TEXTILE MACHINERY AT THE PARIS EXHIBITION.

(*Continued from page* 673.)

HAVING described the more important devices for testing the counts and physical qualities of threads and yarns, which are exhibited in the Textile Machinery building of the Exhibition, we may pass on to consider briefly the principal characteristics of tissues which are produced from such yarns. In doing this we may be traversing some of the ground covered by elementary text-books; but a recapitulation of the distinguishing features of different fabrics will be useful as an introduction to the different machines that produce them, and which are shown in the Exhibition. The word "fabric" serves not only to define all classes of stuff made from textile materials, and suitable for clothing, upholstery, &c., but its use is extended to combinations of interlaced thread, employed for a variety of purposes. All woven materials may be broadly divided, according to their characteristics, into four principal categories. 1. Ordinary tissues, such as calicoes, &c., produced in the common loom. 2. Upholstering goods, such as carpets, hangings, &c.; this class is distinguished by great variety of colour and richness of design. 3. Hosiery. 4. Tulle, lace, &c. Tissues may be defined generally as fabrics produced from threads interlaced according to some regular method, and weaving is the operation by which such fabrics are produced. But this classification and definition of tissues is too general for practical purposes, and, moreover, is not strictly correct; because such a material as felt, for example, may be classified as a tissue, because it fills certain purposes of a fabric, although no operation of weaving is required for its production; on the other hand, wire cloth cannot be defined as a tissue, although it is actually a woven material. Again, knitted goods may be spoken of as tissues, though the operation by which they are produced cannot certainly be called weaving.

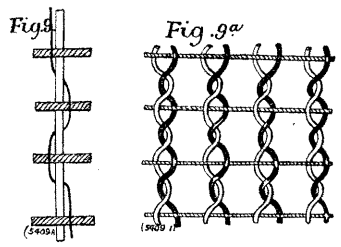
In order to avoid these difficulties a more complicated terminology has been adopted. The professor of spinning and weaving at the Conservatoire des Arts et Métiers, of Paris, defines a tissue as follows: "A stable aggregation of flexible elements, producing compact or open coverings, uniformly flexible, and of a limited thickness;" this definition allows felt to be included as a stable aggregation of flexible elements, but it excludes cotton wool which is an unstable aggregation, as well as the many varieties of passementerie which do not form covering surfaces. It would appear, therefore, more logical, and certainly more practically useful, to distinguish the different classes of tissues according to their textures, as illustrated by characteristic types, and by the methods of laying and interlacing the component threads, which furnishes the clearest and most characteristic distinctions from a practical point of view. It is this mode of classification that we propose to adopt in dealing with the textile exhibits at Paris, and we shall find that it leads to eight comprehensive divisions, as follow:

1. Tissues made in the ordinary loom, and represented as a class by calico weaving.
2. Tissues less closely woven, and with the warp and weft threads tied together by "whip thread." Gauze weaving is the representative of this class.
3. Tissues produced in the Jacquard loom, such as brocades.
4. Openly-woven tissues, the threads of which are mutually and continuously interlaced; tulles are the representatives of this class.
5. Lace tissues.
6. Close-woven tissues in which the weft threads are knotted on the warp to produce a pile; of this class, some natures of tapestry, carpets, &c., are representative.
7. Open knotted tissues, such as fishing nets.
8. Tissues produced by the involutions of one thread, such as hosiery and knitted goods.

We will endeavour briefly to describe the characteristics of these different classes of tissues, a clear understanding on this point being absolutely necessary for useful examination of the machines by which they are produced.

1. *Tissues Produced in the Ordinary Loom.* (The French definition for this is *Croisement Simple.*)—This is the most simple method of producing fabrics. A thread crosses at right angles to a series of parallel threads passing under and over these, the character depending upon the system of alternations; this is the work produced by the ordinary weaver in a simple loom, in which the alternate threads of the warp rise and fall simultaneously. Or instead of being at right angles, the travel of the weft may be made obliquely between a warp of a given width, the threads of which pass alternately one below and the next above on the line of meeting, the angle of the weft being made equal and opposite for each adjoining width. This method of weaving only produces a stable fabric if the warp and weft are sufficiently close, as in linen tissues, or if they are fixed by dressing, as in certain classes of muslins.

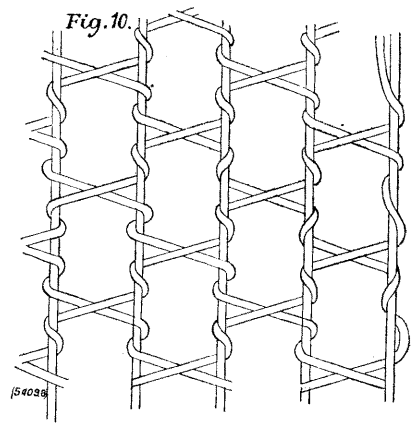
2. *Tissues less Closely Woven, and with the Warp and Weft Threads Tied together by Spiral Ligatures (Croisements Liés).* —The special purpose of this method of weaving is to supply the lack of stability unavoidable in producing fabrics by the previous method. It is illustrated in Fig. 9, where it will

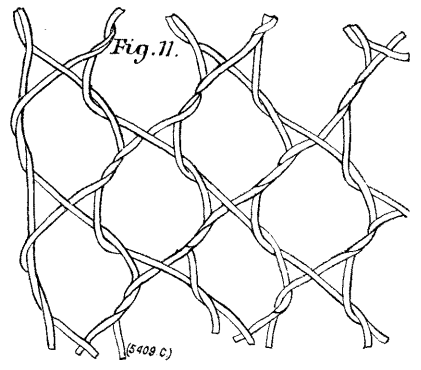


be seen that a whip thread is twisted round each warp thread, and locks around it and the weft at every point of intersection of the two threads, which cross at right angles to each other. This whip thread consists of a second but finer longitudinal thread, which envelopes the first one with an alternating spiral; it also ties the transverse thread at each point of intersection, and is then twisted under the lower longitudinal thread. The structure so produced is that of gauzes in their most simple form: it is made by means of special devices added to the ordinary loom, and is capable of various modifications, producing different effects.

3. *Tissues Produced in the Jacquard Loom, such as Brocade (Enveloppements Fractionés).* — This operation, which is simple in principle, but very delicate in operation, consists in passing from left to right, for example, between the raised and lowered threads of a part of the warp, a small special shuttle, then in returning this shuttle from right to left between the other raised and lowered threads of the same group of the warp, and continuing this operation between the same or other groups of threads, following a progressive or intermittent system, according to the requirements of the design. This is the decorative and supplementary work executed on ordinary tissues, either locally or over their whole surface, or produced continuously, according to the pattern, on highly finished brocaded tissues, in which the most elaborate and richly coloured designs can be woven.

4. *Openly Woven Tissues, the Threads of which are Mutually and Continuously Interlaced (Enveloppements Continus Helicöidal).*—This variety is produced by a binding thread which, twisting once or more round a warp thread, is then turned to connect it with another adjacent warp thread, around which it makes similar turns, and so on. The process is somewhat similar to that indicated for gauze weaving, except that the binding thread from the bobbin, after being twisted once or twice round a warp thread, passes on to the next one to repeat the same evolution, and so on. A slow movement is given to the warp in the direction of its length, the bobbins passing to and fro continuously as the warp is displaced. This product is characteristic of the various tulle fabrics. The special purpose of the mechanism is to obtain a reticular tissue having clear open spaces, with uniformly divided and secure connections, giving at the same time a special decorative effect. This method is often combined with the use of additional threads twisted around single threads or groups of threads of the warp; these passing from one to the other, according to the nature of the design, can be made to produce figured materials of great beauty. A piece of tulle is illustrated by the diagram Fig. 10; it consists of a series of parallel threads, round which each weft thread makes one turn in the body of the fabric, and two turns at the selvage. The intersections are made as follow: One set of





weft threads travelling in one direction and another, symmetrically in the opposite direction, are twisted around each warp thread so as to form six-sided meshes, as is shown in Fig. 11, which represents the tissue obtained by the three series of threads when the warp is no longer stretched on the loom; one set of the weft threads draw the warp to the right, and the other set to the left, as indicated on the diagram. We shall see later on that varieties of this method of interlacing are shown at the Exhibition on some very remarkable machinery in operation.

5. *Lace Tissues (Torsion Mutuelle).*—This method in principle is the interlacing of two threads twisted together; this operation is not continuous as in spinning; two threads coming from two different points meet, and turning one around the other either with a half twist or one complete turn at the most, separate in order to repeat, each on its own side, similar evolutions with other threads. This interlacing is produced in its most simple form in a meshed tissue, where each thread is twisted successively around its neighbour to right and left. It is, in fact, an imitation by mechanical means, of the tedious but highly artistic work of the hand-lacemaker executed with so much skill, but to the uninitiated onlooker, in a capriciously irregular manner, according to the requirements of the design and by means of pins fixed in pillows; these workers also employ other and ordinary methods of twisting, and occasionally of knotting, to consolidate their work. This class of interlacing in the loom involves the use of a number of separate

threads wound upon spools, each of which, acting quite independently of the others, can be brought into any necessary direction in order to meet other threads coming from an opposite direction.

6. *Tissues with Knotted Wefts Around the Warp (Enveloppements Noués).*—In this division a weft thread is wrapped around one or several warp threads, with at least one complete twist, and is then locked against it or them, by a knot made in passing the free end through the loop formed by the evolution around the warp. It follows from this method of interlacing that any pull exerted on the end of the enveloping thread tends to lock it more securely. In a tissue of this kind the necessity of employing a continuous weft involves the operation of passing the shuttle or bobbin carrying the thread which forms the loop through the latter. From this microscopic and difficult operation results the production of very beautiful piled fabrics, examples of which are to be found in the celebrated Gobelins tapestries; in these, each loop is attached in the manner described by a running knot to the threads of the warp, which renders the finished fabric extremely solid without affecting the execution of a variety of work admirable alike in design and colour.

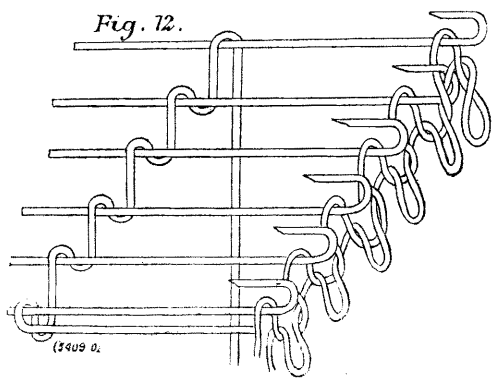
7. *Open Knotted Tissues (Noeuds Mutuels).*—This differs essentially from the previous method of interlacing, in which the knot, formed by the enveloping weft, can obviously be made to slide along the enveloped warp. It is produced by two threads, which are knotted together at given points of their length. It is necessary that the knot should be a fixed one and occupy a definite position, and that the two threads should make similar and opposite movements in order that the two loops formed by them should interlace and be mutually locked. The production of fishing-nets is an example of this kind of work. It can be made as a trellis between the threads of a single series, each of which is knotted alternately to its neighbour to the right or left; the formation of the knot requires either a single loop made simultaneously in the two threads to be knotted, and closed by them with a twist made by the two ends

that traverse the loop, or by two successive and opposite twists traversed by the ends of the threads. In fishing-nets made by hand, only one thread is used, which is knotted at regular intervals with the meshes of the row already made, thus forming gradually a new row of loops.

8. *Tissues Produced by the Involution of One Thread* (*Mailles*).—This method of weaving is the interlacing of a thread upon itself by means of successive loops twisted into one another without the end of the thread ever passing through any of the loops (see Fig. 12). From this it results that whatever may be the length of the interlaced portion, or of the tissue already finished, a pull exerted at the end of the thread unfastens, one by one, and successively, all the loops, and consequently the entire tissue, just as a length of chain stitch composed of a series of loops can be unravelled. For this reason, tissues of such a character require to be stopped from time to time, and especially at the ends, by a closed knot. The characteristic type of this class is hosiery, and it is also illustrated by knitting, produced either by hand or machine, by crochet work, &c.

A few words remain to be added about some of the fundamental operations common to all classes of weaving, and which may be illustrated by the ordinary calico fabric. All tissues of this nature are the result of interlacing threads of two classes: those previously arranged parallel to each other lengthways of the stuff, and called warp threads; and those which are passed through the warp at right angles, half the threads of the latter being raised, and the other half lowered for the passage of the shuttle containing the transverse or weft

Fig. 12.

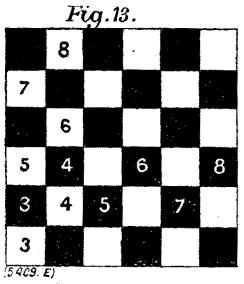


thread. The shuttle (*navette* in French, from *navire*, a ship), carries the weft to and fro from one side to the other, the edge of the warp being the selvage of the material. Usually one or several, continuous threads are used for the weft (the latter where several shuttles are employed); but short weft threads are also used; in this case the length is about double the width of the stuff,

and is applied in such a way as to secure the selvage edges. The loops and free ends of the weft are left, in such a case, alternately on each side of the fabric, so that the selvages on each side parallel to the warp, are secured by the closed loop of the weft, the alternating open ends being left free. In the warp, the left-hand thread is called the first thread, and these are thus divided into "odd and even," the same distinction being applied to the weft.

At the risk of appearing to introduce still further elementary matters belonging properly to textile handbooks, a few more points have still to be mentioned as introductory to our subsequent notices of exhibited textile machinery, the operations of which depend upon fundamental principles. The superposition of the weft and warp threads, resulting from the alternate raising and lowering the latter, may be shown graphically as in Fig. 13, where the black

Fig. 13.

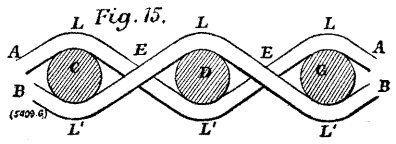


squares represent the lifted warp, and the white squares the positions of the weft. In the diagram called the "pattern," Fig. 13, it is easy to see that the black squares 3, 5, 7, &c., represent the warp thread 1; and the black squares 4, 6, 8 the warp 2, and so on. The white squares 3, 5, 7 are weft thread No. 1; and 4, 6, 8, weft 2. In order to determine the class of texture of any stuff, the pattern, Fig. 13, can be reduced as shown in Fig. 14. Two natures

Fig. 14.

of pattern are required, one to determine the character of the fabric, and the other the quantity of warp or weft thread absolutely necessary for the completion of a pattern. Every pattern has, therefore, two functions: 1. The transverse function, referring to the number of warp threads shown by the number of squares in the width of the material to be produced. 2. The longitudinal function, showing the number of weft threads required for the same pattern. The passage of two consecutive wefts under two warps lifted alternately, produces an interlacing indicated in Fig. 15. This inter-

Fig. 15.



lacing has two definite characteristics: 1. The binding points L L^1 at the top or bottom of each thread as it passes over or under the weft. 2. The point of intersection E between each of the threads C, D, E. There are two distinct kinds of "patterns," the weaving, and the figure pattern; the former are those which determine the modes of intersection, to constitute the underside of the fabric; the other also shows the underside, but also determines a surface grain or configuration which is systematically repeated, and is known by various names, such as diagonals, lozenge, pheasants' eye, &c. There are four fundamental kinds of weaving patterns, from which many varieties of stuffs are derived. They are: (1) linen; (2) twills; (3) serge; (4) satin. These patterns have the two following characteristics: The first is that the transverse and longitudinal ratios are alike, because the number of intersections of the warp and weft threads are the same, conformably with the second characteristic, that the sequence is the same for all the threads, warp and weft, respectively. The sequence of a fundamental pattern and its derivatives is shown by the order of the black or coloured squares of the pattern and of the squares left white, which comprises, on the whole length of the pattern, a weft thread selected as No. 1; the others following in the same order, but starting from a different warp thread; the variations thus obtained may be graded from left to right or right to left.

In calico weaving, the sequence is always one warp thread "taken," one "left."

In batavia (fancy twill), the sequence is two "taken" and two "left."

In serge (regular twill), with n squares, it is one "taken," and n—1 "left."

In satin (satin twill), with n squares, the sequence is the same.

It is the first weft thread of each pattern that decides the sequence of the tissue, provided that the first square on the left indicates the commencement of the warp, numbering always by 1 or n threads taken. In figured linen the gradation is

Fig. 16.

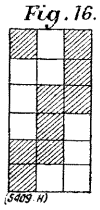
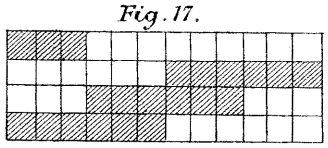


Fig. 17.



by one and one, continued diagonally. In the diagram, Fig. 16, the warp gradation is by one and one, that of the weft by two and two. In Fig. 17 the gradations are by threes. The same order can be observed either transversely or longitudinally.

(To be continued.)