data indicate an increase of 50–100% in number of looms per weaver and 5–7% in loom efficiency by reason of the lower number of warp breaks attained by the device.

The further advantage of the device lowering warp tension at beat-up consists of attaining — under similar load conditions — higher weft densities. E.g. on SZTB looms only weft density of 175/10 cm can be achieved in fabrics intended for blue jeans, which is unsatisfactory. By means of the device JE-MHL, weft density can be increased by 8.5% to 190/10 cm, that is, the SZTB looms can be made suitable to weave fabrics for blue jeans.

Table 2

Results achieved by the device JE-MHL in reducing warp breaks on SZTB looms

Fabric	Initial values			Values with the device HE-MHL		
	Specific warp breaks	Looms per weaver	Effi-ciency, %	Specific warp breaks (% of initial value)	Looms per weaver	Effi-ciency, %
Bristol cord	1.012*	4	72	0.52* (51.4%)	8	78
Linen fabric BGY 476	2.72*	2	53	1.7* (62.5%)	3	60
Woolen fabric	0.661**	5	75	0.39** (56.5%)	9	82
Woolen fabric Repi	3.24**	1	52	1.875** (67%)	2	58

* breaks per 10^3 warp per 10^4 weft threads
** breaks per 10^3 weft threads

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