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1929

VOL·I

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THE WORLD'S LEADING
TEXTILE JOURNAL

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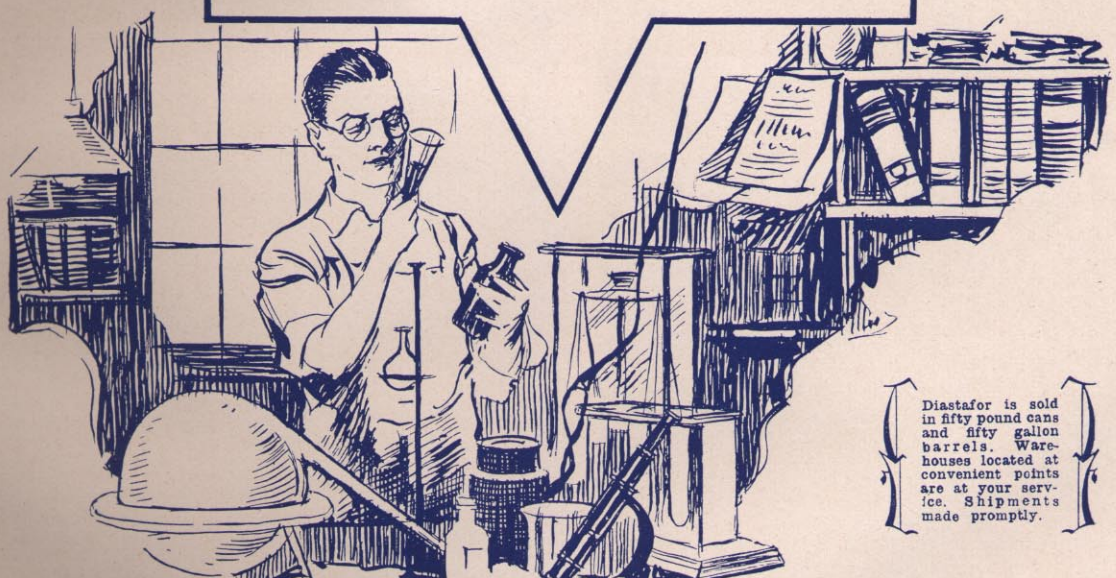

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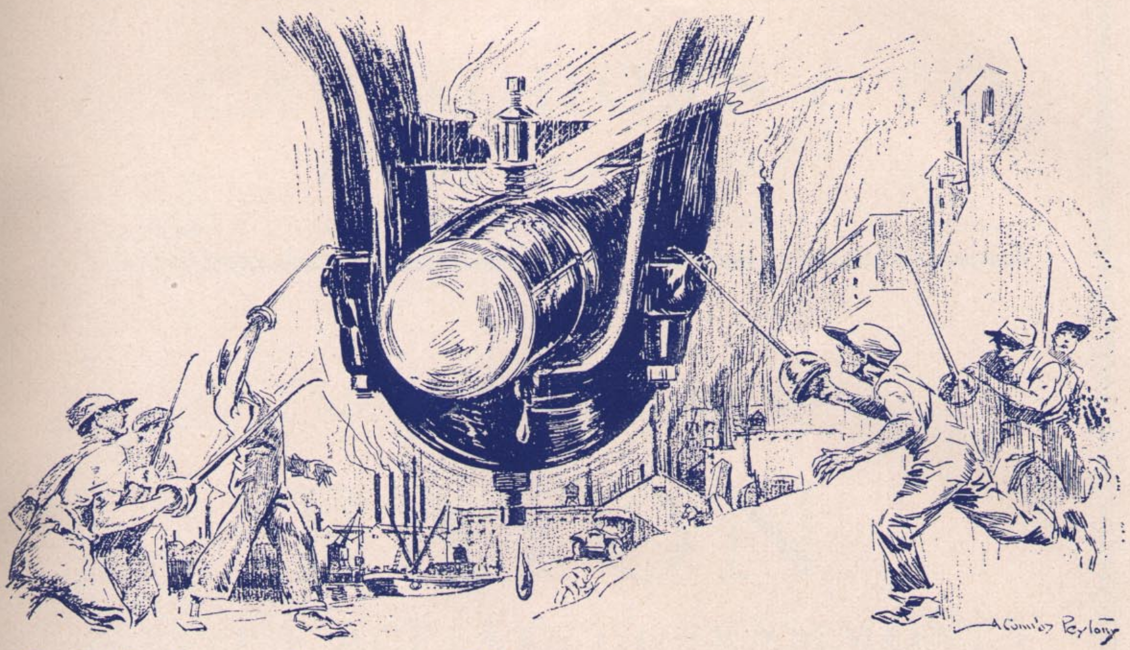

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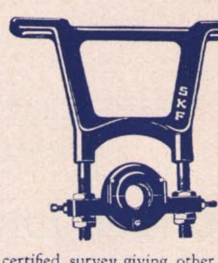


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# Drawframe Draft

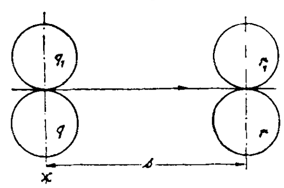
By Chief Engineer *H. Weissbach*

By draft is generally understood the drawing out or extension of slivers by means of suitable appliances whereby the average number of the fibres in the cross-section of the slubbing is reduced. If the cross-section of the sliver before drafting contains on an average Z fibres and after drafting $Z_1$, then realation is

$$\frac{Z}{Z_1} = v, \text{ the draft.} \qquad 1)$$

This result is attained technically by passing the sliver through two pairs of rollers $q\,q_1$ and $r\,r_1$, the second of which, the drawing rollers $r\,r_1$, have a speed which is v times greater than that of the first pair, the feeding

Fig. 1.



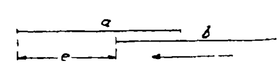
rollers $q\,q_1$ (see Figure 1). The distance s between the nips x and y of such a drawframe is adapted to the material and is so large that the longest fibres cannot be gripped by both pairs of rollers at the same time, as otherwise they would be torn by the action of the different speeds, or the draft would be disturbed.

The fibres move forward with the speed of the feeding rollers, about c, so long as they are in the nip of $q\,q_1$, but as soon as the tips of the fibres are caught by the nip of the drawing rollers $r\,r_1$, they move forward at the rate $v \times c$. In passing the draftframe the fibres thus have two consecutive rates of speed, namely from $q\,q_1$ the speed c and from $r\,r_1$ the speed $v \times c$. Usually the most of the fibres are not so long that their tips are caught by the drawing rollers just as their ends are being released by the feeding rollers, so that the change from one speed to the other follows directly. The shorter fibres, and that is the majority, after having been liberated by the feeding rollers, must pass over part of the path s free, before they are caught by the drawing rollers. At this stage the speed of the forward movement is purely a matter of chance. That is to say, if these short fibres are connected by friction or by interwining with fibres which have already been caught by $r\,r_1$, then they will proceed at the same velocity before their tips have reached $r\,r_1$. But if they are connected with such fibres as are still moving at the rate c of $q\,q_1$, then they will retain the speed c for a little while longer. On the other hand, if they are connected at both ends, their rate of speed will correspond to the result of the combination of both. The more irregular the staple is, the larger is the number of such fibres the speed of which is due to chance, but the greater also is the danger of an accumulation of fibres either forwards or backwards. In other words, the greater is the danger of producing an uneven, cut yarn.

Naturally attempts have all along been made to reduce the number of these chance movements as far as possible by building members everywhere between the two pairs of rollers where it could be done, the object of which was to compel the fibres to retain the speed c which they received from the feeding rollers until their tips reached the drawing rollers $r\,r_1$. It is not our intention here to investigate how far this ideal condition has been attained by constructors of machinery. The following observations, on the contrary, presume that it has actually been reached, so that it can be shown how drafting proceeds when all chance movements of the fibres to be drawn have been eliminated.

If two fibres a and b of a sliver (Figure 2a) pass through such an ideal drawframe, the relative position of the two fibres to one another suffers a change which is expressed by the distance between their tips becoming greater.

Fig. 2a

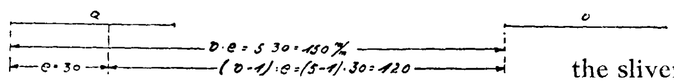


In Figure 2a the tip of the fibre a overlaps that of the fibre b in the direction of movement, indicated by the arrow, by the distance e. The two tips will retain this interval until the tip of the fibre a has been caught by the drawing rollers r $r_1$. From this moment on the fibre a moves with the speed v×c, while the fibre b retains the speed c until its tip has also been caught by the drawing rollers r $r_1$ that is, until it has covered the interval e. During this time t the fibre a covers a distance of v×c×t, and the fibre b the distance c×t.

Since c×t is equal to the distance of the tips e, the distance between the two tips $e_1$ after having passed the ideal drawframe with a draft of v is

2) $e_1 = e + (v \times c \times t) - (c \times t)$ from which follows $e_1 = v \times e$.

*Fig. 2b*



As soon as the tip of the fibre b has also been caught by the drawing rollers, the fibre b moves also with the speed v×c, and the distance between the two tips is not further reduced.

Let v = 5 and the distance between the two tips before drafting = 30 millimetres, then the distance between the two tips after drafting is 5×30 = 150 millimetres (Figure 2b).

What applies for these two fibres must also apply for all the other fibres of the sliver, so

Case A.

I Uniform length L of all fibres with identical thickness, and the same volume by weight, i. e. the staple is absolutely uniform.

II The same number of fibres z in every cross-section, i. e. the sliver is completely uniform.

III Uniform distribution of the fibre tips among the fibres of the sliver, i. e. the same distance from the tip of one fibre to the next.

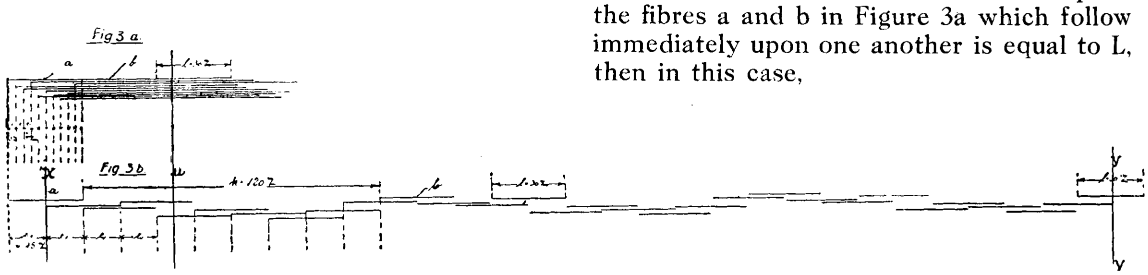
If L = 30 millimetres (length of the fibres), and z = 10 (number of fibres in the cross-section of the sliver) then according to hypothesis III the distance between the tips must be $e = \frac{L}{z} = 3$ millimetres. This sliver is diagramatically shown in Figure 3a in such a manner that the fibres of the sliver lying above and beside one another in a more or less elliptical cross-section are all straightened out in one plane beside one another. The ends and tips of the fibres are indicated by points.

By the drawing the distances e of the tips of the fibres from one another of this completely regular sliver in the ideal drawframe is raised according to formula 2) to

$$e_1 = e \times v = 3v$$

when v = 5, then $e_1$ = 15 millimetres (Figure 3b).

Since the distance between the fibre tips of the fibres a and b in Figure 3a which follow immediately upon one another is equal to L, then in this case,



*Length of fibre after one draft v = 5*

Fig. 3 b

that it can be said in general that in an ideal drawing frame the distance between the fibre tips must be v times greater, when v is the draft.

We have thus here the possibility of showing diagramatically the change which a sliver undergoes in passing through an ideal drawframe through the axial displacement of the fibres contained in it.

The graphical representation of the change of draft will now be shown in systematic development by a sliver under the following three hypotheses:

3) $$e_1 = v \times L.$$

Accordingly gaps k must occur between all the fibres of a sliver which follow directly after one another owing to the draft v, and the size of the gaps can be determined by the formula $k = e_1 - L$, or by the use of formula 3)

4) $$k = (v - 1)\ L.$$

According to formula 1) $v = \frac{z}{z_1}$ becomes $z_1 = \frac{z}{v}$,

if z = 10 and v = 5, then $z_1 = \frac{10}{5} = 2$.

In order to be able to represent diagramatically sliver with any number of fibres, it is simpler to think of the fibres of the sliver as being so ordered beside one another that those fibres, the tips of which are nearest to each other, lie together, and those fibres, the ends and tips of which fall in the same cross-section, that is to say which follow directly after one another, are made to lie behind one another upon a line. Then the sliver of Figure 3a appears as shown in Figure 3c, from which, as developed above, the Figure 3d of the sliver with a draft of 5 proceeds.

Lines connecting the tips of the fibres lying beside one another in Figure 3c must, according to hypothesis III, cross the axis of the sliver as straight lines at an acute angle and, according to hypothesis I (same length of fibre), must be parallel, as is also the case with the drafted sliver (Figure 3d).

The representation according to Figure 3c will always remain the same whether the number of the fibres z in the cross-sections is large or small. Merely the density will be changed by the presence of a larger or smaller amount of fibres z, in which the fibres are pictured as lying beside one another. The closer the position of the fibres, the more fibres are present in the cross-section, and the smaller is the distance between the fibre tips e.

In the following diagrams accordingly the single fibres are no longer represented, but surfaces evenly covered with fibres, the two-dimensional extension of the surfaces being no longer absolute, but merely expressing the relative number of fibres in the cross-section.

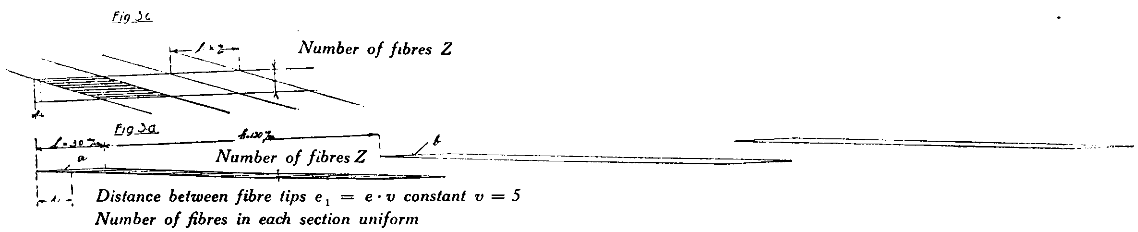



Fig. 3 c

## Case B

The three hypotheses of case A were still all valid for the sliver represented in Figure 3c. If hypothesis III is so altered that the distances between the tips of the fibres are no longer identical, but continually increase and decrease, so that, for example, three-fifths of all the fibre tips, as in Figure 4a, which were distributed over a length L, now fall upon one-third of the length L, while the rest of the fibres are distributed upon two-thirds of L, then all the tip lines assume a similar parabolic curved form.

If this sliver is again drawn with a draft = 5 in the ideal drawframe, then the drafted sliver, shown diagramatically in Figure 4b, is produced.

Between fibres a and b there is again a gap

$$k = (v - 1)L$$
$$= (5 - 1)30 = 120 \text{ millimetres.}$$

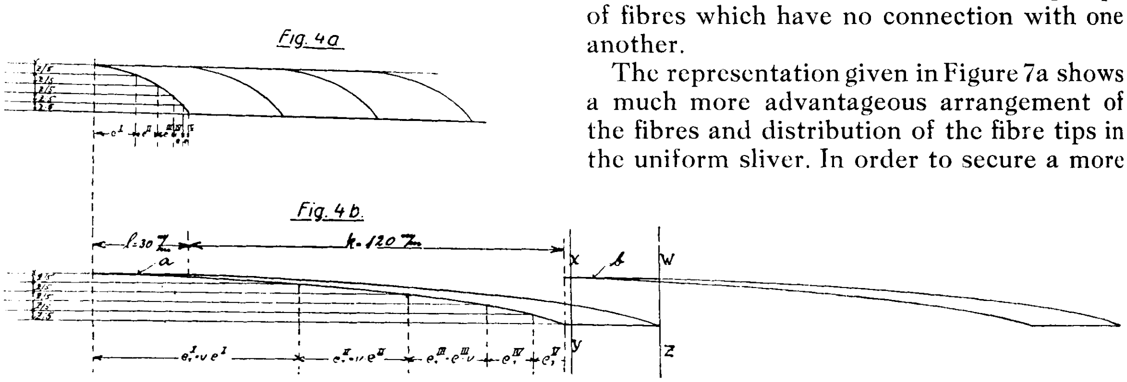
The distances between the tips eI eII eIII eIV eV are, according to the formulae

$$e_1\mathrm{I} = e \times v, \text{ extended to}$$
$$e_1\mathrm{I} = e\mathrm{I} \times v$$
$$e_1\mathrm{II} = e\mathrm{II} \times v$$
$$e_1\mathrm{III} = e\mathrm{III} \times v \text{ and so on.}$$

From Figure 4b it can be seen that hypothesis II as a condition for the uniformity of the sliver (identical number of fibres in all cross-sections), assumed for Figure 4a, no longer applies for drafted sliver. The bisecting line xy cuts about six times as many fibres as the line wz. The reduction of the number of fibres in the cross-section by the draft v proceeds still according the the formula $z^1 = \frac{Z}{V}$, but only for the average of all cross-sections, and no longer for each of them as in case A.

It follows from this that a uniform sliver composed of uniform fibres can only be drawn to a uniform yarn when the tips of the fibres lying in it are absolutely regularly distributed. If this is not so and the tips accumulate in heaps, *then even the ideal drawframe can only produce an irregular yarn*, however uniform the sliver worked upon may be.

There are no means known in practice of arranging the fibre tips; they are the subject of chance. But just as it cannot be assumed that chance arranges the fibres so that the tips lie as in Figure 3c, the contrary can as little be assumed that they lie in an absolutely unfavourable position as in Figure 4a. In practice constantly varying distances between the fibre tips must be reckoned with, which, however, are less marked the smaller the average distance is; that is to say, the more numerous the fibres in the cross-section of the yarn or sliver are.




*Distance between tips of fibres $e^{I} > e^{II} > e^{III} > e^{IV} > e^{V}$*
*Number of fibres at xy greater than in section at wz*

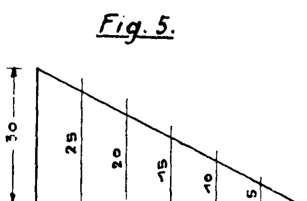
Fig. 4a

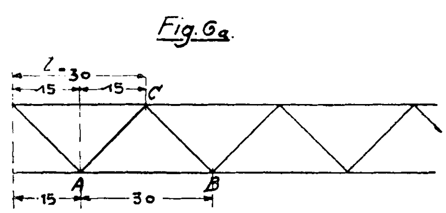
of fibres of each length is present (staple diagram Figure 5). If a uniforms liver composed of this material passes through the ideal drawframe (Figure 6a) with a draft of 5, then something is produced which cannot be termed sliver, thread, or yarn (Figure 6b). Although the distances between the tips are uniform in the sliver, the draft has split up the mass of fibres in the drawframe into groups of fibres which have no connection with one another.

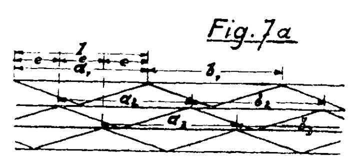
The representation given in Figure 7a shows a much more advantageous arrangement of the fibres and distribution of the fibre tips in the uniform sliver. In order to secure a more uniform draft, the sliver shown there is composed of three uniform single slivers according to Figure 6a in such a way that the one sliver is always axially displaced against the next by one-third L. By this means the thin

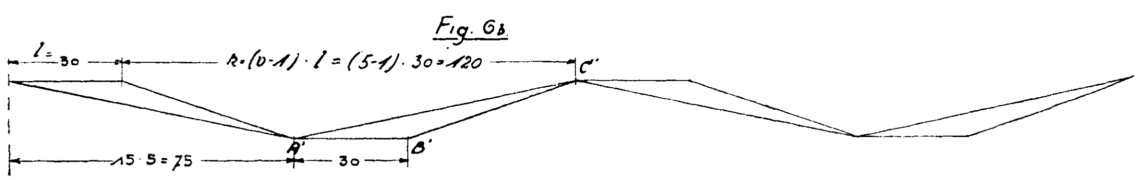
Case C

The following remarks refer to a sliver the fibres of which are not uniform, as in case A, hypothesis I, but vary from 0 to 30 millimetres, in such a way that an equal number



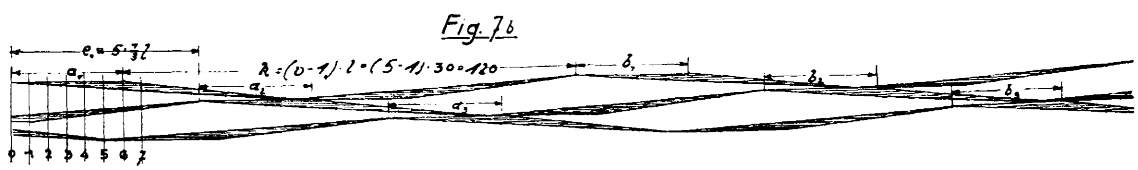



Fig. 8a.

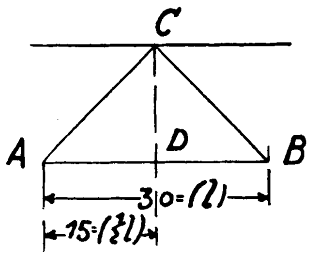
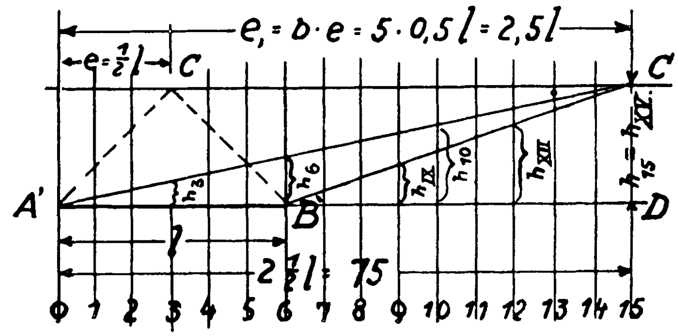



Fig. 8b.




and thick places of each sliver hide one another when being drafted. The yarn producted in this way can be pronounced very good in quality as the following proportional figures show which have been calculated from the fibres in Figure 7 b cut across by the lines 0, 1, 2, and so on.

In the Figure 8 b used for the calculation, the triangle A'B'C' represents the triangle ABC of Figures 6a and 8a which has been displaced by draft 5. Now since the triangle A'B'C' is the surface covered with fibres, the difference of the height of these two triangles A'DC' and B'DC' gives the proportional figures of the fibres which can be cut by any number of sections at right angles to the base line A'D.

If $A'D = 2.5 \times L$ (from $e_1 = 5 \times e - 5 \times \frac{L}{2} = 75$), then the proportional figures of the fibres cut by the section lines in Figure 8 b are, for example:

For section line : 0 = 0

„ „ „ : 1 = 0.0667

from $\frac{h_1}{h_{15}} = \frac{0.1666 \times L}{2.5 \times L}$, therefore $h_{15} = 1$, $h_1 = 0.0666$.

for section line : 2 = 0.1333
„ „ „ : 3 = 0.2
„ „ „ : 4 = 0.2667
„ „ „ : 5 = 0.333
„ „ „ : 6 = 0.4
„ „ „ : 7 = 0.3555
„ „ „ : 8 = 0.3111
„ „ „ : 9 = 0.2667
„ „ „ : 10 = 0.2222
„ „ „ : 11 = 0.1778
„ „ „ : 12 = 0.1333
„ „ „ : 13 = 0.0885
„ „ „ : 14 = 0.0444
„ „ „ : 15 = 0

Transferred to Figure 7 b, we get the proportional figures of all the fibres cut across in the three single slivers from the sum of the proportional figures of each of the three slivers. When section lines 0, 1, 2, 3, and so on are again plotted at intervals of one-sixth L, these amount to:

for section line : 0 = 0 + 0.333 + 0.222 = 0.555
„ „ „ : 1 = 0.0667 + 0.4 + 0.1778 = 0.614
„ „ „ : 2 = 0.622
„ „ „ : 3 = 0.6
„ „ „ : 4 = 0.578
„ „ „ : 5 = 0.555
„ „ „ : 6 = 0.644
„ „ „ : 7 = 0.622

and so on.

Thus the proportion of the fibres in the thinnest parts of the whole of the drafted sliver to the fibres in the thickest parts in the above case is, for instance, as 55.5 to 64.4. A yarn with such proportional figures for the cross-sections of the thickest and thinnest parts (the fibres being regarded as uniformly thick) deserves to be termed practically uniform.

The above considerations lead to the conclusion that the drafting is more uniform the more single slivers in the sense of Figure 7 b are taken to make up the sliver to be drafted, that is to say, the more possibilities there are of adjustment of differences.

In order to secure an absolutely regular draft, the sliver would evidently have to be composed of as many single slivers as the material to be spun contains different lenghts.

Suppose that material to be spun consists of fibres of 5 millimetres length, increasing by 5 millimetres to 30 millimetres, than the uniform sliver would contain 6 slivers arranged as in Figure 6a, corresponding to the 6 length groups, which would have to be so disposed among each other that each lay 5 millimetres behind the next one.

Figure 9a is a diagramatic representation of such a sliver. If the fibres of each length group in this Figure are removed and laid beside one another, taking care not to displace them axially, then the sliver falls, as shown in Figure 9b, into six separate slivers each of which contains only fibres of one and the same length group, which are arranged

Fig. 9a.

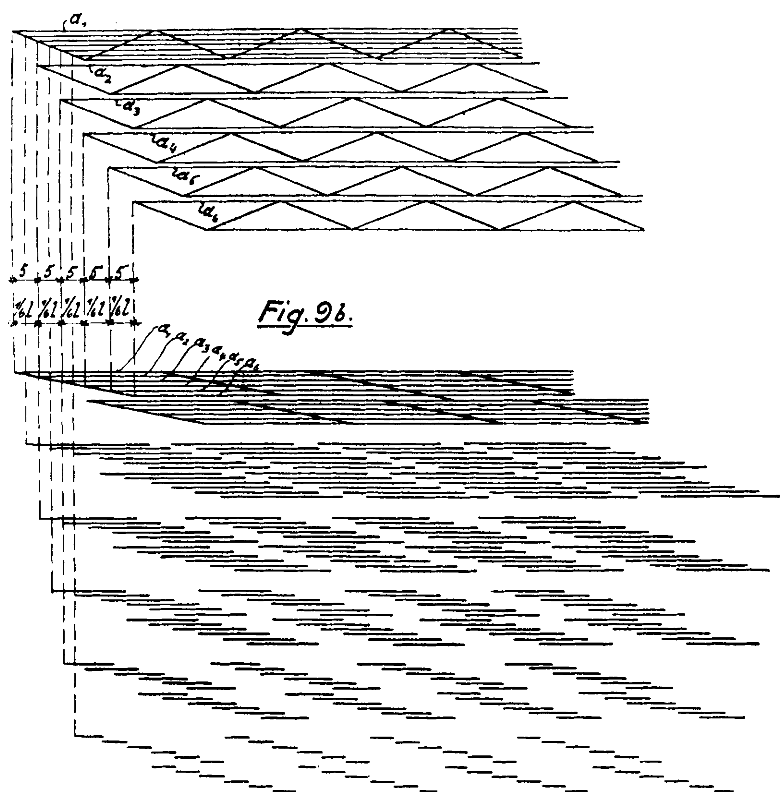



Fig 9 a und 9 b :
Sliver composed of six single slivers with fibres of 5, 10, 15, 20, 25 and 30 millimetres in length and total of 42 fibres in cross-section

with uniform intervals between the tips, just as in Figure 3c. Since the draft of each single sliver proceeds uniformly according to Figure 3c, provided that the number of fibres in the cross-section of each sliver can be divided without remainder by v, it follows that the whole of the sliver must be regularly drafted. In this case it is of no moment how the single slivers lie axially to one another.

When it was said in discussing Figure 4b that a sliver of uniformly long fibres can be more uniformly drafted the more numerous the fibres in the cross-section, the same principle must apply for every other sliver. Every sliver composed of fibres of different length, as shown above, can be regarded as a collection of a number of slivers each with uniformly long fibres, whereby the fibres may be more or less numerous in the cross-section of each separate sliver according to the course of the tip curve in the staple diagram. If the number of fibres in the cross-section of the sliver as a whole increases, it increases also in the cross-section of each single sliver, whereby the uniformity not only of each sliver, but of the whole sliver is improved.

If the fibres of one of these six single slivers were arranged according to Figure 4a, then these single slivers would be unevenly distributed according to Figure 4b and impair as a whole the uniformity of the yarn to be spun, the damage being greater the larger the proportion of the fibres of this single sliver, by percentage of weight and numerically, to the total number of fibres.

Since the fibres of each length group in the sliver according to Figure 9a are numerically the same, the share of the length groups by weight must be proportional to the length of the fibres, so that, for example, for the 30 millimetre long fibres it would be six times as great as for the 5 millimetre fibres. An irregular distribution of the fibre tips in the single sliver with the 30 millimetre fibres would therefore act more unfavourably on the uniformity as a whole than that of every other single sliver. For this reason it is desirable that the length group which has the greatest share by weight in a sliver also contains the most fibres, that is to say, that the tip curve of a staple diagram should run as convex as possible and remain longest at one height where the longest fibres are.

Of course it might be thought that uniformity could be attained by irregularities of the single slivers adjusting or cancelling themselves. But even so the extent of the adjustment is again dependent upon the number of possibilities of adjustment, that is, upon the number of fibres in the cross-section, a phenomenon which may be shortly designated a function of plurality. This function of plurality is the counteraction of chance, that is of the chance occurrence of only unfavourable moments. The principle can be recognized everywhere by its action in reducing errors or in hindering action where final figures are found from a number of average values or where average values are calculated from a number of single values. It is the function upon the basis of which multiplication is carried out.

# The Control of Output and Operating Efficiency which must Precede the Reorganization of the Production of a Weaving Mill

By Professor *Th. Abt*

If we are placed in a weaving mill with the object of increasing the output, our attention will first of all be directed to investigating the quantity of goods produced. Only when this has been done are we in a position to say why the production is merely fair and what must be done to remedy this state of affairs.

The following lines are intended to show the way to getting a clear idea of the yardage of a cretonne weaving mill with 500 power looms.

In the first place the quantities produced during each payday period (of one week, or a fortnight) for the whole year must be calculated as an average uniform number of picks per centimetre, so as to make them comparable. Then this yardage is converted to a percentage of the production.

The percentage of the output of a payday period can easily be found by multiplying the production, which has been converted into the average number of picks, by 100 and dividing the result by the theoretical production similarly reduced to terms of the number of picks.

$$\text{percentage of production} = \frac{\text{actual output in unit metres} \times 100}{\text{theoretical output in unit metres}}$$

In order to arrive at the theoretical output, the speed of a large number of looms of each type must be measured during several days at different hours. The average speed of the loom can be calculated from these figures as follows.

Suppose that the speeds given below have been found for four types of looms —

150 looms Type A with 210 picks per minute
$150 \times 210 =$ 31,500 picks per min.
100 looms Type B with 200 picks per minute
$100 \times 200 =$ 20,000 picks per min.
100 looms Type C with 195 picks per minute
$100 \times 195 =$ 19,500 picks per min.
150 looms Type D with 190 picks per minute
$150 \times 190 =$ 28,500 picks per min.
500 looms would weave 99,500 picks per min.

without any interval, that is to say, the average loom speed is 99,500 : 500 = 199 picks per minute.

Let us assume that the standard number of picks is 25 per centimetre.

The theoretical output of 500 looms during a payday period of 90 working hours can be calculated from the formula given below:

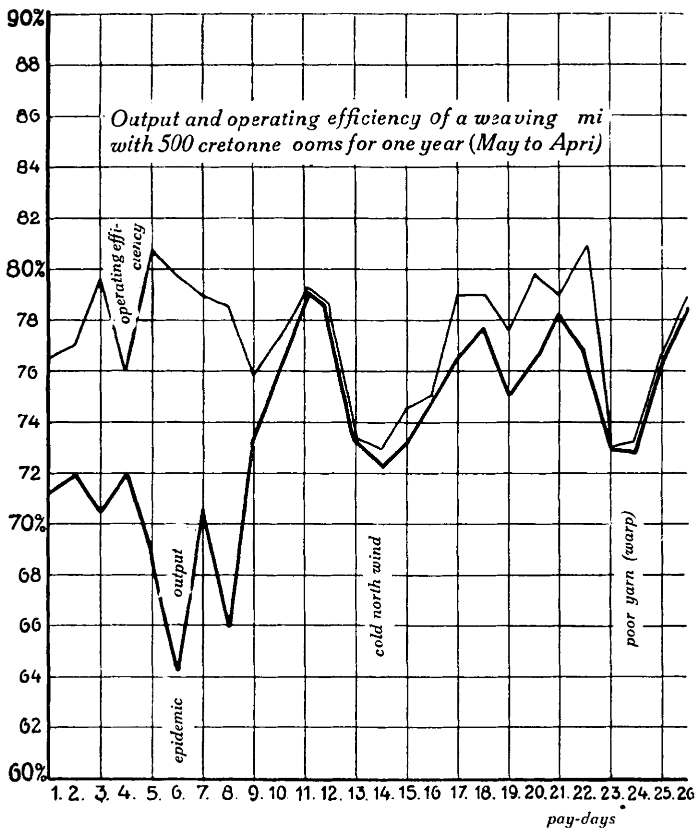
$$Pr_{th} = \frac{\overset{\text{picks/min.}}{199} \times \overset{\text{minutes}}{60} \times \overset{\text{working hours}}{90} \times \overset{\text{looms}}{500}}{\underset{\text{picks centimetre}}{25} \times \underset{\text{centimetres per metre}}{100}}$$

$Pr_{th}$ = 214,920 metres with 25 picks per centimetre.

Owing to holidays the number of the working hours varies, so that the theoretical output for all conceivable payday periods should be tabulated.

| | | | |
|---|---|---|---|
| In 75 working hours the loom | | 179,100 | metres |
| „ 80 | has a theoretical | 191,040 | „ |
| „ 85 | output of | 202,980 | „ |
| „ 90 | | 214,920 | „ |
| „ 95 | | 226,860 | „ |
| „ 100 | | 238,800 | „ |
| „ 105 | | 250,740 | „ |
| „ 110 | | 262,680 | „ |

Having calculated the percentage production for the paydays of the year past, these figures are tabulated, which will be of assistance in plotting a graph of the production.




Example: During the first payday period of 100 hours the mill produced 170,253 unit metres, then on this assumption the percentage

$$\text{of output} = \frac{170{,}253 \times 100}{238{,}800} = 71.3\%.$$

The table of production already gives us a certain view of the course of the business under review, but we do not know whether every loom is working properly, because the figures give no information upon the idle looms during the year just past. In many such cases the production may appear to be very low owing to lack of labour, although the looms at work have almost reached their maximum output.

In order to get to learn the proper run of the looms at work, the operating efficiency must be calculated. The efficiency operating of a weaving mill is the quotient of the actual yardage and the theoretical output of the looms at work. The theoretical production of the looms at work is found by calculating that worked out for 500 looms. To find the efficiency capacity we must first copy the figures from the book of the head foreman for a payday period, from which we see that during ten months of the year the working day was of 10 hours, and for two months 9 hours, as prescribed by law, apart from Saturdays.

These are the figures for the first fortnightly payday period:

First week:

| | | |
|---|---|---|
| Monday | 10 hours | 36 looms |
| Tuesday | 10 „ | 32 „ |
| Wednesday | 10 „ | 32 „ |
| Thursday | 10 „ | 40 „ |
| Friday | 10 „ | 32 „ |
| Saturday | 5 „ | 36/2=18 „ |
| | in 55 hours | 190 looms |

Second week:

| | | |
|---|---|---|
| Monday | 10 hours | 52 looms |
| Tuesday | 10 „ | 32 „ |
| Wednesday | 10 „ | 32 „ |
| Thursday | 0 „ | holiday |
| Friday | 10 „ | 24 „ |
| Saturday | 5 „ | 24/2=12 „ |
| | in 45 hours | 152 looms |

During 100 working hours 342 looms were idle, i. e. 34.2 per day of 10 hours.

The idle looms having been entered in a second column of the table mentioned above, we can now proceed to calculate the efficiency capacity.

In order to find the percentage of the efficiency capacity of a payday period, the actual output is multiplied by 100 and the product is divided by the theoretical output of the looms which were at work during the period in question.

Example: During the first payday period 34.2 looms were idle on an average and the mill had an output of 170,253 metres.

The theoretical production of 500 looms for

100 hours is 238,000 metres and for (500—34,2) = 465,8 looms amounts to 222,467 metres % of the operating efficiency =

$$= \frac{170{,}253 \times 100}{222{,}467} = 76.5\ \%.$$

The operating efficiency for the total number of paydays, say 26, is entered in a third column of the table which is reproduced below in extenso.

In order to arrive at an absolutely clear conception of the output and efficiency capacity, a graph is plotted (see figure), the abscissa of which shows the 26 paydays during the year and the ordinate the percentages for production and efficiency capacity from 60 to 90 per cent.

| Pay-day | Hours | Actual production in metres at 25 picks per centimetre | Percentage of output % | Idle looms | Percentage of operating efficiency % |
|---|---|---|---|---|---|
| 1 | 100 | 170,253 | ~71,3 | 34,2 | ~76,5 |
| 2 | 100 | 171,687 | „ 71,9 | 32,4 | „ 77 |
| 3 | 110 | 185,302 | „ 70,5 | 56 | „ 79,6 |
| 4 | 110 | 189,607 | „ 72 | 23,5 | „ 76 |
| 5 | 110 | 181,499 | „ 69,2 | 71 | „ 80,7 |
| 6 | 100 | 153,806 | „ 64,4 | 98 | „ 79,8 |
| 7 | 95 | 160,002 | „ 70,5 | 53 | „ 79 |
| 8 | 110 | 173,683 | „ 66 | 79 | „ 78,5 |
| 9 | 110 | 192,365 | „ 73,5 | 16 | „ 75,8 |
| 10 | 110 | 199,708 | „ 76 | 6,4 | „ 77,2 |
| 11 | 110 | 207,312 | „ 79 | — | „ 79 |
| 12 | 110 | 205,993 | „ 78,5 | — | „ 78,5 |
| 13 | 110 | 192,300 | „ 73,2 | — | „ 73,2 |
| 14 | 110 | 189,678 | „ 72,2 | 4 | „ 72,8 |
| 15 | 75 | 131,250 | „ 73,2 | 8,8 | „ 74,5 |
| 16 | 95 | 169,963 | „ 75 | — | „ 75 |
| 17 | 95 | 173,496 | „ 76,5 | 15,5 | „ 79 |
| 18 | 85 | 157,502 | „ 77,6 | 9,2 | „ 79 |
| 19 | 100 | 179,481 | „ 75 | 14,1 | „ 77,5 |
| 20 | 110 | 201,103 | „ 76,5 | 19,9 | „ 79,8 |
| 21 | 110 | 205,025 | „ 78 | 6 | „ 79 |
| 22 | 110 | 200,981 | „ 76,5 | 25,5 | „ 80,8 |
| 23 | 110 | 191,598 | „ 73 | — | „ 73 |
| 24 | 110 | 190,893 | „ 72,8 | 4 | „ 73,2 |
| 25 | 100 | 180,912 | „ 75,8 | 2,9 | „ 76,3 |
| 26 | 100 | 189,334 | „ 78,5 | — | „ 78,5 |

The diagram shows that the two curves unite several times at those points where all the looms are at work, that is to say, when production is equal to the efficiency capacity (the output has reached its maximum). The space between the two curves represents the idle looms. The black curve, which represents the output, keeps us at all times informed of the cost of manufacture, which is a function of the actual yardage.

The thin efficiency capacity curve indicates whether the looms are running normally, whenever it falls the manager must investigate the matter.

The figures were read off the slide rule and are thus accurate enough.

Besides all this the graph shows us also that the output is poor between ordinates 5 and 8, (owing to shortness of labour, an epidemic of influenza, and lack of substitutes).

For two thirds of the year the efficiency capacity is good, but is low between ordinates 13—16 and 23—24. Investigation showed that there was often a cold north wind between 13 and 16, so that the conditioning equipment is either working badly, or is insufficient. Between 23 and 24, two thirds of the looms were working on poor yarn.

From these lines and the diagram it can be seen that it is evidently quite possible to raise the output of this weaving mill by training the operatives and making working methods more efficient, for good hands working on ordinary power looms can attain an output of from 85 to 90%, or even, in the case of the best workers, as much as 95 per cent.

Every owner of a weaving mill who is not satisfied with the work done should carry out this little investigation when he has occasion to appoint a new manager, so that he can make his salary depend upon the progress in organization made by the mill.

# A Rapid Method of Doffing or Changing Bobbins on Spinning or Doubling Frames

By *E. Toenniessen*, Engineer

Changing full bobbins or tubes on a spinning frame is still done by hand and from two to five minutes are required for a frame with 500 spindles according to the number of operatives and their dexterity. A properly managed spinning mill will not lose more time than this, but if the operatives are not set about it properly, as is so often the case, twice as much time or even more may well be lost. As the usefulness of the machine is almost entirely dependent upon the pauses for doffing, this must be done as rapidly as poss-

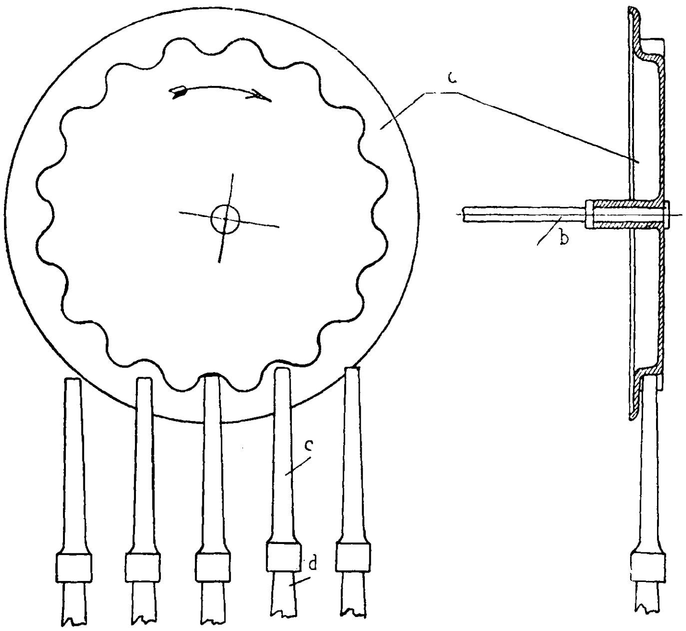



Fig. 1

ible, but at the same time, in spite of all haste, with care. It often happens, however, that a large number of the tubes or bobbins, in particular the heavy and Northrop bobbins, sit quite loosely on the spindles and consequently tend to slip during spinning, that is, they do not have the same rate of revolution as the spindle. This leads to trouble in the weaving shed owing to the yarn not being twisted in places. It is especially noticeable when the tube or bobbin has about three quarters run off, because the thread must withstand an even stronger pull by slipping off over the bare tube and at once breaks owing to insufficient twist. This slipping of the tubes is also noticeable in the spinning frame itself by the large number of broken threads, particularly when starting spinning.

To remedy this state of affairs, it is the custom in many mills to press down by means of a long stick those tubes which are stuck loosely on the spindles, quite forgetting that the tubes are not all of the same diameter, that is to say, that they stick on the spindle at a higher or lower level. The stick accordingly presses down only those which sit highest up, that is, the narrowest, and damages them so that they are all the more difficult to doff later on, while the wide tubes still slip on the spindles. Many mills are aware of this and forbid the use of the stick. To press on the tubes or bobbins by hand alone, however, takes up much time, a single worker, for example, taking on an average 60 seconds for one side of the frame. Consequently a press-on wheel has been constructed (German Patent No. 439 533, patents applied for abroad) *by means of which a worker can press 250 tubes, the whole side of a frame, each onto its own spindle, in six seconds* (see Figures 1 and 2). The wheel is preferably made of some light metal and is of such a size and so formed that it presses simultaneously upon two spindles only. The edge a is undulating and corresponds to the pitch of the spindles. A leather cover prevents the tubes from being damaged. After the full tubes have been taken from the spindles c and empty tubes have been loosely stuck upon them, the operative places the wheel upon the heads of the tubes and rolls it over them with quite a light pressure upon the axle b. The worker must take care to incline the wheel a little towards herself and move in the direction of the pigtail guides, so that they cannot be injured. The frame must be

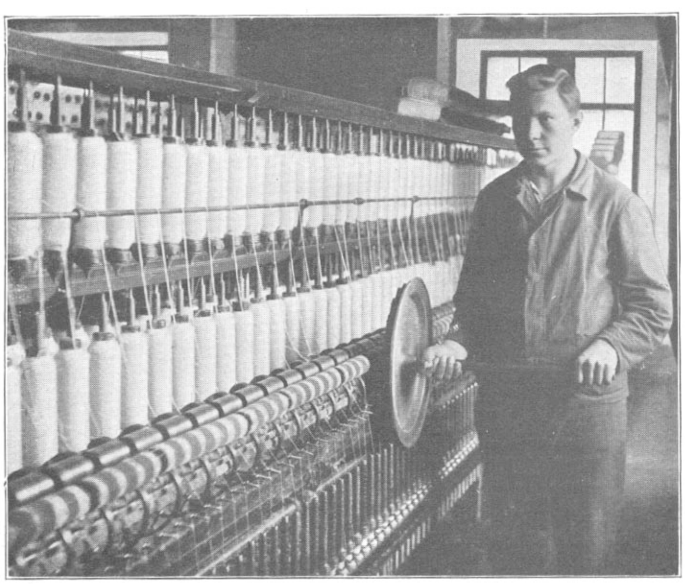


Fig. 2

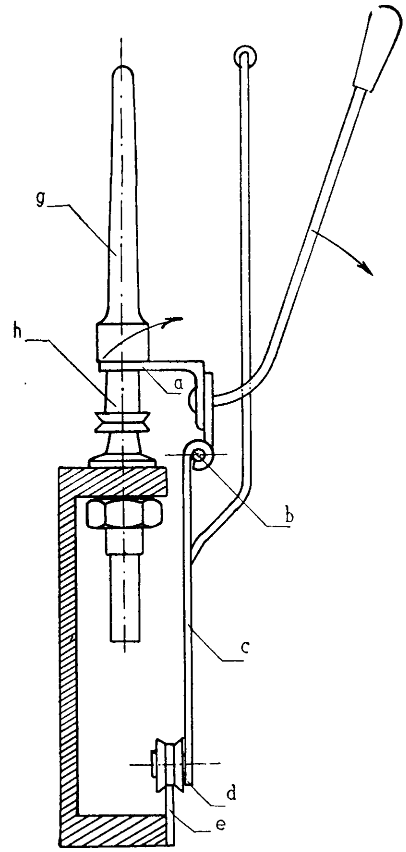



Fig. 3

Fig. 4

so arranged that the pigtail guides can be tipped up from the headstock of the machine, as is always the case with modern machines.

The press-on wheel affords other advantages besides this. The wheel does not miss a single tube or bobbin and cannot injure either these or the spindle itself, because pressure is always exerted vertically. In order to prevent an accumulation of yarn between the traveller and the drawing rollers, it is advisable to stop the machine quickly before applying the wheel; otherwise a loop of yarn might be caught and pinched by the bobbin as it slipped down. This can also be prevented by laying the yarn behind the spindles when putting the empty bobbins on the skewers, which can be done without loss of time. Care must further be taken that the upper tip of the tube is not lower than the tip of the spindle. These press-on wheels have been in use in a number of spinning mills for a year and have given the greatest satisfaction. It has been found in practice that one wheel is enough for two or three machines.

But even today it still takes too long to remove the tubes from the spindles and a press-off device has accordingly been constructed (Patents applied for in Germany and abroad) to facilitate and accelerate this operation. It consists of a fork a, the prongs of which are adjusted to the distance of the skewers and is mounted in a frame c so that it can turn at the point b (see Figures 3 and 4). The frame runs by means of two small wheels d upon a rail e which is screwed onto the lower part of the spindle frame. The wheel usually lifts from 20 to 25 tubes g at a time from the spindles h. *This is done in the direction of the axis of the spindles so that no side pressure is exerted upon them, as happens when the tubes are removed by hand, which pressure is severe and very injurious both for the tube and the yarn.* The roller bearing spindles which have recently come into vogue are particularly sensitive to lateral pressure. As soon as the first group of tubes has been removed by the spinner, she disengages it from the head of the tubes, rolls the frame to the next group, presses these off, and so on. The yarn cannot be pinched because the prongs of the fork push the yarn backwards when they are inserted under the tubes. One such device is generally enough for two machines. Practical trials have shown that the time taken to remove the tubes can be reduced by fifty per cent, through loosening them beforehand, which takes only a few seconds, because the operatives are not impeded in their work by tightly fitting tubes and are not made tired. It is evident that more or less time can be saved by the use of this contrivance, but the extent of the saving depends entirely upon the intelligence of the operatives and especially upon the overlooker who must direct systematically the work of the bobbin doffers.

The machine should be doffed in the following way. Two workers on each side of the frame start to press off the tubes and are at once followed by the bobbin doffers who lay the full bobbins orderly in trays. Then the empty tubes are lightly placed on the spindles and as soon as all have been set up the presson wheel is passed over both rows of spindles, beginning at the headstock, passing along the right side towards the back and returning on the left side. The use of these two devices in this way effects a very important saving of time.

# The Use of Weave and Material for Effects in Artificial Silk Fabrics

By *F. Müller*

In a fabric of artificial silk material and weave stand to one another not merely in a definite reciprocal relation, as is, indeed, the case with all other kinds of fabric also, but quite peculiar effects can be produced in an artificial silk fabric when both factors are properly and skilfully applied. Effects of like character cannot be achieved even with natural silk, for it is one of the best characteristics of artificial silk that it reacts effectively even to the very simplest expedients of the art of weaving. It is possible, for instance, by the use of the simplest of all weaves, the tabby weave, to make such diverse fabrics of striking effect with artificial silk, either by itself or in combination, that the design can be enlivened at will by new combinations of the material.

These effects are very much heightened in Jacqard fabrics, in which the weave by means of the figured pattern is not only able to influence the material in the most advantageous manner, but also serves to increase the effect of the lustre. The interplay of two or more fundamentally different weaves is often very important and is sometimes indeed the sole and decisive factor for evaluating the material in warp and weft.

A pure silk cloth is generally preferred to a union fabric, which is more difficult to deal with, but just the reverse applies with artificial silk, for it is just the mixed fabrics which are favoured owing to the greater capability of expression peculiar to them. Novelties can often be created in this line with simple means and cheaply, such, for instance, as the new fabric "Ramagé" shows, which combines in a very effective manner either artificial silk with wool or artificial silk with cotton.

More deserving of attention from the point of view of weaving technique are, however, the fabrics composed entirely of artificial silk, because their design presents much more difficulty than does that of the mixed fabrics. These latter have a material at hand for the most difficult part of the weave, that is to say, the warp, in the way of wool, cotton, etc., which offers no great resistance to being incorporated in the fabric. With artificial silk this is very different and it can be woven at all satisfactorily only by taking the utmost care and by preparing it suitably beforehand.

Difficulty upon difficulty may crop up when artificial silk is used for warp, although the quality is by no means inferior. Consequently it is generally customary to prepare the warp beforehand, either in the hank in the dyehouse, or by sizing in the weaving mill. This treatment by dressing, sizing, or otherwise, is all the more necessary when the conditions are not quite favourable owing to the nature of the weave and the closeness of the warp. Close weaves or the crossing of threads and a closely set warp are two great enemies of artificial silk. One-sided combinations of threads in patterns or figured designs also act unfavourably upon artificial silk warp because that part of the warp which is woven less closely soon tends to sag and the slack threads cause trouble just as do the warp threads which become tighter and tighter owing to the closer weaves. Care must therefore be taken in designing patterns for Jacquard fabrics to make sure, first of all, that the design units are distributed as regularly as can be over the breadth of the pattern or the repeat. Square divisions have proved themselves to be most suitable for this purpose and most numerous variations of patterns of this type have been brought out. They are in particular favour for the cravat industry, because these are generally woven with comparatively close warps so that suitable weaves and patterns must be carefully chosen. A characteristic style is the draughts board pattern, Figure 1. This class of patterns is to be met with nowadays much oftener than used to be the case, chiefly in artificial silk fabrics, because it permits most readily of a balanced interplay of weaves, and it is to be found in every imaginable shape and hue. The weaves generally taken are satin, taffeta, and twill.

If cross stripes generally of a contrasting colour and in a special weave are used for relief, as for example in Figure 1, it is as a rule necessary to have a special warp beam for these artificial silk warp stripes. If these effect stripes also are partly used in the foundation weave, as is shown by Figure 2, then the close plain weave is missing in the other half, so that the floating threads soon sag when they run from the same beam as the foundation weave and the tension is not specially regulated. As artificial silk is not elastic, it is well in such a case to consider beforehand how far it is possible to treat both groups of threads in the same way from the point of view of weaving technique, because the necessary separation begins with the warping.

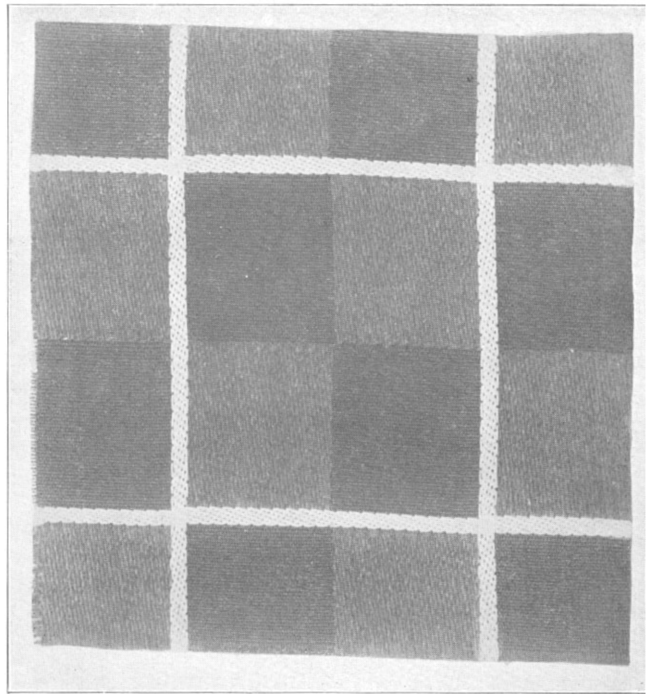


Fig. 1

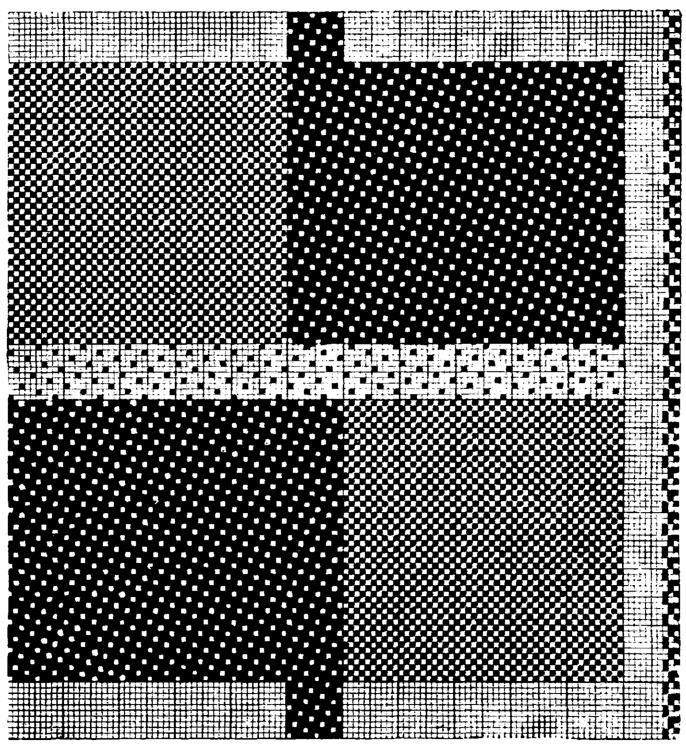


Fig. 2

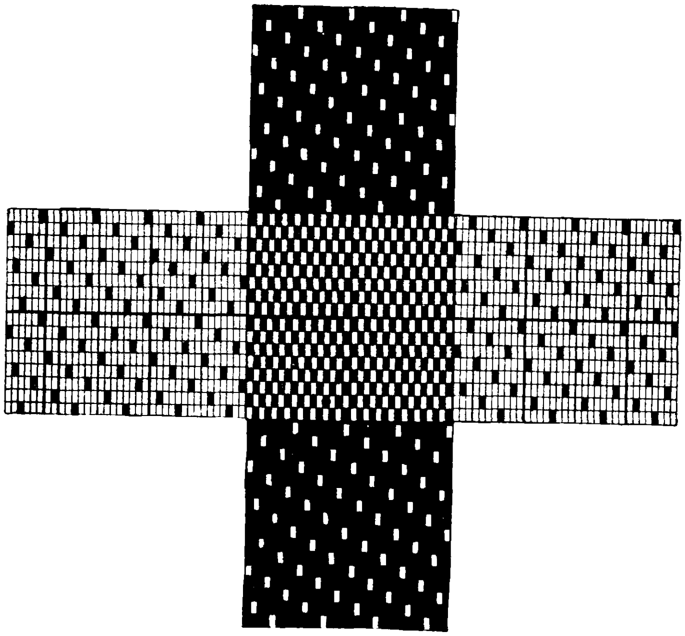


Fig. 3

effects which cannot be done with a one face satin weave, but only with a double-face weave, for which the plain weave comes into consideration.

Figure 3 shows a weave effect of this type in which a broad warp stripe, for example, blue, alternates with a similar weft stripe in green. The two stripes mix with one another at the plain weave interlacing point to form a shot effect which has much the same appearance as a shot silk.

It is a disadvantage of these blocks that the warp and weft threads do not cluster together at this point as they do, for instance, in the wide and loosely weaving satins. Consequently the warp and weft of stripes which have been woven pretty wide and close are inclined to crowd at the place in question, so that the block appears rather creased and crumpled. There is further the danger that artificial silk, which frays very readily, may cause irregularities in the weave when the threads are so crowded, giving rise to nests and loose threads which are very prejudicial to the appearance of the goods. In this event the pattern card must be altered, even if it has already been cut, for instance, by taking a double-tabby weave instead of a tabby weave, which can be done without much difficulty. The shot effect, however, with double weaves is not quite the same as with a satin weave.

For these effect stripes, whether warp or weft, weaves must be chosen which are suitable in character. In the weave design shown in Figure 2 the white warp stripe is marked by colouring over and is crossed by the white weft stripes, in satin weave. At the junction of the two stripes the warp stripe is covered by the weft and is thus interrupted. The reverse may also happen, so that the weft floats and the warp weaves all the way. When different colours and broader stripes are used, these crossings are employed to produce shot

The squares of the weave plan are often provided with jacquard figured patterns, as shown in Figure 4. In order to give these jacquard patterns an appliqué figuring, they are made to change their weave when they enter another field, in other words the figure is shown up upon the ground by a different intercrossing of the threads. If the figure appears on a plain weave in satin, then it changes to a twill on a satin ground. Figure 5 shows the design plan as well as the corresponding relation between warp and weft.

It can further be seen from Figure 4 that the jacquard figures have been systematically distributed so that no irregular weaves can appear in the design which

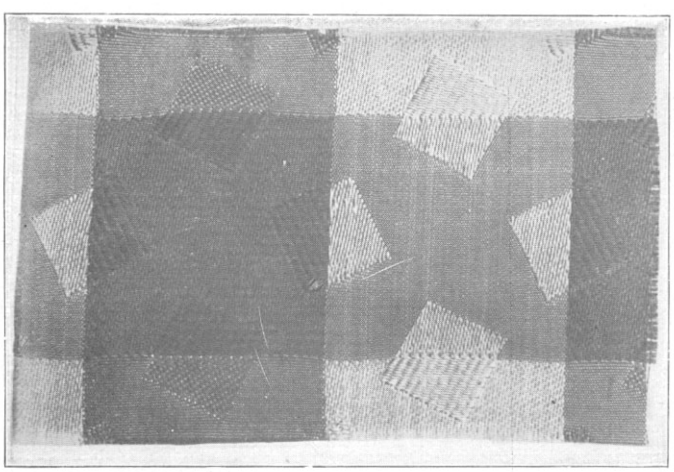


Fig. 4

would be detrimental to the employment of artificial silk.

For this reason small patterns are much in favour for artificial silk cloths, so as to get as lively a woven surface as possible like Figure 6, for example, in which each smallest part of the weave seems to be continually in motion. It can always be observed that the weave effects produced by an artificial silk warp dominate on the face of the goods. These warp effects then usually lie on the surface in the form of irregular small weave blocks, whereby they preserve their own colour in coloured fabrics and make an effective contrast with the mixed shade of the other parts of the weave.

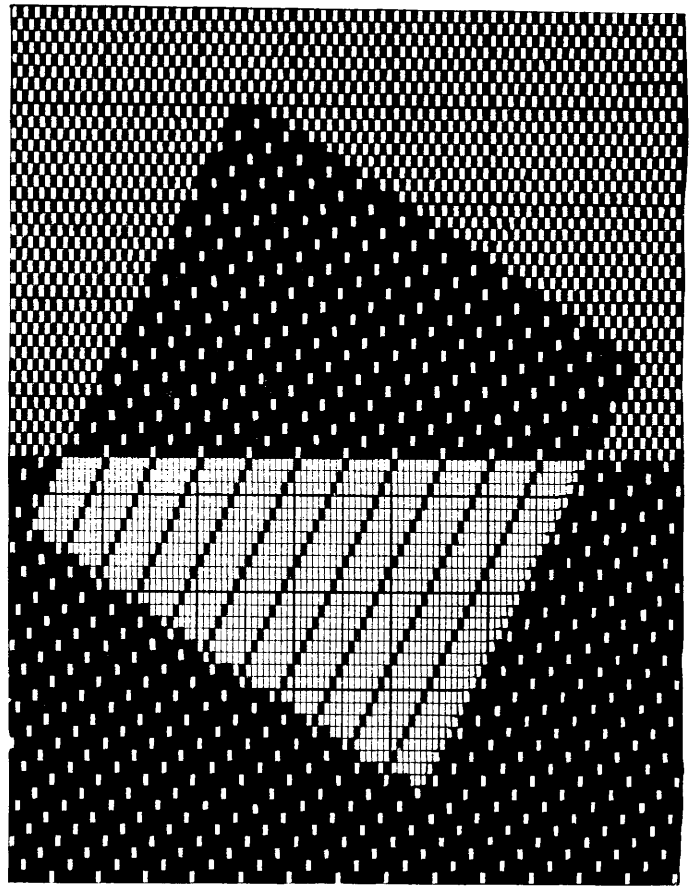


Fig. 5

It is surprising to find in all artificial silk cloths that the number of ends per centimetre is comparatively so low, more than 50 not being often met with. This was not due to chance, but was the result of the marked sensitiveness of the artificial silk warp. Although it was not merely the aim to use artificial silk for the warp without doubling it, but this was actually done, it made no change in the stubborn nature of the artificial silk. At the present time artificial silk is on the highroad to being perfected and improvements are continually being made, so that it will not be long before this last impediment in the way of the universal application of artificial silk will have vanished. It is already possible, by the use of suitable qualities of artificial silk, to work without trouble with 100 ends and more per centimetre. This brings the question of the replacement of natural silk by artificial silk well to the front. The idea has often been rejected with the argument that artificial silk can never hope to rival natural silk because it is an independent material of quite a different nature which above all does not possess the qualities and the value of natural silk. Such an opinion is today, when the state of the production of artificial silk is borne in mind, at least antiquated and is no longer sound because the producers of artificial silk are today striving to make it qualitatively more and more like natural silk. In fact they have for the most part been successful in their endeavours, and natural silk has even been improved upon in certain particulars.

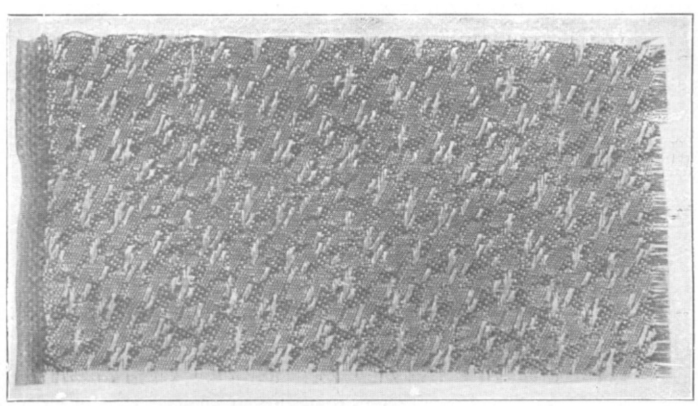


Fig. 6

It is well known to all engaged in the trade that it is more advantageous to work with artificial tram than with natural tram silk and this applies particularly to the weaving of coloured silk, which was often subject to trouble caused by the methods of weighting the silk. Nowadays only very little natural silk is used, and that is confined to organzine for close warps. But it has been found possible to produce a fine artificial silk and a warp is obtainable which is capable of being worked up just as well as the expensive doubled organzine, so that this too will disappear in the course of time, just as tram has been disappearing for years and even decades. It is merely a question of time, because further great advances in the production of artificial silk are before us which in the near future will open new vistas for its use in the textile industry. Finally artificial silk will give rise to new types of fabric unrivalled for compactness, strength, and cheapness.

At the present time endeavours are being made to select weaves for artificial silk, especially for artificial silk warp, which will treat the material as gently and as advantageously as possible to prevent it from fraying. It should, however, be pointed out that artificial silk which has not been doubled is used for warp because it has more covering power, and even in this state it is better to work with than organzine which is doubled, but also weighted. The weave effects attained by this means are always striking in accordance with the character of artificial silk.

# The Technical Basis of the Examination of Textile Materials and the Influence of Moisture Thereon

By Professor *F. Pichler*

Most mills make it a point to test very carefully the yarn they purchase before starting to work it up. This examination extends to checking the weight of the goods and the tare of the tubes, the correctness of the yarn number, the cleanness of the yarn and its evenness, the twist, the strength, and the elasticity of the yarn, the moisture content, the quality of the raw material used, the ash and fat content, and, when dealing with mixed yarns, the percentage of each present.

This examination is necessary, because otherwise unpleasant surprises may be expected when the yarn is advanced or even being finished, and faults discovered which cannot be made good as it is then too late to lay a claim for loss or damage. Every spinning mill in fact should examine its yarn with like thoroughness before delivery, which would practically obviate complaints by the consumer.

Everyone who has to do with the acceptance or delivery of yarn must be fully conversant with the methods used for testing yarn and the customs as between producer and consumer which have been developed in the course of time. It is also of value for experts and judges who have to decide commercial cases to have a good knowledge of these facts.

Whatever form the examination may take, it is based upon trade usages and customs which have been developed in actual practice. But besides this the material in question must meet certain definite requirements if it is to be manufactured into goods which are irreproachable in appearance and condition.

To carry out an examination of this extent each mill would of course have to be equipped with all the instruments and apparatus of precision required. But this would be an unfair demand and public material testing offices fitted with all the latest technical equipment have been set up in a number of centres of the textile industry for the purpose of carrying out such tests, and the Government has empowered these testing houses to draw up and issue documents which are legally binding.

The most important apparatus and instruments to be found in every testing office are as follows:

1. An analytical balance sensitive to 1 milligram and accurate gram weights.
2. A precision balance for technical use sensitive to 0.1 milligram.
3. Conditioning apparatus for testing regain.
4. Apparatus of different construction and strength for testing strength and extensibility.
5. Apparatus and balances for determining the yarn number and silk count.
6. Precision reels for various types of yarn and yarn counts.
7. Tensioning apparatus with device for measuring extensibility.

8. Rubbing testing machines.
9. Apparatus for determining the purity and evenness of yarn.
10. Balance for determining the weight per square metre.
11. Apparatus for determining thickness with micrometer scale.
12. Hygrometer for measuring atmospheric humidity.
13. Apparatus for counting threads accurately with device to tension the fabric.
14. Shallow dishes of platinum or quartz glass with blowpipe arrangement for ash tests.
15. Extraction apparatus for determination of the fatty content.
16. Microscope and microphotographic apparatus with the requisite optical accessories.
17. Airtight tins for transporting the material.
18. Apparatus for testing permeability by water and air.
19. Hank hooks.
20. A textile chemical laboratory.
And other equipment.

Even if such a testing office is completely furnished with all these instruments, the work can only be carried out accurately and with precision when the investigator has not merely scrupulously considered all the factors that can in any way influence the progress of the tests and their results, but has faithfully observed and weighed them with the greatest objectivity.

The results of control tests never agree completely, whecher made in the same office or elsewhere and with the same instruments or with others. This is due to differences in the nature and sharpness of subjective observation and to the more or less accurate functioning of the apparatus and instruments employed. For this reason a margin of divergence must always be recognized as permissible, all the more as it is impossible to observe the same material twice under precisely identical conditions, e. g. in the ash test.

The result of tests depends very often upon the varying humidity of the atmosphere, for all textile materials are very hygroscopic, and are inclined to adapt their moisture content to that of the surrounding air wherever they are in process of manufacture, or in storage, or being tested.

A definite humidity of the air is often called for in workrooms and storerooms, and various systems have been devised for conditioning the air or defogging it to meet this requirement.

The relative humidity of the atmosphere varies in Central Europe between 65° and 80°, and is much higher in countries such as England with an ocean climate. It is said that this naturally higher relative humidity in England alone makes it much easier than in Central Europe to spin the very finest cotton yarn numbers.

On account of the extremely many-sided effect of atmospheric humidity this aspect of the question will be dealt with more fully in the following lines.

The amount of vapour actually present in one cubic metre is known as the absolute humidity. But air, as a rule, is never completely saturated with moisture. By observing and measuring atmospheric humidity, it has been found that a definite relationship exists between temperature and degree of saturation, one cubic metre of air saturated with water vapour containing

| | | | | | | |
|---|---|---|---|---|---|---|
| at — | 5° C . . . | 3.5 | grams | per | cubic | metre |
| ,, | 0° C . . . | 4.9 | ,, | ,, | ,, | ,, |
| ,, | + 5° C . . . | 6.8 | ,, | ,, | ,, | ,, |
| ,, | +10° C . . . | 9.4 | ,, | ,, | ,, | ,, |
| ,, | +15° C . . . | 13.0 | ,, | ,, | ,, | ,, |
| ,, | +18° C . . . | 15.3 | ,, | ,, | ,, | ,, |
| ,, | +20° C . . . | 17.0 | ,, | ,, | ,, | ,, |
| ,, | +50° C . . . | 30.0 | ,, | ,, | ,, | ,, |

If one cubic metre of air contains more vapour than shown in this table, the superfluous moisture must be precipitated in the form of dew, mist, or rain.

The percentage proportion of the amount of water vapour actually contained in one cubic metre of air at a given temperature to the quantity of moisture required to produce saturation is known as the relative humidity. Its calculation can be explained by the following example. What is the percentage of the relative humidity if air at a temperature of 18° C needs 15.3 grams per cubic metre for saturation, but actually contains only 10 grams per cubic metre. This gives us the following equation

10 grams per cub. metre : 15.3 grams per cub. metre = x : 100

$$x = \frac{10 \cdot 100}{15 \cdot 3} = 65{,}36\ \%.$$

That is to say, the relative humidity is 65.36 per cent.

Conditioning and the influence of the relative humidity upon the results of conditioning.

The relative humidity of air has a far-reaching influence upon the properties of textile materials, and this influence, as I intend to show, is much greater than generally supposed or admitted.

Air yields moisture to all hygroscopic bodies, such as vegetable fibres, and, to an even higher degree, animal fibres, especially wool, more easily and more rapidly the nearer it has approached its saturation point, that is to say, the higher the relative humidity and the drier the goods are.

In the various customary regulations for the control of the yarn trade is laid down also the technical basis of the conditions under which textile materials must be tested for moisture. There is also settled what percentage of moisture may be contained in each of the different kinds of yarn in order to show the normal humidity, and how the moisture is to be tested for, or how the conditioning is to be carried out.

First of all the conditioning apparatus (Figure 1) will be more closely described so as better to understand how atmospheric moisture can affect the conditioning.

This apparatus is equipped as a rule for being heated electrically or by gas and consists of a predryer and a main dryer. In dryness testers of the Schopper type so much used the predryer consists of the following parts:

1. A heating chamber H provided with two independent gas burners, one being a ring burner and the other an end burner. If heated by electricity the current can be regulated at 30 amperes.
2. A chamber for heating the air (L) streaming in through a pipe from the main heater.
3. Three chambers for predrying the yarn.
4. Three baskets (d) with thermometers ($t_1$) to hold the material to be dried. (Only two are shown in the Figure.)
5. Three thermometers ($t_2$) to measure the dry air.
6. An outlet pipe for the moist air (m).
7. An outlet pipe for the combustion gases, if heated by gas (n).

The main dryer consists practically of the same parts as the predryer, but it contains only one drying chamber (R) and one basket (d) which is suspended directly in a precision balance W, so that weighing can be done during drying in the drying chamber itself. This is very important, because otherwise it would be impossible to weigh absolutely dry material accurately in normal moist air.

Two pipes lead from the main dryer to the predryer, one being for the exit of the gases of combustion (o) which must not come into contact with the material to be dried. Otherwise the goods would absorb moisture again, because much water is produced as a gaseous combustion product when illuminating gas is burnt.

The second pipe (p) serves to conduct away the moisture escaping from the material being dried. This moisture is swept forward by the fresh air entering at the side, which itself always contains a certain amount of relative humidity. The escape of this moisture can be hastened by the use of an electric ventilating fan. Thus a large amount of hot, relatively very dry air is led uninterruptedly to the material to be dried. The hot air escaping from the main dryer is led into the predryer and there utilized once more. The hollow axle of the basket contains a thermometer ($t_1$) and other thermometers ($t_2$) can be suspended in the predryer either at the front or in the rear.

Before beginning the testing the constants must be settled (by Schopper's method), that is to say, the heating is so adjusted that the temperature in the drying chamber remains constant at 105—110° C.

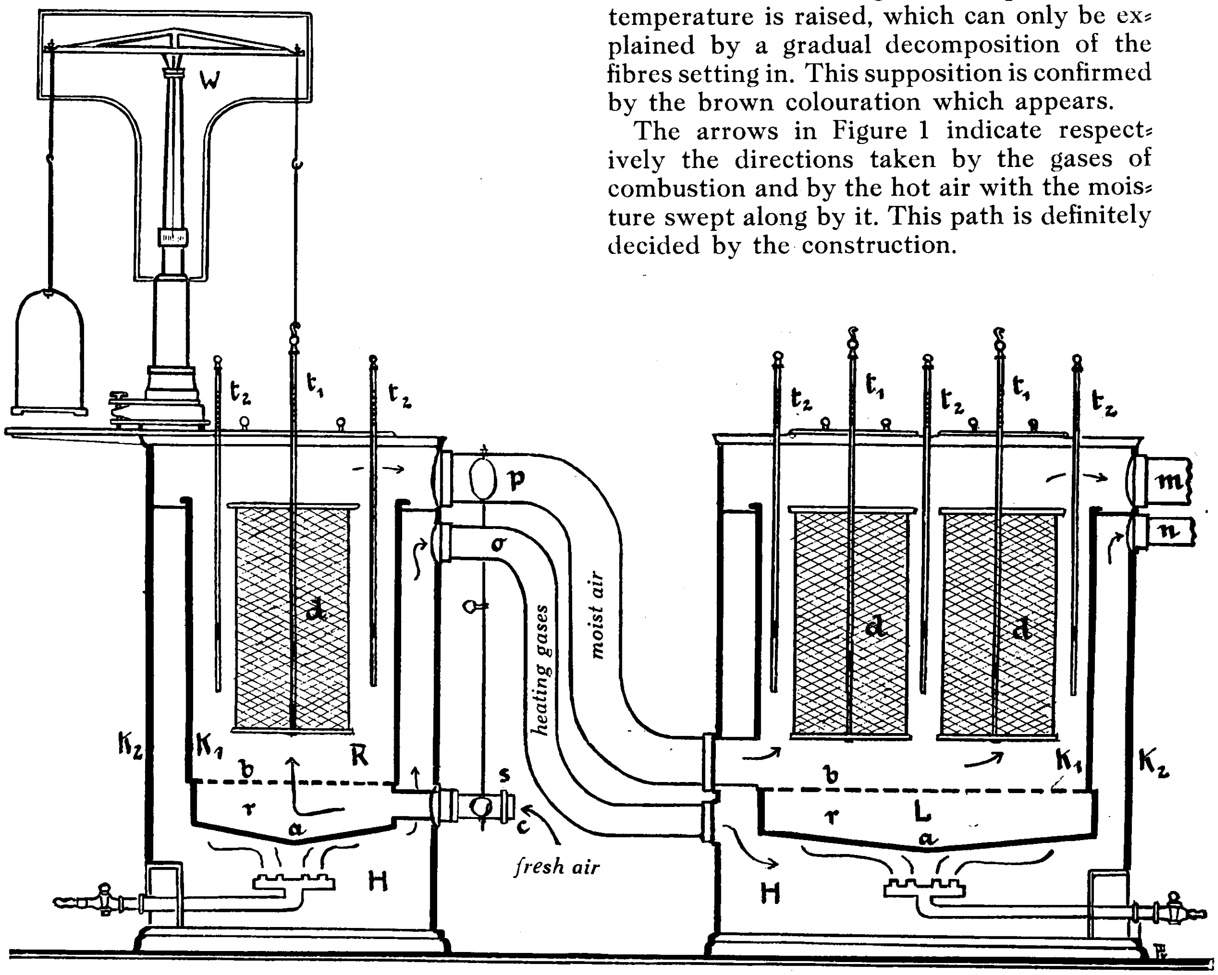
For this purpose both burners are allowed to burn for about 20 minutes until the thermometers at the sides indicate 70° C. Then the end burner is turned off and the ring burner alone provides the heat. The flame is turned down till the gas pressure of about 2.5 centimetre water column is indicated. In about 10 minutes a temperature of about 105—110° C is reached and this is then maintained.

If too much heat is present, the gas supply through the burner must be reduced or the current of air accelerated.

The baskets are first carefully tared and the material, which has been accurately weighed, is put into them and they are hung up. Then the inlet and outlet valves are opened and the hot air cooled in passing over the baskets until almost all the moisture has been expelled. Consequently the thermometer in the basket always indicates a lower temperature than that indicated by the thermometers placed at the sides which then serves to regulate the heating.

Weighing can be started when the thermometer in the basket shows 100° C.

The German cotton contract terms provide that drying must be continued until the reduction of weight between two weighings




Main dryer Figure 1. Conditioning apparatus Predryer

within 10 minutes is less than 0.05%, that is, until the material can be regarded as being theoretically absolutely dry. Strictly speaking, however, conditioning is not really finished until the last weighings give absolutely identical results. Under no circumstances should the last weighing read higher than the previous one.

It is, however, impossible to gauge accurately the precise moment when complete dryness is reached, because at that very moment the relative humidity, amounting to about 55—65%, of the air entering the drying chamber by the lower inlet-port makes itself unpleasantly noticeable. In spite of the high temperature, the absolutely dry material at once absorbs moisture and the weight rises quite considerably. This increase may be as much as several tenths of a gram if the buner has been turned down. After having been dried for about two hours the weight of the material will have become fairly constant and then the weight must be uninterruptedly and accurately kept under observation, so as not to overlook the state of absolute dryness.

If the weight has increased, a further considerable loss of weight takes place if the temperature is raised, which can only be explained by a gradual decomposition of the fibres setting in. This supposition is confirmed by the brown colouration which appears.

The arrows in Figure 1 indicate respectively the directions taken by the gases of combustion and by the hot air with the moisture swept along by it. This path is definitely decided by the construction.

The main dryer consists of two boilers $K_1$ and $K_2$, the larger of which encloses the smaller concentrically, so that each is a completely closed space by itself. A stout cast iron plate (a) is fitted directly above the flame and a little higher up a perforated plate (p). The fresh air from outside passes through the tube (c), which can be more or less completely closed by means of a slide (s), into the space (r) between the two plates. It is warmed by the heat rising from the castiron plate, becomes thereby specifically ligther, rises, passes over the basket (d) containing the material to be tested, penetrates the material itself, and carries with it the moisture which has been converted into steam at from 105—110° C. A supply of fresh air is continually brought in by suction. The air laden with moisture which passes through the tube (p) into the predryer heats this in turn and is carried off by the suction at m in the outlet shaft. Through this arrangement, as can be seen from the sketch, the gases of combustion, which contain much water vapour, do not come into contact with the material to be dried; they merely pass round the hollow space between the two boilers in the predryer, pass through the tube (o) and unite with the heating gases originating there, then pass round the inner boiler again and pass through the tube (n) into an air shaft or the chimney.

In order to make the conditioning results independent also of any chance external influence of moisture, the German cotton contract terms provide that the samples of each lot of material must be sent to the Testing Office in hermetically sealed tins or glasses.

It is further provided that the samples taken in the way prescribed are to be divided into three portions and weighed accurately to one-tenth gram. Two of these lots are dried at 105—110° C. Silk and artificial silk, on the other hand, are dried at a higher temperature. The valid commercial weight is calculated from the dry weight by adding the permissible regain. The maximum divergence or the limit of error between the two results has been fixed at 0.5% (for silk one-third per cent.).

If the loss of weight in the two parcels agrees to within one-half per cent, the drying can be regarded as having been sufficient, but if the difference is more than 0.5%, but less than 1%, then the third lot also must be dried. If the maximum difference between the results of the three dryings does not exceed one per cent, then the average of all three dryings is taken as the commercial weight.

If a control test by another Testing Office does not differ from the result of the first test by more than 0.5%, then the result of the first test is held to be authoritative, otherwise the average of the two. If the result is to be controlled by another Testing Office, fresh samples must be taken; it is not permissible to weigh and dry the same sample a second time.

The following calculation may serve as a technical basis for conditioning to settle the valid commercial weight:

net weight of one lot.... 480.000 grams

Readings of the last four weighings:

| | Time hours | min. | dry weight | moisture grams | moisture % |
|---|---|---|---|---|---|
| 1. | 4 | 10 | 442.600 | 37.400 | 8.450 |
| 2. | 4 | 20 | 442.390 | 37.610 | 8.502 |
| 3. | 4 | 30 | 442.270 | 37.730 | 8.533 |
| 4. | 4 | 40 | 4422.70 | 37.730 | 8.533 |

| | |
|---|---|
| Found on the first reading | 8.450 % |
| „ „ „ second „ | 8.502 % |
| difference | 0.052 % |

The difference, that is to say, amounts to more than 0.05%, so that a third reading is taken after 10 minutes.

| | |
|---|---|
| Found on the second reading | 8.502 % |
| „ „ „ third „ | 8.533 % |
| difference | 0.31 % |

The difference now amounts to less than 0.05%, so that the drying can be considered as completed, since no loss of weight can be found even after 10 minutes.

If a further increase in weight were found again after another 10 minutes, that would be a proof that the material was absolutely dry. The result of the last weighing must not be higher than that of the one before.

As indicated above, two parcels of the material must always be dried and the results of the two weighings must not differ by more than 0.5% as shown by the following two examples.

The drying of a lot of woollen yarn in two parcels gave the following results:

| | first parcel | second parcel |
|---|---|---|
| net weight | 518.880 grams | 511.680 grams |
| dry weight | 440.750 grams | 440.300 grams |
| moisture in grams | 74.130 grams | 71.380 grams |
| moisture in % | 16.600 % | 16.211 % |

The difference is 0.389% and is thus less than 0.5%; the limit of error is not exceeded so that the third parcel need not be dried.

As can be seen from the above, the moisture content of textile materials is very dependent upon the relative atmospheric humidity, but it could very easily be raised to a greater extent than is allowed, to the loss of the purchaser. On the other hand, the vendor has the right to take the usual regain allowed in the trade as a basis for payment, so that a conditioning is often absolutely necessary. For many classes of goods excessive moisture can otherwise be injurious also and this must be taken into account in tropical countries overseas where the action of atmospheric moisture is enhanced by the salt content of the air. It is therefore provided that goods which are sensitive in this respect must be packed in hermetically closed and soldered zinc containers which in turn are packed in wooden cases.

The influence of atmospheric humidity on the yarn number.

In the trade a yarn count is held to be correct when the yarn has the prescribed moisture content.

To determine the number of yarn supplied in the form of cops or hanks, as large lengths of yarn as possible must be wound on an accurate reel and measured, so as to cancel variations in thickness. Even during winding the yarn loses a few grams in weight, because the rapid motion of the swift causes a loss of moisture. Storage in rooms of different humidity can also influence the calculation of the yarn number by raising or lowering the weight. If the yarn is moist, the pressure between the fibres caused by their swelling up always rises.

First of all the exact length of the yarn must be found, but even this is not very easy. The length depends upon a number of factors, which may be summarized as follows:

1. Whether the yarn was wound parallel on the swift, or was wound crossways on a cross reel.
2. The tension of the yarn running to the swift; this tension must be measured.
3. The twist of the yarn. The extension of sharply twisted and fine yarns is less than that of coarse, weakly twisted, soft spun, long-fibred woollen yarns.
4. The crinkling of the fibres and the extension caused by the pull.
5. The rate of revolution of the swift. If the rate of speed is too high, soft spun, long-fibred woollen yarn tends to stretch very much and can only be removed with difficulty from the swift. Wool and cotton yarn is wound at the rate of 250 metres per minute, silk yarn at 50—75 metres per minute.
6. The manner in which the yarn is guided under the action of the braking and clearing motion.
7. The way the cops are creeled and the axial and radial course of the yarn from the cops.
8. The form of the cops and the progressive unwinding of the yarn from them.

For these reasons it is advisable to calculate the mean number of from five to ten series of tests, so as to attain approximate accuracy. Besides this it is customary in the trade to allow a certain definite toleration upwards and downwards for yarns of different materials.

The yarn number always refers to the raw yarn and should always be calculated from the valid commercial weight with the normal moisture content. The following allowances are made for loss in bleaching linen yarn: for a full bleach 20%, for a three quarter bleach 18%, for a half bleach 15%. The loss in bleaching cotton is from 2 to 5%. Suppose 500 metres raw linen yarn weigh 25 grams and lose in a full bleach 20%, that amounts to 5 grams.

The metrical number for this bleached yarn is therefore $500 : 20 = 25$ metres.

The metrical number for the unbleached yarn is $500 : 25 = 20$ metres.

If the yarn has been dyed, from 2 to 5% is added to the count according to the colour dyed. For sized yarn the addition is from 4 to 8 per cent.

The following calculation shows what an influence moisture has on the yarn number, the same yarn length with too much moisture having a lower number and a too high number with less moisture.

For instance let

N represent the valid commercial weight with the correct regain;

$N_1$ the number of the yarn with too much or too little regain;

G the weight of one metre yarn with normal regain;

$G_1$ the weight of one metre yarn with too much or too little regain.

Then the number $N = \frac{1}{G}$ and the moisture or dry number $N_1 = \frac{1}{G_1}$. Then

$$N : N_1 = \frac{1}{G} : \frac{1}{G_1}$$

from which follows that $N_1 = \dfrac{\frac{N \cdot 1}{G_1}}{\frac{1}{G}} = \dfrac{N \cdot G}{G_1}$.

$N_1 = \dfrac{N \cdot G}{G_1}$ = the dry or moisture number.

$N = \dfrac{N \cdot G_1}{G}$ = the valid commercial number.

For instance, 400 kilograms 60s yarn lose 10 kilos weight in storage, what is the number of the too dry yarn?

$$N_1 = \frac{60 \cdot 400}{390} = 61{,}52 \text{ (metric).}$$

Twenty bobbins taken from a damp yarn store (78/2 worsted yarn) weighed 1124 grams and showed the number 77 (metric). After conditioning a commercial weight of 1109.60 grams was found; what is the commercial number?

$$N = \frac{77 \cdot 1124}{1109 \cdot 60} = 75/2 \text{ (metric)}.$$

It is important to know in dealing with bundled yarn whether the bundle contains the proper yarn length or yarn number. Although the weight of the bundle is in order the conclusion cannot be drawn that the length or the yarn number corresponds exactly with the yarn number invoiced, for any loss in weight can easily be replaced by more moisture.

For example, the yarn of a bundle weighing 5 kilos may have a moisture content of 7.83% of its normal weight or 8.5% of its dry weight; 7.83% of 5 kilos = 391.5 grams, consequently the dry weight of a 5 kilos package = 5000 grams — 391.5 grams = 4608.5 grams.

But if the dry weight of a bundle were only 4400 grams, this would correspond only to a valid commercial weight of 4774 grams with a moisture content of 8.5%.

A 5 kilo bundle of 40s cotton (metric) must have 200,000 metres; if these show a valid commercial weight of 4774 grams, then the correct number is 200,000 : 4771 = 41.89 (metric).

A deviation of only 4.5% is allowed for yarns above 40, but 4.5% of number 40 amounts to 1.8, so that the deviation is more than allowed and the yarn can be placed at the disposal of the vendor.

In a 5 kilos package of 40s bundled yarn (metric) there are 40 knots of 200 hanks of 1000 metres each, i. e. 200,000 metres, which must weigh 5 kilos. One hank weighs 25 grams, two weigh 50 grams and are 2,000 metres long. If two hanks are missing in a bundle, then the whole bundle has a length of only 198,000 metres and the bundle would be 50 grams too light, that is, it would weigh 4950 grams, the normal humidity of which (7.83%) would be 387.585 grams.

The permissible dry weight is 4950 grams — 387.585 grams = 4562.415 grams, but if the weight of the two missing hanks is replaced by 50 grams water, the net weight of the bundle is actually 5000 grams, but the permissible dry weight is only 4562.415 grams. The moisture content would be 437.415 grams = 9.59% of the dry weight, so that the goods have 9.59% — 8.5% = 1.09% moisture too much.

Now if 198,000 metres including water weigh 5,000 grams, the number would be 39.6, while the valid commercial number of the bundle would be 198,000:4945 = 40 (metric).

In a 10 pound bundle of 40/1 (English) = 10 hanks of 840 yards each go to a pound. Ten hanks make one knot, so that 40 knots contain 400 hanks of 840 yards amounting to 336,000 yards and weigh 10 pounds.

If the valid commercial weight of a 5 pound bundle is 4536 grams, the corresponding dry weight is 4180.83 grams, that is 7.83% of the normal weight of 4536 grams. The yarn has the proper moisture content of 8.5% and the correct English count 40.

But if the dry weight were only 3991 grams, that would give 339 grams regain at 8.5% and the valid commercial weight would be 3991 +339 = 4330 grams and the yarn count would be 41.9 instead of 40 (English).

If the dry weight amounts to 4085 grams with a net weight of 4536 grams, the moisture actually present is 4536 — 4085 grams = 451 grams, which represents as much as 11% moisture.

If, however, the dry weight is 3991 grams and the valid commercial weight 4536 grams, then the moisture is actually 13.65%.

According to the terms of the German cotton contract the purchaser is entitled to return to the vendor any cotton which contains more than 10% of moisture. The same applies to cotton above 30 (English), when the count differs by more than 4.5% from the count invoiced. In the case of 40s yarn that is 4.5% = 1.8%, consequently the yarn count 41.9 must be returned.

If the correct yarn count has been figured on the basis of the normal moisture content, it is customary in the trade to admit variations from the proper count in accordance with the fineness of the yarn and the unavoidable sources of error. As a rule a number of spinning machines work together the yarn of which is combined to form one lot, so that variations can readily arise here.

If the yarn delivered is objected to because of the number being wrong, a number of samples corresponding to the size of the lot must be taken from different sections and all examined to settle the count. The average result of all the values found is then taken as the right yarn count.

Certain yarns, however, are excluded from this average calculation. Such yarns, for instance, as show a variation from the number invoiced upwards or downwards up to 24s of 5—7% according to the rules of the Exchanges in Vienna and Prague, and 4.5—10% according to the terms of the German cotton contract.

If finer yarn is supplied than was contracted for, no compensation is made. If the yarn supplied is coarser than invoiced and the variation downwards is more than 3%, no redress can be demanded. But if the difference is more than 3%, the amount by which it exceeds 2% must be compensated according to the greater amount used in working it up.

According to the rules of the Exchanges in Vienna and Prague the following variations are not compensated: in the case of yarns up to No. 14 inclusive a variation of more than 7%; from No. 14 up to No. 24 inclusive a variation of more than 6%; above No. 24 of more than 5%.

The following variations are not compensated according to the rules of the German cotton contract:

when the variation up to No 5 is more than 10%

| | | | | | |
|---|---|---|---|---|---|
| from No. | 5 | to No. | 10 | inclusive | 8% |
| ,, | 10 | ,, | 14 | ,, | 7% |
| ,, | 14 | ,, | 22 | ,, | 6% |
| ,, | 22 | ,, | 30 | ,, | 5% |
| above No. | 30 | ,, | | | 4.5% |

Effect of moisture on the weight of the tubes.

Different places have different regulations for the permissible weight of the tare of the tubes. In spinning mills the yarn is generally overmoistened in the conditioning room because it is known that part of the moisture is lost already during storage in the yarn packing room and while the cops are being packed in boxes, so that the moisture in the yarn after it has been packed for shipment has adjusted itself. But over-moistened yarn imparts its moisture also to the highly hygroscopic paper tubes. On the other hand, the outer parts of the cops in the chests dry out more strongly than the inner parts, especially when the wood of the chests is rather dry and the relative humidity in the storeroom was rather low. Besides this, hot, dry summer days during railway transit also have their effect. Under these conditions the tubes may have a higher percentage of moisture compared with the weight of the yarn which may form a ground for claims.

If the yarn has been wound on a swift from more than ten cops, in order to determine their weight the empty tubes must at once be shut up airtight, or weighed at once accurately to one-hundredth of a gram according to the regulations. The tare of the tubes is calculated from the weight of the tubes found in this way and the weight of the yarn plus the tubes.

If the tubes are allowed to lie open for some time in a room with a different relative humidity from the moisture of the tubes themselves, the percentage of moisture in the tubes would be raised or reduced accordingly.

According to the German cotton contract terms the weight of the paper tubes of warp cops and mule cops on short tubes must not exceed 1.5% of the invoiced weight of the cops (yarn and tubes), in the case of weft cops of normal size and larger as well as ring warp cops on light tubes and cheeses 2.5 per cent.

Warp cops are such as weigh more than 36 grams, weft cops of normal size have a tube length of 140 millimetres with a diameter of 24 millimetres with a minimum weight of 16 grams.

If the tube weight exceeds these limits, compensation must be made for the difference between the permissible and the actual weight of the tubes at the full price of the yarn. For example, a purchase was made of 1,000 kilos warp cops. The permissible tube tare is 2.5%, that is, 25 kilos, which are not compensated. But if the tube tare amounted to 2.8%, then the weight of the tubes is 28 kilos, and for the difference between the permissible tare of 25 kilos and the actual weight of the tubes compensation must be paid to the purchaser. If, however, the tubes had lost weight to as much as 0.3% by lying in too dry air before being weighed, then there would be no question of compensation, although the purchaser would be entitled to demand it.

It is therefore to the interest of the purchaser to have the tare of the tubes correctly ascertained.

Effect of moisture on the strength of the yarn.

Great variations in the temperature of the rooms where the yarn is stored, worked up, and examined, as well a sudden violent changes in the weather exercise a very noticeable effect upon the power of adhesion of the yarn fibres. The connection between moisture and the strength of yarn has often been the subject of searching investigations and articles in the literature of the trade. Unfortunately there do not exist any normal tests or regulations as to the conditions of moisture under which tests of the strength of yarns and fabrics should be carried out.

At any rate it would be very important to test all yarns in regard to strength at the moisture content allowed them. At the least

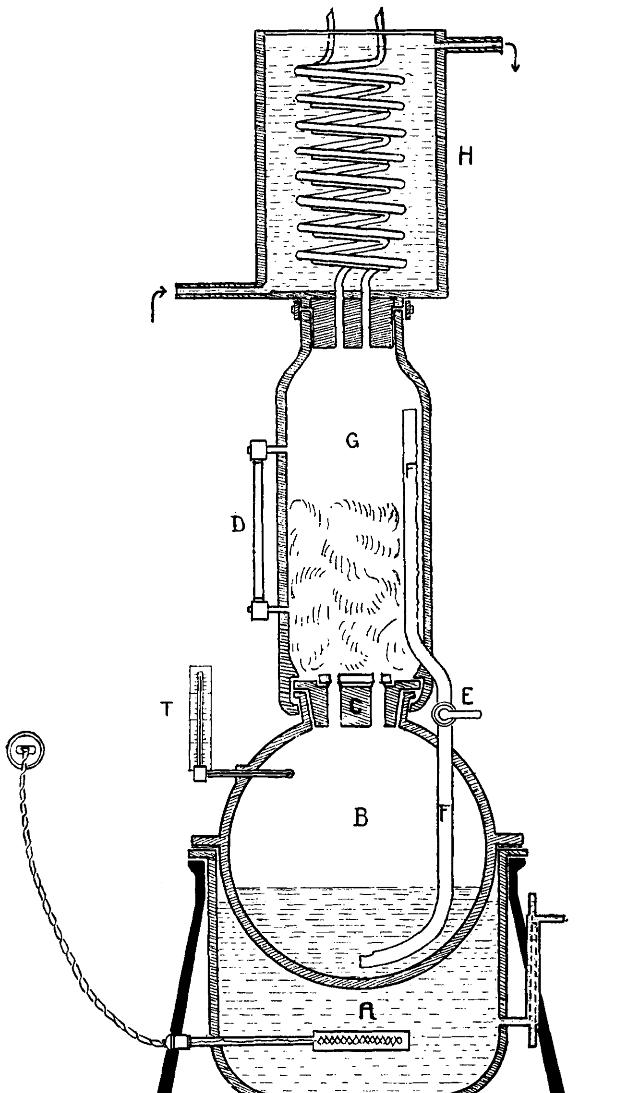



Fig. 2

it would have to be known at what room temperature, at what atmospheric moisture and for how long a yarn which is to be tested for strength would have to lie in the testing room in order to show the normal moisture content. The percentage moisture content of the yarn to be examined for strength would also have to be mentioned in the award submitted.

It is a matter of common experience that the strength increases with the moisture content. According to Fiedler cotton warp yarn (40s) showed the following strengths after prolonged storage in moist rooms:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| at 6.5% | moisture | content | a | strength | of | 125 | grams |
| „ 7.5% | „ | „ | „ | „ | „ | 131 | „ |
| „ 8.5% | „ | „ | „ | „ | „ | 135 | „ |
| „ 9,5% | „ | „ | „ | „ | „ | 140 | „ |

Warp yarn, on the other hand, showed the following average strength after having lain for a long time in a room with

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 20% | relative | atm. | humidity | 210 | grams | average | strength |
| 40% | „ | „ | „ | 222 | „ | „ | „ |
| 70% | „ | „ | „ | 244 | „ | „ | „ |
| 95% | „ | „ | „ | 260 | „ | „ | „ |

As can be seen, all fibres adapt themselves very quickly, owing to their hygroscopicity, to the conditions of humidity prevailing in the room they happen to be in.

At any rate, it is important for the strength test always to test the yarn at the same moisture content with which it was sold or worked up. Therefore it should lie for a considerable time in the room where it is to be examined at a constant atmospheric humidity of 60%. To save time, however, this is not always done.

Influence of the relative humidity on the ash test for cotton.

It is necessary to test the incombustible residue, the ash content, when preparing waste cotton for nitration.

If the waste cotton contains 8.5% moisture, the percentage weight will agree when the ash residue is determined, but it will not agree if the moisture content is higher or lower. For example, if 50 grams cotton with normal moisture content yield 0.5 gram ash, that is 1%. But if the cotton contains 5 grams more or less moisture, that is to say, if it weighs 55 grams or 45 grams, the ash residue in each case is 0.999% and in the other 1.111% per cent.

The ash itself is also hygroscopic. If it is weighed immediately, as ought to be done, the weight found is always less than when it has been allowed to stand for some time in a room with 65% relative humidity.

When using a good blowpipe, the reduction of 50 grams of cotton completely to ash occupies about one hour and a half, and care must be taken that the whole has been completely burned to ash.

All sorts of cotton waste are used in cotton waste breaking mills for the manufacture of waste cotton. Coloured material is first bleached, but any metallic mordants present are not removed and these may affect the natural ash content of the cotton to any extent.

For this reason and owing to the varying nature and origin of the raw material, a control test made in the same Testing Office or elsewhere can never give the same percentage of ash content. This affords a natural explanation even for the great differences that may be expected.

Influence of the relative humidity when testing the fatty content of fibres.

Cotton always naturally contains a small quantity of fat and this content is increased by ginning, for the crushed cotton seeds which are rich in oil give up part of it to the raw cotton.

Wool also is often treated with oils and oil emulsions in woollen and worsted spinning mills to facilitate the movement of the yarn during spinning. The additions of this nature are sometimes particularly large in the case of carded wool that is spun in oil, so that testing offices often have to test the fatty content also.

The ingenious Soxhlet apparatus is suitable for use with small quantities. But it is made of glass and is consequently fragile and cannot withstand any high gas pressure. For these reasons extreme precautions must be observed in the use of such easily inflammable fat solvents as ether and carbon bisulphide. Besides all this the apparatus permits of the examination of small quantities only, which tends to lower the accuracy of the tests.

Pinagel's extracting apparatus overcomes these difficulties in a clever manner and allows of the examination of larger quantities of wool (from 3 to 5 kilos). Apart from this, the apparatus is very handy, is wholly constructed of copper and only the screws are of brass.

As can be seen from Figure 2, the apparatus consists of the following parts.

1. A copper water-bath A with means of keeping the level of the water constant. The bath is filled with hot water or can be steam-heated.

2. A round copper container B to hold and evaporate the solvent (ether, carbon bisulphide) is set into the water-bath. It is fitted with a thermometer T mounted at right angles so that the boiling point of the ether (35° C) or the carbon bisulphide (45° C) can be accurately observed and maintained.

3. An oval container G, into which the wool to be treated is packed, is mounted on the container B by means of rightly fitting ring.

The container G is closed to the container B by means of a valvelike block C with three perforations which is fitted in the bottom of the container G. Three short tubes are inserted in the block and are very loosely filled with wool, so that the vapours of ether or carbon bisulphide can pass through.

The two vessels are connected by an external tube F provided with a cock E. The upper part of the tube inside the container G. is studded with perforations and the tube ends above the bottom of the vessel B.

A glass tube is mounted at the side of the vessel G which indicates the height of the liquid recondensing from the vapour of the solvent. By opening the valve E in the tube F the condensed solvent continually flows back into the container B, and this circulation is kept up until all the fat has been extracted, as is shown by the solvent collecting in the observation glass being clean and clear.

When the water-bath is kept at the proper temperature the solvent evaporates and its vapours pass through the three valve tubes into the wool packed in the vessel Gand extract it.

4. A cooling vessel H containing cold water from the main at from 7—10° C provided with three cooling worms is screwed onto the extraction vessel. The vapours rise up through the many windings of these coils, are condensed by the cold water, and the condensed solvent drips back into the extraction vessel and is re-evaporated by the rising vapours, hastening in this way the extraction.

The observation glass shows when the solvent has thoroughly soaked the wool and almost completely filled the space G. Then the valve E is opened again and the solvent which has collected and is saturated with oil flows back into the container B and enters into circulation once more when the valve E is closed.

This circulation accelerates the removal of the fat. With a little experience the colour of the liquid in the observation glass will serve to show when all the fat has been dissolved. Then the valve E is kept open so that the solvent can flow back into the container B.

Carbon bisulphide has the advantage of being cheaper than ether, but it is much more inflammable and poisonous. For this reason other non-inflammable solvents are used, such as carbon tetrachloride, the boiling point of which, however, is about 78° C, dichlorethylene (boiling point 55° C) and trichlorethylene (boiling point 88° C). Since dichlorethylene is not dearer than carbon bisulphide and is indifferent to all kinds of fats and oils, carbon bisulphide can now be dispensed with.

As a matter of precaution, the water-bath must not be heated by an open gas flame and it is therefore filled with hot water, which is rather tedious. For this reason I have built an electric heater into the bath. This is able to heat one litre of water from 15° C to 100° C in about 15 minutes and is arranged for a current consumption of 500 watts. If the bath, which holds about 3.5 litres, is first filled with water at from 40—50° C, the addition of heat can be provided by the electric heater, and the temperature of the water can be maintained with ease at about 50° C by employing a resistance. Even when using the very dangerous carbon bisulphide, the employment of electric heating practically eliminates any risk of explosion.

Extraction apparatus of this type have also the advantage that not only the fat content can be determined but also the loss caused by washing dirty wool. This can be arranged very simply by first weighing 3—5 kilos of dirty wool accurately to one-hundredth gram, then washing out the earthy impurities with lukewarm water, drying in the drying oven, dissolving the fat in the extraction apparatus, then rinsing with water, drying the wool at 105—110° C in the case of carded wool, adding 17% for moisture, in order to obtain the valid commercial weight. The difference between the first weighing and the last gives the loss by washing.

Example of the calculation of the loss caused by washing carded wool.

| | | |
|---|---|---|
| Weight of the dirty wool | 4.515 | kilograms |
| absolutely dry weight of the defatted and washed wool | 3.005 | „ |
| loss by washing that is 33.44% | 1.510 | „ |

As regards the permissible 17% of moisture content in carded wool, the percentage calculation works out in the following way:

| | | |
|---|---|---|
| Weight of the dirty wool | 100.00 | kilos |
| loss by washing | 33.44 | „ |
| weight of the clean washed and absolutely dry wool | 66.56 | „ |
| 17% added for moisture | 11.32 | „ |
| valid commercial weight | 77.88 | „ |
| loss by washing | 22.12 | „ |
| | 100.00 | „ |

That is to say, the loss by washing amounts to 22.2% of the weight of the dirty wool, reckoning a regain of 17 per cent.

In mixed yarns of wool and cotton the content of fat and moisture is often very irregular, but as a rule very high.

It will be seen from the foregoing that conditioning cannot be dispensed with in determining regain if it is desired to avoid the loss involved in merely estimating it. Endeavours are constantly being made to find a simpler process which is also reliable.

Influence of moisture on the weigt of fabric per square metre.

A definite weight per square metre is often stipulated for before accepting certain goods, because it is possible in this way to judge rapidly whether the goods are over or under weight, that is to say, whether the requisite quantity of material has been worked in.

For customs purposes too the weight of fabrics per square metre is distinctly defined, because duty is imposed upon the fineness of the yarn and the density of the weave, that is to say also according to the weight.

Accordingly, when settling the weight per square metre, for which purpose specially constructed dial and pointer scales are used, the regain and the valid commercial weight of the goods must also be found.

It has happened a few years ago, when textile raw materials were very scarce, that a contractor tried to beat his rivals for a supply of uniform cloth by delivering inferior cloth which he had previously rolled between moist linen cloths so as to give it to all appearance the weight prescribed by the military authorities. A conditioning disclosed the fraud and the case was brought before the criminal court.

Moisture and the quantitative determination of a mixture of cotton, wool, and silk.

In order to calculate accurately the percentage composition of such a mixture of fibres, the material is first conditioned, then the silk is dissolved out by means of a basic solution of zinc chloride and the material is washed with water, dried, and weighed. Then the wool is dissolved out by boiling with NaOH, and the material is washed again, dried, and weighed. Finally the weight of the cotton left behind is determined, bearing in mind the percentage lost in washing out the wool and the cotton, and its percentage content calculated. In order to secure accurate results, the drying must be done by conditioning on the basis of the permissible moisture content.

This process gives rapid results and can be carried out much more quickly than the tedious drying in the air, when the very different relative humidities can very easily confuse the result.

In the Testing Offices of the German Customs service the percentage of cotton present in union fabrics is determined as follows.

A piece of cotton fabric of 10 square centimetres is cut into four pieces and laid for one hour in the drying oven at 110° C, and then, while still warm, in a weighing bottle. This bottle is furnished with a glass stopper smeared with fat and has previously been weighed accurately to one milligram. The bottle is then carefully closed, weighed on an analytical balance, and, after cooling in the exsiccator, weighed on the same balance accurately to one milligram.

Then the dried and weighed four pieces of fabric are laid in a beaker holding 500 ccm, and 200 ccm of a 10% solution of caustic soda are poured over them. The beaker is placed on a sheet of asbestos over a Bunsen burner and carefully heated so that the solution is brought to the boil within 20 minutes, when it is boiled for another 10 minutes. The fabric is repeatedly pushed under the surface of the solution by a glass rod. Finally the beaker is filled to the brim with cold water, the contents are stirred with a glass rod, and the liquid carefully decanted off, taking care not to lose any fibres. Then fabric is repeatedly washed until the addition of a few drops of a tartaric acid solution of phenolphthalein no longer causes a red colouration.

Then the washing water is let off and 300 ccm distilled water to which 5—10 drops of concentrated acetic acid have been added, are poured over the fabric in the beaker, and the whole is boiled for a short time. After cooling, the liquid is poured off, the fabric rinsed in the hollow of the hand with distilled water and squeezed out. After standing for two hours in the drying oven at about 100° C, the fabric, while still warm, is placed in the weighing bottle again. The botle is well closed and weighed once more on the same balance after having cooled off in the exsiccator. The percentage weight calculated is the weight of the cotton present in the fabric.

After having now discussed the often very far-reaching influence of moisture on various textile materials and illustrated it by examples, figures could also be given to show the success actually attained by accurate measurements of moisture content.

In all yarn dealings there is a tendency to purchase the best possible, but it often happens that one of the parties has cause to lament his carelessness. Either he pays for water and paper tubes at the price of wool to his own loss when the moisture content is excessive, or the spinner gives the consumer valuable yarn instead of the moisture allowed. Then the spinner has to face the loss, although neither party would be at a disadvantage if conditioning had been properly done.

The importance of conditioning is still not recognized in many quarters and it can therefore readily be understood that quite out of the way cases of unfitness sometimes occur which are due more to criminal negligence than to an actual intention to injure the other party. On the other hand it occasionally happens that someone calculates extremely sharply, but seems to pay little or no attention to conditioning, although he claims to be up to date in every respect.

# New Automatic Adjusting Swift

By *Wiederkehr*

*A Swift* which embodies many new and important features and which will undoubtely considerably increase the production from winding machines and give a better wound package has been introduced under the name of "Schweiter Hank Ryce D. H. 545". It is made in two sizes (No. 1 taking hanks of all diameters between 42 inches and 57 inches, No. 2 between 42 inches and 64 inches) and is simple to work. All that is required to alter the circumference for a certain size of hank is to give the boss a pull and a turn (illustration 3). The pull loosens the locking of the ryce, so that it is possible to turn half of the boss backwards or forwards, thus increasing or decreasing the circumference. Immediately the operator lets go of the boss, the ryce is automatically locked in position. Once it is adjusted for a certain size of hank, any subsequent number of hanks can be put on, as the arms, being made of piano wire, are quite flexible (illustration 4). Owing to its exceptional lightness this swift is particularly suitable for the finest yarns. In actual ounces it may be heavier than some others, but it has this difference — all the weight is centrifugal, or, in other words, confined to the boss. The arms are so elastic that there is no fear of the yarn slipping and the swift remaining stationary when the hank is nearly wound-off.

Excepting for the boss the swift is entirely made of steel, so that atmospheric conditions have no influence on it. It is perfectly stable and concentric even when adjusted to its utmost capacity. It has no projecting parts, and is a really sound firm job.

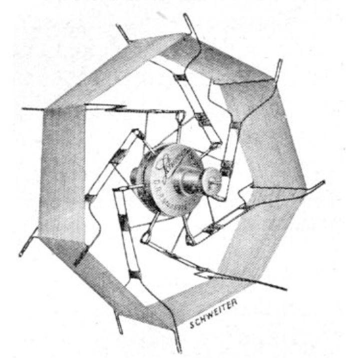



Fig. 1. To take hanks from 42 in. to 57 in. in circumference

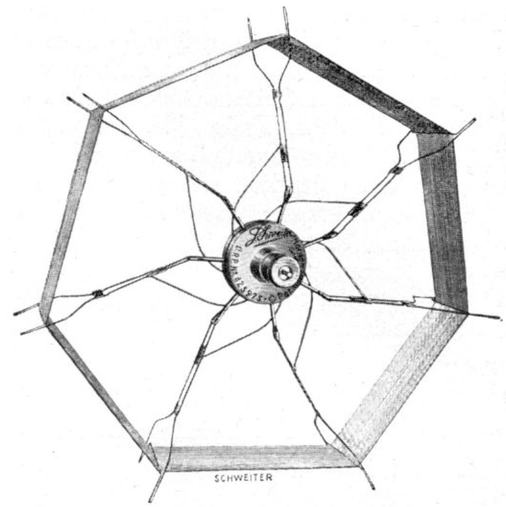



Fig. 2. To take hanks from 42 in. to 64 in. in circumference

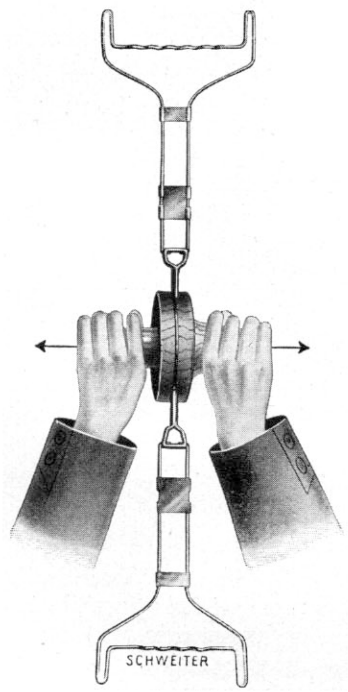



Fig. 3. Handling of the Hank Ryce for the purpose of adjusting the circumference

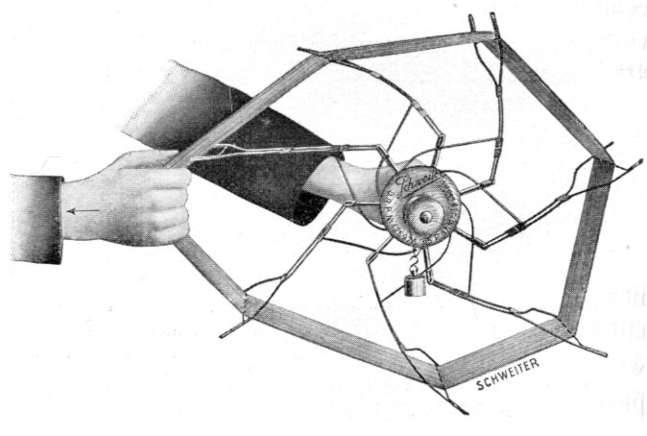



Fig. 4. Putting on a new hank

# The Nature of the Plain Weave

By Dr. *Fr. Stein*

The plain weave, or, as it is sometimes known in the trade, the tabby, calico, or alpaca weave, is by far the most important of all weaves and the one most commonly met with. Every weaver is well aware, however, that its construction tests more rigourously than any other not only the attention and skill of the operative, but also the proper choice and preparation of the yarn for warp and weft, and their combination, as well as the build and equipment of the loom and its accessories.

The importance of the plain weave makes it worth while to examine the facts more minutely and not merely to be content with the superficial explanation that the plain weave is the most intimate combination possible of two threads, from which all other facts are selfevident. There are not many branches of the textile industry where the practical mill man will find himself confronted by such surprising and often evidently contradictory results as in the manufacture of plain woven cloths.

The plain weave had its origin, like every other weave, in plaiting, but, again like every other type of weave, it differs from plaiting by the peculiar system of stresses which are produced in the warp and weft threads during weaving. These *strains* not only severely test the strength of the threads in the loom, but their importance for the appearance of this finished cloth cannot be overestimated. These tensions are not only unavoidable, but form the chief characteristic of a weave. They are formed at two points, that is to say, in the warp owing to a let off motion actuated by a spring or by a weight, and in the weft by a frictional braking action of the thread as it is wound off the pirns and leaves the shuttle.

The tension of the warp is necessary, because the shed can only be accurately formed and maintained if the threads are taut. The tension of the weft is also indispensable, as it alone causes the correct amount of yarn to be taken from the bobbin and lays it in the shed under more or less tension, as desired. The tension of the warp and weft in the fabric still in the loom soon reaches a certain state of equilibrium under the influence of the *weave angle*, to be described later, and these states of equilibrium together with the weave determine the character and appearance of the cloth, not merely in the loom, but also when finished and cut up. Upon them are also dependent the changes which the fabric undergoes when it is liberated from the tension of the loom.

The field of strains will therefore first of all be considered which is formed in a *plain woven cloth* on the loom when in motion, between the fell of the cloth and the breast beam and which is naturally subject to periodic changes corresponding to the period of the revolutions of the crank shaft.

During the period when the reed does not touch the fell of the cloth the fabric has to absorb the whole of the length given off by whatever let off motion is being used (drag weight, back rest regulator). If it be assumed that the shed forming members do not appreciably influence the extent and direction of this pull and that it exerts a force at the edge of the cloth lengthways amounting to $\Sigma P$ in such a way that an average force P is exerted on each warp thread. If it is now assumed that the fabric has been cut across exactly between two picks, that is to say, in

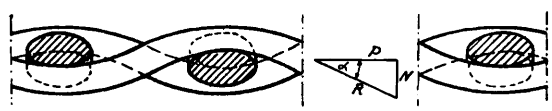


Fig. 1.
Longitudinal section through a plain woven cloth

the plane of intersection of the warp threads (Figure 1), then a pull of the order P would have to be exerted at the point of section on each warp thread in the direction of the warp to maintain equilibrium. But the warp threads at the intersections do not by any means run in the general direction of the warp, but are inclined to this plane by the *weave angle* $\alpha$.

Therefore there must be present in the direction of the axis of each thread a *resultant pull*

$$R = P \frac{1}{\cos \alpha}$$

one component of which, that is, P itself, takes up the longitudinal strain in the cloth, while the other component, the normal force

$$N = P \cdot \operatorname{tg} \alpha = R \cdot \sin \alpha$$

acts transversely to the plane of the fabric. The *resistance* of the warp and weft threads to being crushed flat counterbalances this force.

But it is also this force N which forces the weft and warp threads, that were originally straight, into a sinuous form immediately after weaving. This *undulation* in its turn, as is well known, is the cause of *more warp* being used than the length of the cloth *(warp contraction)*, and also of the reduction in width. The weft has also an *angle of inclination* at its intersections with the warp a kind of *weft weave angle* $\beta$, and the normal force N produces here too, just as with the warp, except that cause and effect are reversed, tension in the direction of the axis of the weft $S = N \cdot \frac{1}{\sin\beta}$ and then together with this a

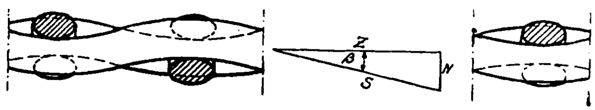


Fig. 2. Cross-section through a plain woven cloth

*transverse pull* across the fabric $Z = N \cdot \cot g\beta$ for each weft thread.

Within the *zone affected by the temples* the weft is still to some extent on the stretch, that is to say, $\beta$ is small, and the transverse pull of the fabric accordingly rises so high that often a very powerful temple is required.

After having passed the temples, the weft is at liberty to bend, whereby the width of the fabric decreases while the weave angle becomes greater. Here also the transverse pull need not disappear, but it becomes so small that the action of the *selvedge* in the shape of a *polygon of forces* can be transferred without difficulty, on the one hand, to the temple and, on the other hand, to the breast beam which offers a certain amount of resistance owing to its friction. This shows at once the extreme importance of the selvedge. *Owing to this action of the polygon of forces it must withstand enormous additional longitudinal strains over and above the ordinary tension of warp and weft. For this reason it is always strengthened, because, if it were to fail, the width would shrink irregularly and thus the whole of the fabric would be distorted.* (Wavy selvedge.)*)

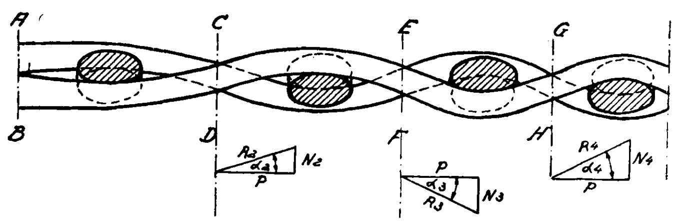


Fig. 3. Longitudinal section through a plain woven cloth during the return of the thread

While the warp between the warp beam and the fell of the cloth is almost continually in motion owing to the play of the shafts, the movement of the back rest, etc., the finished cloth for the eye is only temporarily in motion by the action of the cloth beam taking up motion. (No attention is here paid to the changes in height to which the edge of cloth in which warp and weft float a great deal is subjected, because the present remarks are confined to the plain weave.)

As a matter of fact, however, a great part of the finished fabric is set in motion by the *blow of the reed*, and this motion may often reach to the breastbeam, especially when the *forecloth* (as it may conveniently be termed) *is being formed*, as described below. At this stage the static conditions just described are changed into *dynamic* conditions.

The dynamic conditions are characterized by the fact that the weft tries to create a new state of equilibrium by more or less permanent displacements in the direction of the warp after the beating up of the sley has disturbed the state of tension described in the last paragraph. The first point to be examined below is how the weft behaves at the edge of the cloth just liberated by the reed.

A cursory glance at the warp of a cloth just being woven shows that a varying number of the picks retreat again from the fell of the cloth when the sley retires. This is evidently due to the action of the components of the warp tension as shown in Figure 1, because the tension arising from the warp let off motion exerts its full force on the fabric as soon as the beating up is at an end.

Figure 3 shows a momentary condition to be seen shortly after *beating up with a closed shed.* Assuming that the free warp threads are still parallel to one another, so that the weave angle before the last pick is $\alpha^1 = 0$, then the weft threads would simply act as diverting rollers for the warp threads, *if* there were *no friction at all* between warp and weft. The longitudinal force acting on the axis of a warp thread — which appears at the points of intersection as a force R inclined to

*) The Machine Works Rüti provide the breast beam of their new cotton loom with outwardly directed fluting, whereby the selvedge can offer more resistance to the transverse pull.

the plane of the fabric—would therefore have to remain uniform over its whole length. The *first weft thread* would accordingly be affected by two equal forces, one in the direction of the warp, and the other inclined thereto. The resultant of these two lines of force in turn would have a component in the direction of the warp ($Dr_1$, Figure 4), which would push

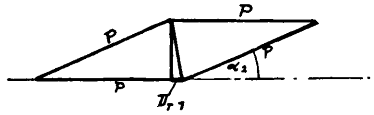



Fig. 4. Diagram of forces

the last pick out of the cloth again. The angle $\alpha_2$ would accordingly always tend to become smaller; as soon as it is smaller than $\alpha_3$, an extrusive force would take effect on the second last weft thread also (Figure 5).

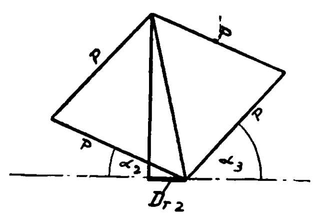



Fig. 5. Diagram of forces

When this thread slipped off, the angle $\alpha_3$ would once more be reduced and in the course of the action the whole of the picks would be pushed out of the cloth into the front shed, so that it would lose its sharp demarcation against the fabric. The longitudinal pull would become less from point of intersection to point of intersection by the difference $D_r$ each time, and this difference would be required to accelerate the weft threads to be pushed out. This action would not be stopped until a new shed had been opened, at which moment the angle $\alpha_1$ becomes finite.

But *in reality* the friction between warp and weft tends to bring the return movement practically to a complete standstill already within a few millimetres, even if the shed remains closed for some time. It is of course true that a certain number of weft threads will by that time have reached a distance from one another which continually increases towards the reed, corresponding to the formula

$$O < \alpha_1 < \alpha_2 < \alpha_3$$

and so on, but their *acceleration* has become so low that it can be neglected. The differential forces $D^r$ thus disappear and the *same longitudinal pulling force $\Sigma P$* must obtain everywhere in the cross-sections and each warp thread has its share P.

The tension R exerted in the direction of the thread axis is therefore greater than P within the fabric and rises besides in proportion to the distance of the cross-section of the warp thread being examined from the fell of the cloth, as appears from Figure 3.

$$R_1 = P \cdot \frac{1}{\cos \alpha_1} \quad R_2 = P \cdot \frac{1}{\cos \alpha_3} \quad R_3 = P \cdot \frac{1}{\cos \alpha_3}$$

$$R_4 = P \cdot \frac{1}{\cos \alpha_4}$$

which is to say that $R_1 < R_2 < R_3 < R_4$ and so on.

Each section of warp thread lying between intersections is attacked by two axially directed pulling forces *of different size.* These forces must not cause any more movement, if the retirement of the weft threads is to be regarded as completed. That is to say, their *difference* must be *equalized* by the *friction* of the warp thread upon the weft thread lying between the two points of intersection.

Only suppositions are at present permissible about the nature of the friction; its effect probably rises as the weave angle increases (owing to the weft being more firmly embraced by the warp threads). That is to say, during the period in which the reed is *not* in contact with the fell of the cloth, the weft threads are subject to a friction which is greater the further they have retired from the fell of the cloth. The accurate investigation of this friction would probably yield valuable results for the understanding of the weaving processes.

The increase of the weave angle towards the breast beam cannot proceed indefinitely and a pick soon appears from which on the angle remains constant. This weft thread is the beginning of the finally finished cloth which is not liable to any further change due to the beating up of the sley. The following considerations will show *which weft thread this is* and *how large the weave angle is* in each case.

When the reed starts to beat up, the angle $\alpha_1$ is first of all increased by the new pick's being brought up. Simultaneously a *part of* the tension arising from the warp let off motion returns from the warp threads over the *new* pick and the reed, but only a part, because the fact that the strip of fabric between the fell of the cloth and the breast beam remains taut in normal weaving, even during beating up, permits of the conclusion that a considerable part Q of the warp tension is continued to the cloth on the breast beam and the cloth beam. The strip of fabric becomes only temporarily slack when the so-called forecloth is being formed, as explained below.

A process now sets in (Figure 6) unter the action of this remaining pulling force Q and under the influence of the continual increase in the angle $\alpha_1$, which is the absolute reverse of that shown in Figure 3.

Here also each pick moves towards the *smaller* weaving angle — in this case in the direction of the *breast beam* — until the action of the friction between warp and weft

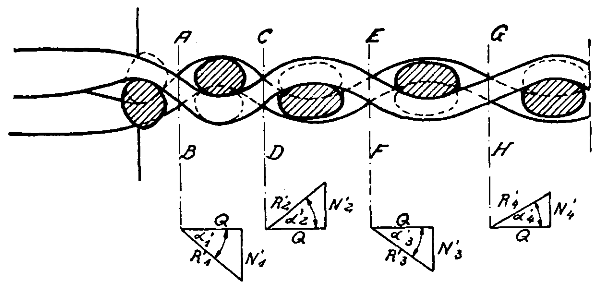



Fig. 6. Longitudinal section through a plain woven cloth during beating up

equalizes the differences of the axial pulling forces appearing in the warp threads.

This establishes a new state of equilibrium which is thereby characterized —

firstly, that the following longitudinal forces are active in each intersection in the direction of the axis of the warp:

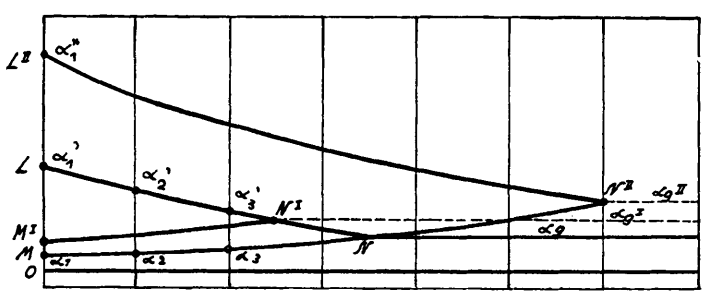


Fig. 7. Graph for finding the final weave angle

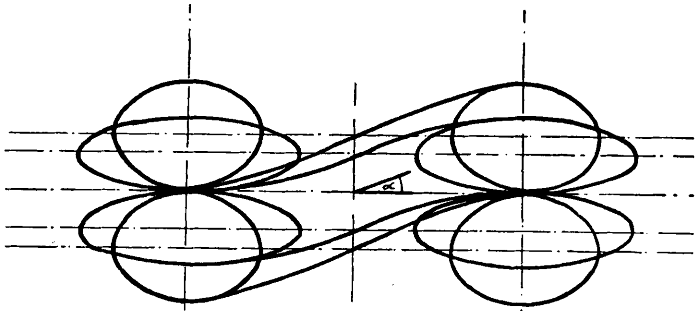


Fig. 8

$$R_1' = Q\frac{1}{\cos\alpha_1'}\quad R_2' = Q\frac{1}{\cos\alpha_2'}\quad R_3' = Q\frac{1}{\cos\alpha_3'}$$

$$R_4' = Q\frac{1}{\cos\alpha_4'}$$

and secondly by $\alpha_1' > \alpha_2' > \alpha_3' > \alpha_4'$ and so on, so that here $R_1' > R_2' > R_3' \geqq R_4'$.

If the angles $\alpha$ for each of the intersections as shown in Figures 3 and 6, are compared with one another,

AB CD EF GH . . XY

$$\alpha_1 > 0^0 \quad \alpha_2 > \alpha_1 \quad \alpha_3 > \alpha_2 \quad \alpha_4 > \alpha_3 \,..\, \alpha_{(n+1)} > \alpha_n$$

$$\alpha_1' < 90^0 \quad \alpha_2' < \alpha_1' \quad \alpha_3' < \alpha_2' \quad \alpha_4' < \alpha_3' \,..\, \alpha'_{(n+1)} < \alpha'_n$$

a *definite cross-section* UV must finally be reached at which the angles $\alpha_g$ and $\alpha_g'$ are identical, or are so close to one another that $\alpha_h > \alpha_h'$ would occur in the next cross-section.

*And this cross-section is the one from which on the cloth can be looked upon as being at rest, in such a way that all weave angles from this point on have the same value $\alpha_g$ which is not changed any more, even temporarily, either by beating up or by shedding. It is the so-called "final weave angle".*

Figure 7 shows diagramatically the course of the weave angle in the various cross-sections of the intersections.

A knowledge of these conditions is important because there exists a close relationship between weave angle and the number of picks per inch. The cross-section of the weft can be drawn into any given weave angle, whereby the flattening of the pick is not of extreme importance at all for the closeness of the picks. This is at least true for large weave angles (Figur 8).

The size of the angle $\alpha_g$ (Figure 7) is thus mainly dependent upon the final density of the weft threads. They can be very close only by having the angle $\alpha_g$ as large as possible. But the height of the $\alpha_g$ line as shown in Figure 7 is determined by the course of the curves LN and MN. The points LM represent the maximum value of $\alpha_1'$, or the minimum value $\alpha_1$.

The rise of the curves is clearly a function of the *friction* between warp and weft which has not yet been accurately determined. For as soon as the movement of the picks is completed and equilibrium has been established, this friction

## Necktie fabrics of Bemberg Silk