The Manufacture of Fancy Laces by Machine

By FRITZ KEUNECKE, BARMEN, GER.

(*Concluded from February issue, p.* 1657)

VII. Influence of Bobbin Release Upon the Thread Tension

The additional thread tension required for the bobbin release action is dependent in a high degree upon the construction of the carrier, and especially upon the brake lever design. Therefore, it is difficult to find exact values. As found by tests with spring-scale for the carrier of the experimental machine the increase in tension required for thread release from the bobbin under normal conditions amounts to from 10 to 20 per cent. Experiences, however, prove that as a result of heavy duty the brake lever easily catches, and this additional friction effects a much higher increase in tension leading to thread breakage.

The tension increase necessary for bobbin brake release must occur at moments when the carrier is at its maximum distance from the braiding point, or shortly before moment $\pi/2$. As visible in Figure 27, on the tension weight carrier the thread tension already has gone down at this time to one-third of the maximum tension. A second short tension increase for the bobbin release, therefore, does not claim a considerable abuse of the thread.

If we consider the tension spring carrier, however, we find according to Figure 30 that the release of the bobbin by the brake lever coincides with the moment of highest thread tension. The increase in tension required for the bobbin release, therefore, means an additional strain, which is easily dangerous for the thread; as in actual service conditions, due to occasional rough usage, the actual tension goes above the theoretical maximum. For carriers with spring tension, therefore, considerable attention must be given in design to the problem of how the tension, due to bobbin release, may be diminished. The new carrier of E. Krenzler, eliminates the dangerous brake lever by leading the thread so that the thread itself hooks into the ratchet teeth of the bobbin.

VIII. Measuring Thread Tension on Machines Under Running Conditions

(a) Arrangement of Experiment.

The necessary experimental rigging is shown in Figure 34. For indication of the thread tension a recorder A was used as shown in Sketch. The recording instrument used was a Torsiograph System Geiger. Its registering lever was disconnected from the influence of the torsiograph. For the experiment the thread (c) of a carrier, instead of leading to the braiding point (D) was held also in radial direction to an outside point and attached to the registering lever (B) near its fulcrum point. The registering lever is under the influence of a tension spring adverse in direction to the thread tension. The recording instrument has been placed so that the thread knotted to the register arm is in the same distance from the upper carrier eyelet as the eyelet is from the braiding point (D) of the experimental machine.

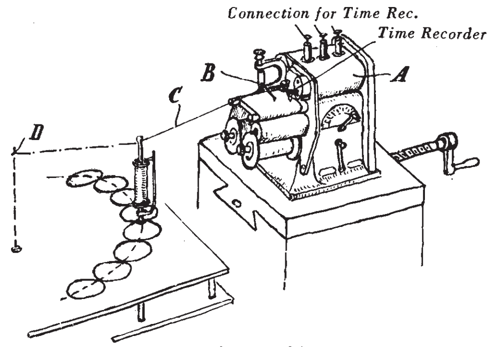

Figure 34

(b) Experiment with Tension Spring Carrier

At first the machine was turned slowly by hand. Due to the Jacquard mechanism the driving plate with the carrier made alternating one-half turn and an adequate stop. The carrier was equipped with an 8 lot tension spring.

Figure 35 shows the diagram received and the scheme of the carrier movement. The diagram shows prominently different yarn tension at the diverse stops though the carriers are about the same distance from the braiding point and the tension spring acts uniformly upon the thread. This difference, however, coincides with the theoretical curve of tension (Figure 33) and can be traced to the fact that while approaching the rest position in the one case the friction is increasing, in the other case decreasing, the yarn tension. This fact has been discussed already when we described Figure 33.

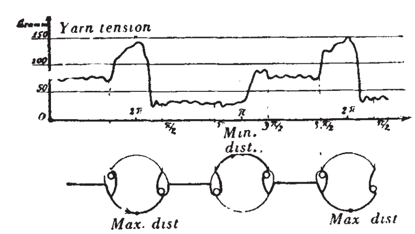

Figure 35

Furthermore, the diagram of Figure 35 proves that immediately after stopping in position 3 $\pi/2$ another drop in tension occurs, which, of course, in the present case is very slight. This decrease in tension is, as already mentioned under Figure 33, due to the shock of the carrier received by the sudden stopping. The difference in tension between thread and spring caused by friction is partly eliminated. In this case the machine was driven slowly by hand at about 60 revolutions per minute and consequently the tension decrease was negligible. The theoretical curve of Figure 33 shows sharp corners. The practical tests show these more or less rounded out. This is due chiefly to the elasticity of the thread, which modifies the sharp contrasts in tension. This yarn elasticity has not been considered in our previous deductions.

Undoubtedly the principal facts are congruent showing the parallel performance of the torsio graphically recorded tension according to the theoretical curve of Figure 33. The sudden tension decrease at the points (2π), where the carrier passes the farthest distant point from the braiding point and the tension effect reverses is remarkable. One difference between both curves may cause questioning. Figure 33 shows $3\ \pi/2$ in the diagram, the tension increase with a higher first step, while Figure 35, the actual recording shows the second step higher than the first. This difference may be due chiefly to the fact that the carrier in rest position is not completely in center caused by the design of the driving horngears, but a little before or after as is to be seen from sketch 35. If, for example, the carrier is moving away from the braiding point (from the nearest point to the machine center to the point farthest away from the machine center) the carrier stops at point $3\ \pi/2$ before it reaches the center line and the course actually covered is made during the first step of tension increase and is less than 90°. The second step of the tension increase from $3\ \pi/2$ to π is much longer, as the actual run of the carrier is wider. Accordingly the curves of the thread tension must show an adequate record.

Thread Tension of Spring Tension Carrier With Different Turning Speeds

Figure 36 shows the thread tension curve for different turning speeds as usual on one thread lace machines, which means a spring tension carrier under periodic stopping. During this experiment the Jacquard mechanism has been adjusted to effect alternating two short stops of ½ turning each and a longer stop of 3/2 turning rotations in succession. Between two stops one-half turn of the driving plate and of the carrier always occurred. Electric time recording registered the turning time of the horngears below each tension curve.

The curves show in general the same character as in Figure 35. The horizontal lines of the curve indicate the stops and appear just as in Figure 35, alternating above or below the medium or average tension value, which is equal to the ideal tension curve and in this particular case amounts to about 50 gramms. The deflection from the average tension becomes smaller with increasing speed, due to the vibration. At n = 280/ minutes; the actual tension at stopping after the first increase even drops down to the ideal theoretical value, while on the other hand at stops after the maximum tension had been reached the thread tension approaches the ideal tension curve from below. At n = 320/ minutes the tension

Thread tension with 10 lot spring (167g)

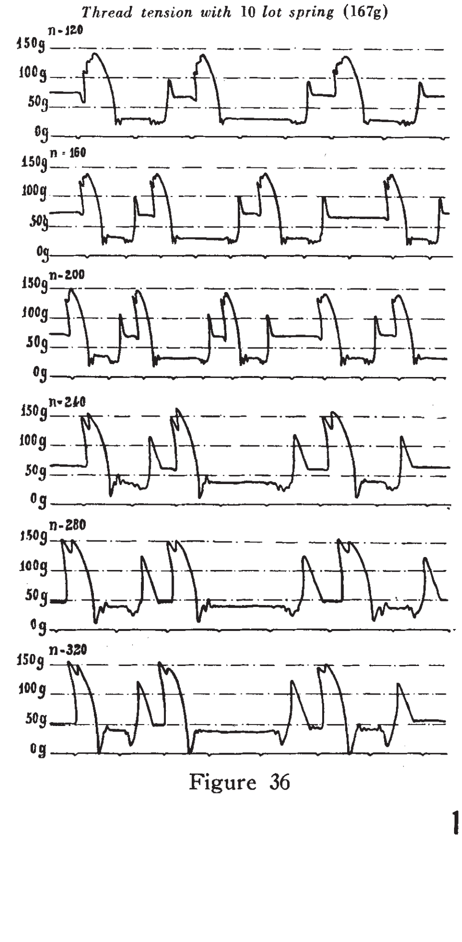

Figure 36

for both stops meets almost completely with the medium value, the average tension.

Furthermore, the experiments, according to Figure 36, show as an important result that the maximal thread take-up only rises slightly at the beginning of the increase of turning speed; however, with increasing speed, an increase of the thread tension does not take place. The machine experimented with was intended for a turning speed of 240 r.p.min. The trials show that, for example, an increase of the turning speed by 33 per cent to 320 r.p.min. can easily be made without endangering the thread. These experiments correspond with the theoretical findings previously dealt with, especially with the experiments about the dependency of the thread friction from speed.

The experiment, according to Figure 36, shows that owing to the large movement of the registering lever, the grasping point of the thread on the lever joins its movement, although only to a limited extent, and, therefore, the conditions of the trial do not correspond entirely with the real condition, where the thread is being tightly held at the braiding point. To overcome this, another trial was

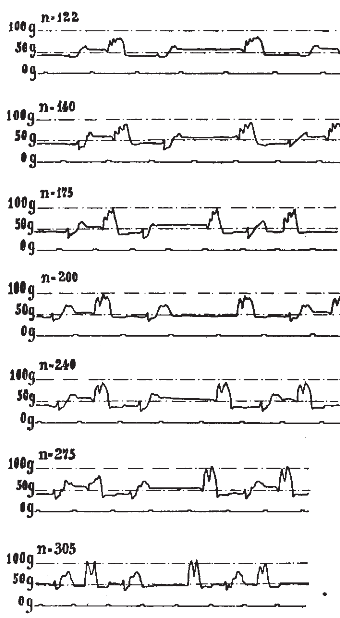

Figure 37

carried out in which the thread was fixed in immediate proximity of the axis of revolution of the registering lever. The result of these trials is shown in Figure 37. As can be seen, the movements of the registering lever, although having a length of about 10 cm., have become rather small. In this, a close approach to the real condition was attained. In general, this experiment confirms in all its parts the accuracy of the previous experimental results.

Comparative Measurements With and Without Stop

Figures 38 and 39 show the comparative movements of the Spring Tension Carrier for the thread tension, for a process with stop on one thread lace machines (Figure 39) and for a process with evenly revolving carriers (Figure 38). Both measurements have been made consecutively, under exactly the same trial conditions. The range of curves in Figure 39 deviates but slightly from previous experiments.

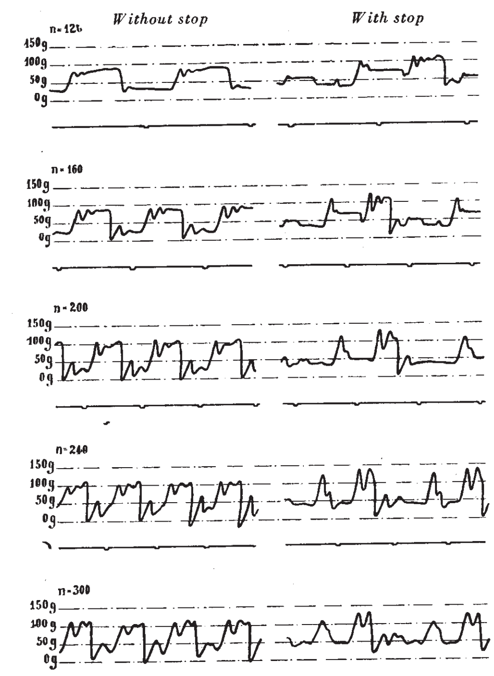

Figure 38 Figure 39

The range of curves in Figure 38, however, corresponds in general with the theoretical curves in Figure 30. It is especially noticeable that a certain large and a smaller gradual increase of tension follow each other, and that hereafter a certain decrease of tension to the minimal value is taking place, while in the intervening time, the tension maintains an average even low value. Corresponding with former trials, the thread tension scarcely increases with higher turning speed. The curves merely become somewhat more irregular. This fact can be explained by the individual oscillation of the registering lever with its spring in cooperation with the elasticity of the thread and is clearly visible as individual oscillation at n-160 r.p.min. (Figure 38).

Measuring of the Tension at the Release of the Thread from the Spool

In order to be able to examine the influence of the thread release on the thread tension in experiment (Figure 34) the recorder was adjusted on a support which was movable in radial direction to the machine towards the braiding point, by aid of a screw spindle.

Influence of thread release on tension

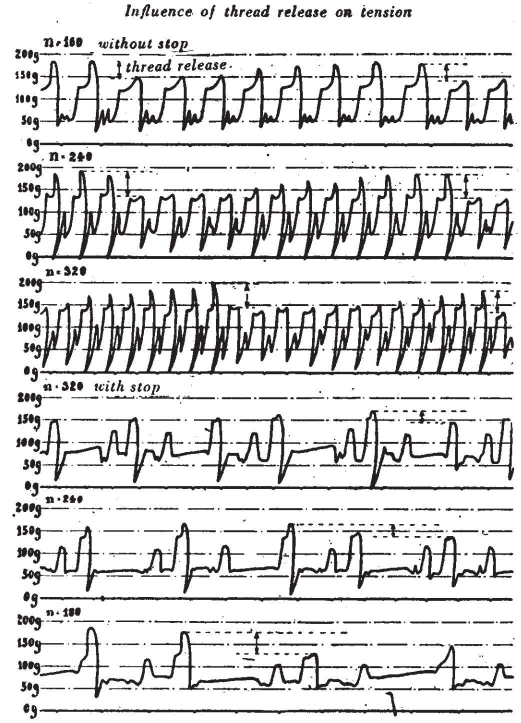

Figure 40

By slow movement of the screw spindle during the measurement, the recorder was equally moved away from the braiding point and the thread slowly pulled out of the carrier. This release took place with a speed of about a ½ mm. per a ½ revolution of the carrier, as is the case when the machine is in actual operation.

The result of this measurement is shown in Figure 40 for the carrier with tension spring. The first three diagrams show the thread tension at fixed revolution of the carrier without stop for the three different turning speeds, 160-240-320 per min. The first diagram shows that after the second revolution a latching of the lever, and with it a thread release from the spool, is taking place, which causes that the maximal value of tension for the next revolution only amounts to about 150 gram, in place of the previous 180 gram. This decrease of tension is shown in the diagrams by small arrows. Owing to the gradual consumption of the thread, in the following revolutions the tension slowly rises to its maximal value; that is, to about 180 gram. Hereafter a new release of the lever and the sudden decline from its maximal value is taking place. As shown in the three first diagrams of Figure 40, the maximal values of thread tension for various revolutions are fluctuating by about 20 to 30 per cent, owing to the consumption of thread and spool release. The tension increase is partly needed to release the lever, while another part can be traced to the increase of the spring force through greater stretching of the spring.

The three last diagrams in Figure 40 show the thread tension at periodical movements of the carrier, meaning the usual short stops. The places where a thread release is taking place are also marked by arrows. The tension increase before thread release and the following tension decrease are of the same nature, as using the permanently revolving carrier in the three first diagrams in Fig. 40. What is the action of the tension increase necessary for the release of the spool with different turning speeds? In the first diagrams, the tension difference seems to grow somewhat with increasing turning speed. In the three last diagrams, however, the opposite can be noticed. It is obvious, therefore, that with increasing turning speed the additional tension necessary for the thread release does not grow considerably, and that the oscillations of tension accruing by thread release amount to about 20 to 30 per cent of the maximal tension value.

(c) Measurement of the Carrier with Tension Weight

Figure 40 shows the procedure of thread tension with a weight carrier with different turning speeds. The course of these curves equals the theoretical findings in Figure 27. Particularly it is noticeable that with increasing turning speed, the thread tension of the weight carrier rises considerably (contrary to spring carrier) being ω^2 faster than the turning speed. For a turning speed higher than 200 per min. no experiments could be carried out on account of thread breakage. Experiments for such high turning speeds have no practical value as machines with weight carrier are generally driven with considerably lower speed.

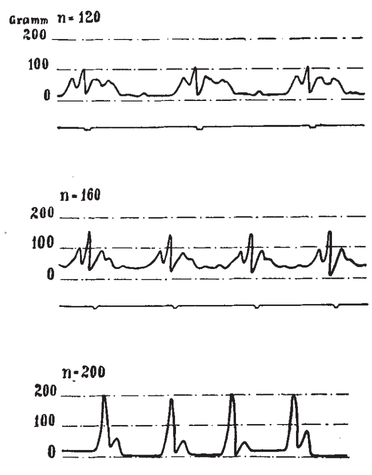

Figure 41

Summarization

In the first place, we found by theoretical considerations the influence of the thread stretcher on the thread tension for weight and spring carriers. Hereafter the influence of friction with different weightings for slow speed was found by experimenting with the carrier, and by further trials the dependency of the friction factor from the thread speed for various yarn materials in connection with eyelets of steel and glass was established. Using this research as a basis, the procedure of tension for weight and spring carrier could be illustrated graphically. The result of these experiments was controlled by the measuring of the thread tension on a running machine, while recording the process of thread tension at various turning speeds. These practical measurements and theoretical research showed a close similarity, and led to the following results:

Weight Carrier

The thread tension is strongly influenced by the speed, viz: in quadratic proportion with increasing turning speed. In addition to this, there is an influence through the friction which results in an increase of the thread tension by about 90 per cent with ascension of the weight, when using cotton yarn of medium size; with descending movement, however, a decrease of tension by about 50 per cent. As the tension increase through friction is proportional to the existing tension and sets in at the moment where the thread tension has its maximal value through weight and speed forces, this maximal value is increased by about 90 per cent through friction. An unfavorable feature is the leaping of the tension increase from the proximity of the minimal value to its maximal value. The thread take-up with increasing turning speed is, therefore, getting soon very dangerous and leads to the breaking of the thread. For this reason, as well as considering the unavoidable flapping of the threads on account of too great speed, a considerable increase of the turning speed is not advisable for machines being operated with weight carriers. With regard to spool and thread release, the conditions are more favorable with the weight carrier as the release of the lever takes place when the thread tension is at low mark and, therefore, the additional force to be brought up by the thread cannot be injurious to the same.

Spring Carrier

When using a carrier with tension spring the factors of speed influencing the thread tension are so small they will not exert any influence worth mentioning. For this reason, and by neglecting the friction, notwithstanding the perpetual changing of the length and the tension change of the spring, the thread tension does become more equal than with weight carriers. As the friction is proportionate to the prevailing tension, and owing to the more regular starting tension, the tension increase by friction is smaller than with the weight carrier. Contrary to the weight carrier, the tension increase by friction at the spring carrier starts at the moment where the tension is in close proximity to its minimal value. Therefore, the tension increase is divided into a small leaping ascension and an additional gradual one. This division of thread take-up by the spring carrier is more advantageous than with the weight carrier. However, the tension decline, after leaving the maximal value, takes place suddenly and drops almost immediately to its minimal value.

With the customary turning speed of lace machines, the thread speed is so great that with higher increase, the thread friction, as well as the thread tension, does not grow. For this reason, there is no objection to increasing the turning speed of the machine. Contrary to the weight carrier, at the spring carrier the greatest take-up of the thread takes place when the latch lever must be opened for the spool for thread release. The force necessary to do this must be furnished by the thread when its tension has reached the highest point. By this that tension is further increased by about 10 per cent. Often it is considerably more on account of the faulty condition of the latch lever, which is a main source of danger for thread breaking. To operate a lace machine with greater efficiency and higher turning speed, and at the same time make feasible the use of finer sizes of yarn, it is, therefore, necessary to find ways and means to manipulate the thread release from the spool without considerable additional take-up of the thread.