TEXTEIL MACHINERY AT THE PARIS EXHIBITION.

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HAYER 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 characteristic of tissues which are produced from such yarns. In this way we may be traversing some of the ground covered by elementary textbooks; 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 threads, 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. Hassery, 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 of tissues is too general for practical purposes, and, moreover, is not strictly correct; because such a material as felt, for example, may be the result of the operation by which they are produced; 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 comprehensive terminology has been adopted. The production of spinning and weaving at the Conservatoire des Arts et Métiers, Paris, defines a tissue as follows: "A stable aggregation of flexible elements, producing compact or open coverings, uniformly finished, and of a limited thickness;" this definition alone fails to be included as a stable aggregation of flexible elements, but it excludes cotton wool, which is not an unstable aggregation, as well as the many varieties of passementerie which do not form covering surfaces. It would appear, therefore, necessary to define, 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 distinction 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." Guaze weaving is the representative of this class.
3. Tissues produced in the Jacquard loom, such as brocamas.
4. Openly-woven tissues, the threads of which are mutually and continuously interlaced; tulle is the representative of this class.
5. Lace tissues.
6. Close-woven tissues in which the warp threads are knotted on the reed; this class includes damask and its varieties, all which have certain characteristics different from those of the other classes, and is best described as a separate division.
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 endow each of these divisions with the characteristic 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. Tissus Produits en the Ordinaire Loom. (The French definition of this class is: "Tissus de Type 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 loom 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 thread 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 warp 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 stiff, as in linen tissues, or if they are fixed by dressing, as in certain classes of muslins.

2. Tissus Less Calico, and with the Warp and Weft Threads Tied Together by Spiral Lattices (Girouettes Spirales). — The special purpose of this method of weaving is to supply the lack of stability and strength in producing fabrics by the former method. It is illustrated in Fig. 9, where it will be seen that a whip thread is twisted round each cloth thread, and travels round it and the warp at every point of intersection of the two threads, which cross at right angles to each other. This whip thread consists of lateral spiral threads, which envelops the first one with an alternating spiral; it also ties the transverse thread at each point of intersection, and is then twisted under the longitudinal warp. The structure so produced is that of gaizes 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. Tissus Produits en the Jacquard Loom, such as Brocades (Developpements Fracturés). — 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 tassel, then return the guides from right to left between other raised and lowered threads of the same group of the warp, and continuing this operation between the same or other groups of threads, forming a progressive or intermitted system, according to the requirements of the design. This is the decorative and supplementary work executed either in one operation, or produced in a separate follow, over the 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 Continuous (Developpements Continus Holcitothè). — 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, and which makes similar turns, and so on. The process is somewhat similar to that intended for guaze 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 the loom, the bobbin is rotated in the same direction as the warp is displaced. This product is characteristic of the various tulle fabrics. The whole system is often combined with the use of additional threads twisted round single threads or groups of threads in one direction or another, 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 tulle, and two turns at the selvedge. The intersections are made as follows: One set of weft threads travelling in one direction and another, symmetrically in the opposite direction, are 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. Frames with Knotted Wefts Around the Warp (Broderages Nœuds).—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 (Nœuds Méthodes).—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 is 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 Interlacing 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 brasserie, 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 thread. The shuttle (œuvette in French, from savire, 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 of the warp, secured by the loops, alternate 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 matter 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 of the latter, may be shown graphically as in Fig. 13, where the black squares represent the lifted warp, and the white squares the positions of the weft. In the diagram called the "pattern," Fig. 15, 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 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 white 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 interlacing has two definite characteristics: 1. The binding points L, L' 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 latter 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;