FABRIC ANALYSIS.

Twist.

OBJECT OF TWIST.

The turns of twist required in twisted yarns varies according to their ultimate use, from hard-twisted sewing yarns to the soft-twisted threads for knit goods purposes; so does also vary the twist in single yarns.

Before considering the twists that custom recommends, in order to obtain these different results, it is necessary to consider the effect the variously twisted singles impart to produce the desired solidity and resistance to tensile strain, while conserving its elasticity. If the twist is not sufficient in the single, there will be a slippage of the fibres over one another; if the twist is too much, the yarn will be dry and harsh to the feel. It is necessary, therefore, in order to obtain a strong and sufficiently elastic yarn, to take a medium course in twist.

The twists of different numbers, spun from the same material, are proportional to the square root of the numbers. But it is evident that the length of the fibres will exercise considerable influence on the strength and elasticity, and must, therefore, have an influence on the twist.

If, for example, a spinner gives a twist of 25 turns per inch to a single yarn made from a cotton of one inch staple, the twist should be different for a staple of 1¼ inches. A twist of 25 turns per inch in the case of a one inch staple indicates a twist of 25 turns per length of the fibre. This yarn being found suitable in strength and elasticity with turns of 25 (that is, 25 points of contact of the fibres with each other) the question may arise to ascertain the turns necessary to get the same strength and elasticity from fibres of 1¼ inches in staple. Then the same number of points of contact should suffice; that is, 25 turns per staple (or 1¼ inches). By proportion we then find that:

$1\frac{1}{4} : 1 : : 25 : \times$, or $\frac{25}{1\frac{1}{4}} = 20$ turns per inch, *Ans.*

It may therefore be stated that, all other conditions being equal, the twist should be in inverse proportion to the length of the fibres, and the *constants* or *standards* for twist are based on this idea.

To the mill manager a knowledge of the influence wielded by twist, not only in the finished thread, but also in the single yarn used, is of considerable importance, especially when dealing with the higher qualities of yarns and fabrics.

The twist of the doubled and twisted thread is almost invariably in the direction reverse to the single; it is evident therefore that some portion of the twist in the single yarn is removed during the subsequent doubling and twisting operation.

Taking for an example a 2/70's cotton yarn into consideration. The twist in the single thread (according to rules) will be about $\sqrt{70} \times 3.39 = 8.36 \times 3.39 = 28$ turns per inch; the twist put into the folded yarn for usual twist is 30 turns per inch.

At an intermediate stage (between one turn and 30 turns per inch) so much twist will have been taken out of the single that a state of equilibrium will have been established between the twist in the single and that of the folded yarn. Actually this balance will occur when the folded yarn has received 11 to 12 turns per inch. In this condition the thread contains only the turns requisite for a very soft thread, and in this condition will be oozy, lustrous, soft, and pliant; but it will not be of the strength, elasticity and compactness necessary for most purposes.

The question then arises: Is it advantageous to increase the single twist until the balance of twist approximates to the finished twist (necessary to obtain the required strength, appearance, etc.) or to increase the finished twist independently of the single twist?

A harder twisted single will make the stronger thread at all doubling twists from 11 to 12 turns to 30 turns; it will be more compact, wiry and elastic.

The softer twisted single will be weaker in the soft and medium doubling twists, but will rapidly gain in strength, until in extra-hard twists (32 to 34 turns per inch) it would be as strong as the previous single.

Knowing the use to which the single yarn will be put to, it remains a question to be solved whether it is of advantage for the spinner to put more twist in the single (which will naturally cost more) or to use the ordinary doubling filling and lose on the extra turns required in the folded yarn to obtain the same strength. The spinner will vary the twist in the single for various reasons; but as a rule he is only governed so far as twist is concerned by the least amount he can put in to ensure good spinning and to produce a yarn somewhere near the strength required.

If the overseer of the twisting department would ask the boss spinner what twist there is in the single, he may be told that it is ordinary doubling filling, or that the twist standard used was 3.5, or 3.3 × square root of counts. He may consider himself favored, however, should he get the latter reply.

The ascertaining of the actual twist of the single is, however, as simple a matter as that of testing folded yarns for twist. In the case of single yarn, not more than one inch in length should be tested at one operation, while with folded yarns ten inches should be the least taken for length. If the staple of the material used in the single thread is less than one inch, it will be better to reduce the setting of the twist tester to approximately the length of the staple, since the loose ends of the fibre have an objectionable way of re-twisting on one another.

The twists employed, as mentioned before, must be in accordance with the result it is desired to obtain in the finished thread, or fabric. There is a fairly standard list, although the twister will rarely use a constant multiplier with the square root of the counts. Occasionally the buyer will stipulate the twist or range of twists he will require. In any case the testing of twists in folded yarn is so simple and so universally adopted by buyers of yarns, that the utmost care should be taken that the twists are up to standard and uniform.

In general practice (for example) the twists for 2-fold cotton yarns (from 2/20's to 2/200's) expressed in turns of twist per inch are:

	2/20	2/30	2/40	2/50	2/60	2/80
Extra hard	—	—	—	—	32	34
Usual	20	22	24	26	28	30
Medium	16	18	20	21	23	26
Mercerizing ...	11	12	13	14	16	19
Soft	—	—	13/14	16	18	22
Extra soft	—	—	10	11	12	13

	2/100	2/120	2/140	2/160	2/180	2/200
Extra hard	38	40	42	44	46	50 to 52
Usual	34	36	38	42	46	50
Medium	30	33	36	40	44	—
Mercerizing ...	23	25	27	—	—	—
Soft	25	28	32	36	39	—
Extra soft	15	17	19	21	—	—

INFLUENCE OF TWIST UPON THE FABRIC.

The twist which is put into yarn in order to bind the fibres together not only affects the handle, strength and wearing property of a fabric, but also has a considerable influence upon its appearance, more particularly in connection with such fabrics in which any form of twill line is developed. Generally, just sufficient twist is inserted to enable the threads to withstand the strain of weaving. More turns per inch are required in fine than in thick threads, and for short than for long-fibred materials, while warp yarns are mostly harder twisted than filling yarns. The twist, while strengthening the yarn, makes it harder, and reduces its lustre; to many fabrics the necessary firmness of structure is imparted by the warp, and softness and brightness by the filling. For special purposes, yarns are twisted more or less than the normal, according to the effect required in the fabric, thus *voile, crepon* and *grenadine* yarns are very hard twisted, whereas yarns for raised (napped) fabrics are soft twisted, in order to be able to produce the required nap to the cloth in the finishing process.

To explain the importance of ascertaining the direction of the twist, the six diagrams in Fig. 73 are given.

Provided the direction of the twist imparted to the yarn is to the right, as shown at *A* it is termed *open-band*, and if to the left, as represented at *B*, *cross-band*.

In *cotton* yarns, *A* represents warp twist (twist way) and *B* filling twist (filling way), whereas in *worsted* yarns, warp twist is as shown at *B*, and filling twist as shown at *A*. Single *woolen* yarn (warp and filling) is almost invariably twisted as indicated at *B*. In twisting (throwing) silk, tram and first—spinning of organzine is to the right, as shown at *A*, the second twist of organzine is to the left, as shown at *B*. In *folded* yarns, the twist is most always inserted in the opposite direction to that of the single threads, since this causes some of the twist to be taken out of the singles, and a softer folded yarn results than if the direction of the twist is the same in both twisting operations; the latter method increases the twist in the singles and tends to make the folded yarn hard.

Diagrams *C, D, E,* and *F* in the illustration shows the different ways in which the warp and filling threads may be placed in relation to each other, as regards the direction of the twist.

In *C,* the warp twist is as shown at *A,* and the filling twist as at *B,* the surface direction of the twist being to the right

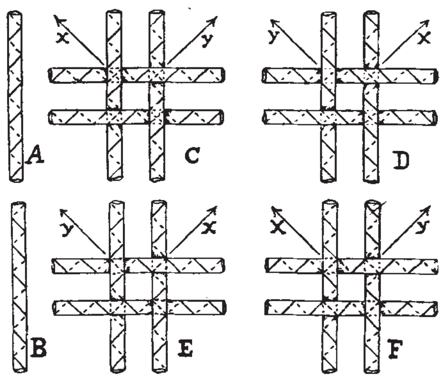

Fig. 73

in both threads when the filling is laid at right angles to the warp.

D shows the exact opposite of *C,* the surface direction of the twist being to the left.

E shows both series of threads twisted as shown at *A,* and *F* same as at *B.*

In *C* and *D,* the direction of the twist on the under side of the top thread, is opposite to that on the upper side of the lower thread, thence the threads do not readily bed into, but tend to stand off from each other, which assists in showing up the weave and structure of the cloth distinctly.

In *E* and *F,* on the other hand, the twist of the under side of the top thread is in the same direction as that on the upper side of the lower thread, hence in this case the conditions are favorable for the threads to bed into each other and form a compact cloth in which the weave and thread structure are not distinct.

In twill fabrics, the clearness and prominence of the twill lines are accentuated if their direction is opposite to the surface direction of the twist of the yarn. If, however, the lines of a twill are required to show indistinctly, the twill should run the same as the surface direction of the twist of the yarn.

If one yarn predominates on the surface, the twill should oppose, or run with the twist of the surface threads, according to whether the effect is required to show prominently or otherwise. Thus in *C* and *D,* the arrows *X* indicate the direction in which the twill should run if the lines are required to show boldly and clearly, and the arrows *Y* if an indistinct twill effect is desired. In *E* and *F* the arrows *X* show the proper direction for producing a bold twill, and the arrows *Y* for producing an indistinct twill if the filling predominates on the surface. If, however, the warp forms the face of the fabric in *E* and *F,* the arrows *Y* indicate the proper direction for a bold twill effect, and the arrows *X* for an indistinct twill.

If a twill runs both to right and left in a fabric (a herring-bone twill) it shows more clearly in one direction than the other. Also, the difference in the appearance of right and left twist is sufficient to show clearly in a twill fabric in which the weave is continuous, and *shadow effects* are produced in warp-face weaves by employing both kinds of twist in the dressing of the warp.

Testing for Twist.

As mentioned before, threads which are perfectly alike in quality and counts, but vary in their twist, may produce a fabric quite different when finished. Therefore, when desiring to produce a yarn similar in character to another yarn, the average number of turns per inch must be found.

Testing for twist consists in untwisting a double and twist thread, or a 3 or more ply twisted thread, and noting the number of turns per inch that was required before a complete parallelism of fibres of this thread had been obtained. Single threads are not so often tested for twist as 2 or more ply yarns, since a turn or two (more or less) does not materially affect the strength or appearance of the ordinary run of single yarns, and for a fact, most manufacturers do not concern themselves about the exact number of turns in singles, so long as there is sufficient strength for working purposes, and sufficient fullness to give a well covered face to the fabric. Double and twist yarns are tested on account of the influence of the twist upon their appearance and suitability for the fabric they are to be used for.

In testing thread for twist, it should be placed on the twist testing machine with the same tension as that of the doubling and twisting frame. When the twist has been extracted from ten inches (or more) of twisted yarn, it will be noticed that the strands of yarn will be slack, indicating that in the twisting process there has been a certain amount of contraction in the length of yarn doubled. Under whatever conditions the yarn has been twisted, this contraction will take place. In threads twisted in doubling in the direction reverse to the single twists, and in soft and extra soft threads, this contraction will be at its minimum. The contraction will be at its maximum in threads twisted in the same direction as the single yarn, and in hard-twisted threads. The extent of it will depend upon: (1) the elasticity, (2) the degree of twist in both single and doubled yarn, (3) in the drag exerted in twisting, and (4) in the relative counts used. This contraction has an important effect on the counts produced; the more contraction there is, the heavier will be the finished counts of the resulting yarn. It is a good system to record the contraction of different threads as you test them, and keep them with a portion of the sample for reference. If in testing a 10 inch thread, the increased length of the minor threads is 10½ inches, then the contraction is ½ inch in 10½ inches of single, or the take-up is 4½ per cent.

$100 : x : : 10.5 : 10 = 95\frac{1}{2}$ and $100 - 95\frac{1}{2} = 4\frac{1}{2}$ *Ans.* Such samples will guide you in your future work.

Fig. 74 shows the Twist Counter as built by Chas. H. Knapp, Paterson, N. J. Quoting letters of references in connection with explanations given will readily explain the working of the apparatus: *a* is the handle for turning the worm *b,* and in turn the dial *c* on which pointer *d* registers. *e* and *f* are the two clamps for holding the two ends of the thread to be tested. *e'* and *f'* are the two screw knobs for tightening the bite of the clamps to securely hold the ends of the threads. Clamp *e* is revolving in a stationary position for all tests, whereas clamp *f* is adjustable to suit any length of thread within compass of the apparatus to be tested by being moved (to suit the length of the thread to be tested) on screw rod *g,* turning the latter by handle *h.*

i is the bar for sustaining the carrier of clamp *f* in proper position in its to and fro adjustment for testing different lengths of threads, it being also graduated either in tenth parts of an inch, or in centimeters, or both, to register any length of thread to be tested.

When the movable clamp *f* has been fixed at the desired distance from the standard clamp *e* and the thread to be tested secured by screws *f'* and *e'* into the jaws of clamps *f* and *e,* the latter is then revolved by turning the hand-wheel *a*

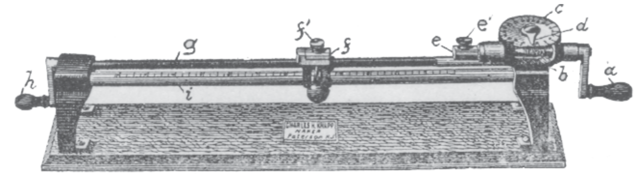

Fig. 74

until the whole of the twist has been removed. The number of revolutions are then read from the dial *c* and divided by the number of inches of yarn tested, giving the number of turns per inch in the yarn.

Example: Suppose pointer *d* on dial *c* indicates 60, and length of thread between the ends of the two clamps *f* and *e* (for example) is 6 inches (it may be more or less) the turns of twist per inch in the yarn are then $(60 \div 6 =)$ 10 turns.

To test single threads, an apparatus is used in which both stands carry movable spindles, so that twist can be taken out from either ends of the thread. If using the twist tester previously described for testing single threads, it may happen that one end, having been untwisted, begins to retwist in the opposite direction before the other end has been untwisted.

(*To be continued.*)