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THE
PRIMARY
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THE PRIMARY STRUCTURES OF FABRICS

an Illustrated Classification

BY I R E N E E M E R Y

The Textile Museum, Washington, D.C.

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D. Two or More Sets of Elements

In fabrics composed of only *one set of elements*, all the elements are equally, though only relatively, vertical and are interworked with one another; whereas in those composed of more than one set, a series of longitudinal elements, which are essentially parallel to each other, is interworked with another series of parallel elements crossing them at more or less right angles. The longitudinal elements are called *warp*, the transverse elements, *weft*; and at least two sets (one of each) are essential to the structure of a *woven fabric*, or *textile*. A group of elements whose function in a fabric structure differs from that of other elements running in the same direction is regarded as a separate *set of elements*, warp or weft according to its direction.

Warp: essentially parallel elements that run longitudinally in a loom or fabric, crossed at more or less right angles and interworked by transverse elements. (Note that in four-selvedge fabrics, the long dimension is not necessarily in the warp direction.)

Weft: the transverse elements in a fabric (generally parallel to each other and to the terminal edges or ends of the fabric) which cross and interwork with the *warp* elements at more or less right angles. (Also called *woof* or *filling*.)

Fabric structures made up of *two or more sets of elements* vary in a number of ways. There are different kinds of interworking (i.e. variety in the nature of the relationship between elements); there are different orders of interworking (i.e. variety in the numerical pattern of the grouping of elements); and there are different degrees and kinds of complexity (i.e. variety in the number and uses of warp and/or weft sets in excess of the necessary two).

Fabric structures composed of only *two sets of elements* are frequently called 'single constructions' because they are made up of one set each of warp and weft elements; but they are more commonly known as *simple weaves* in contradistinction to those having more than the two basic sets, which are referred to as *compound*. *Simple-weave* structures are grouped according to certain characteristic variations in the order, as well as in the kind, of interworking. *Compound* structures are grouped primarily according to the way component sets-of-elements or weaves are related in the fabric structure. In some there is a *simple* (one-warp-one-weft-set) 'ground' or 'foundation' weave throughout, and any additional warp or weft sets are clearly *supplementary*; in others, there are at least two sets of elements in either the warp or the weft direction that are *complementary* to each other and co-equal in the fabric structure; while in still others, the *compound* structure is composed of two (or more) complete and correlative weave structures, either separate but *interconnected* (as in *double-cloth*), or completely interwoven, that is, *integrated*.

Interlacing is the simplest kind of interworking. There is no *interaction* between elements of the same set (their courses run parallel to each other), and elements running at right angles to each other simply inter-cross. But within the limits of this basic simplicity, there are uncounted possibilities of varying the order of the interlacing, and of compounding the structure by the addition either of sets of warp and/or weft or of complete weave structures. The other ways of interworking *two or more sets of elements* all involve inter-element relationships that are structurally more complex. Instead of, or in addition to, *interlacing*, there may be *interaction* between adjacent elements of one set — either a *crossing* and *re-crossing*, with the crossings secured by the *interlacing* of elements of the opposite set, or a *twining* of adjacent elements about each other, enclosing instead of being inter-

laced by elements of the opposite set — or the movement of one set may be a progressive encircling, or *wrapping*, of the elements of the set they intersect, with or without the formation of *knots* to secure each wrapping. But although these interworking relationships are more complex than *interlacing*, their range of variation is comparatively so much less extensive that the *simple* (one-warp-one-weft-set) forms seem adequate to illustrate the principles on which one is distinguished from another and to suggest the possibilities of varying each. *Compound* forms of interworking other than *interlacing* will be illustrated only when some wide-spread use of a structure involves employment of more than the two basic sets of elements (e.g. 'knotted pile,' pp. 221 ff.).

1. Interlacing Warps and Wefts

Interlacing was described on page 62 as "the most straightforward way of interworking elements, inasmuch as each element simply passes under or over elements that cross its path." This applies not only to *oblique interlacing* of the elements of a single set but to *interlacing* of weft with warp elements. *Warp-weft interlacing* is the type of interworking that is characteristic of most loom-woven fabrics, and it has been of major importance in the whole development of *textiles*. The uncomplicated nature of the interworking relationship between elements permits almost endless variation in the order as well as considerable functional differentiation and specialization in the use of elements. It also makes the *interlacing* process peculiarly adaptable to mechanization. It is possible, for example, to effect *interlacing* of weft with warp by separating the warp elements into two groups (those that are to lie over, and those that are to lie under, a passage of the weft), and, after laying the weft in the opening between the two groups, either reversing or otherwise altering the grouping of the warps for the next passage of weft. Such an opening between groups of warp elements is called a *shed*, and a device for effecting the opening, a *shedding device*.

Shed: a temporary opening between two planes of warp threads selectively separated for passage of the weft.

Shedding device: any device (no matter how simple or complex) used to effect a *shed*.

Warp-weft interlacing is straight over-and-under inter-crossing of parallel transverse elements with parallel longitudinal elements. It does not include structures in which elements consistently deviate

from their parallel courses to *cross* or to *twine* about other elements of the same set; nor does it include structures in which elements encircle (i.e. *wrap*) those of the opposite set instead of simply *interlacing* them. Slight deviations or *deflections* from the parallel courses that do not involve any *crossing* of elements having the same general direction do not affect the essentially rectilinear quality of a fabric structure.

A. SIMPLE WEAVES

Simple warp-weft structures are those having only one set of longitudinal, or *warp*, elements and only one set of transverse, or *weft*, elements. Variation of structure is effected by varying either the numerical order in which the elements or units of one set interlace with those of the other, the alignment of the interlacings, or both. If the numerical order is over-1-under-1, there can be no variation of alignment and the weave is *plain*. Any other numerical order creates *floats*, and the alignment of floats can be varied in many ways, producing *twill*, *satin*, and other *float weaves* (see pp. 92 ff.).

Float: any portion of a warp or weft element that extends unbound over two or more units of the opposite set on either face of a fabric.

It is characteristic of *simple interlacing* that the structure of one face of the fabric is reflected on the opposite face. No element appears on only one face; and if there are *weft floats* on one face, there are correlated *warp floats* on the other.

NOTE: that if warp and weft elements are dissimilar in size and/or spacing, the correspondence between warp and weft floats may be difficult to detect; but if the order of interlacing is *uneven*, there will be a structural distinction between the two faces whether or not immediately apparent.

1. PLAIN WEAVE

The simplest possible interlacing of warp and weft elements produces *plain weave* (also called *tabby*, *taffeta weave*, *linen weave*, *cloth weave*, *checker weave*, and so on). The principle of the interlacing is unvarying alternation. Each weft unit passes alternately over and under successive warp units, and each reverses the procedure of the one before it. The warps are separated into only two groups. All warps that lie above one passage of weft lie below the next, above the third, and so on. It is possible to vary the nature of the fabric by modifying the spacing, pliability, or size relationships between warp and weft elements, or by grouping elements into units, without varying the simple alternating order of interlacing which constitutes *plain weave*. The obverse and reverse of *plain weave* are structurally identical.

BALANCED PLAIN WEAVE If the warp and weft elements are equally spaced and either identical or approximately equal in size and flexibility, the *plain weave* can be described as *balanced* (fig. 85).

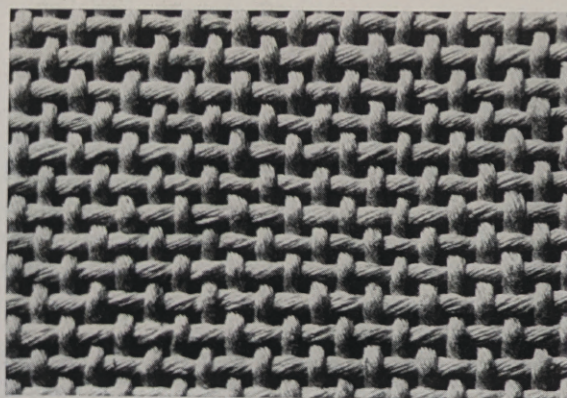


FIG. 85 *Balanced plain weave*, warp and weft equal in size, spacing, and count.

NOTE: that the term *thread count* refers to the number of warp and weft elements to the linear unit of measurement, *square count* to an equal number of each. But the fact that the *thread count* is 'square' does not necessarily mean that the *weave* is *balanced*. If warp and weft differ conspicuously in size, the 'count,' unaffected by the diameter of the elements, may be 'square' but the space between elements will differ in the two sets according to the difference in element size, the bulkier elements lying closer together than the finer ones.

WARP-FACED PLAIN WEAVE The greater the number and the closer the spacing of warp elements in relation to weft, the more the warp will tend to conceal the weft. If the warp elements hide the weft elements completely, the weft will affect the fabric only by its presence, not by its appearance, and the fabric is said to be *warp-faced* (fig. 86). If the warps outnumber the wefts yet do not entirely conceal them, the fabric can be described as having a *predominant warp*.

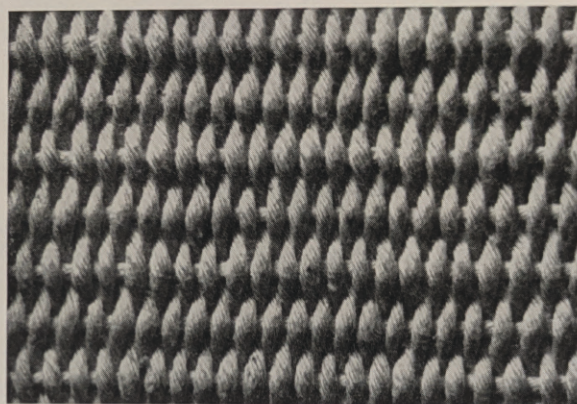


FIG. 86 *Warp-faced plain weave*.

It is obvious that there can be considerable variation in the degree of predominance of warp over weft, and that the line of demarcation between a *warp-faced fabric* and one with a *predominant warp* will always be subject to individual interpretation. However, approximate diameters of threads, given in conjunction with thread counts, will clarify the use of terms in specific instances. (In fig. 86, for example, warp and weft are identical yarns spaced 20 warps x $4\frac{1}{2}$ wefts to the inch.)

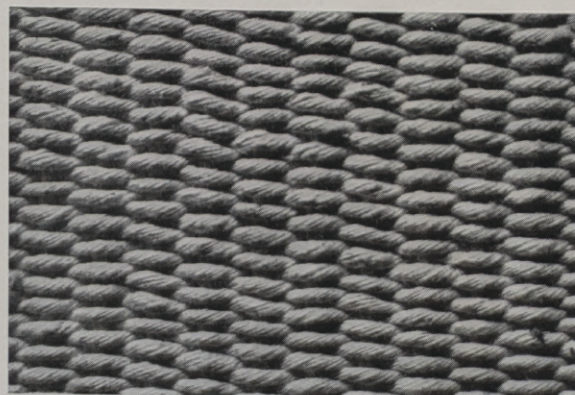


FIG. 87 *Weft-faced plain weave*.

WEFT-FACED PLAIN WEAVE If, on the other hand, the relationship between warp and weft is reversed and the wefts are sufficiently numerous and sufficiently compacted to completely cover the warps, the fabric is *weft-faced* (fig. 87); if the weft obscures but does not conceal the warp, the fabric can be described as having a *predominant weft*.

NOTE: that partial or complete predominance of warp over weft or weft over warp is commonly used as a means of varying texture and quality without weave variation. It is possible in almost all weave structures, and occasional examples will be illustrated.

RIBBED PLAIN WEAVE In *plain weave*, a marked numerical predominance of one set of elements over the other tends to produce a 'ribbed' effect sometimes referred to as *rep* (see p. 86 for discussion of the use of the term). The ribs extend in the direction of the concealed elements. The prominence of the ribs depends on the relative size and spacing of the elements of the two sets. In general, the larger the concealed elements in proportion to the elements that cover them, the more prominent the effect of ribbing; but ribbing can be produced by spacing alone with warp and weft elements that are identical, as are those in figures 86 and 87. The appearance of ribbing is made more pronounced if large and small units are alternated in the hidden set, a characteristic sometimes specifically implied by the use of the term *rep*, or *repp*.

MULTIPLE-ELEMENT UNITS Warp and weft elements are not necessarily used singly as in the illustrations on page 76. The elements of either or both sets can be *paired* (figs. 88 and 89), *tripled* (fig. 90), or used in larger groups — regularly or irregularly disposed (figs. 91 and 92). If identical units are used in warp and weft (figs. 89 and 90) the *plain weave* structure is often called 'basket' or 'matt' weave. If the units of only one set are multiple (fig. 88) the weave is sometimes described as 'half-' or 'semi-basket' (an unhappily indefinite designation since it fails to indicate whether it is warp or weft elements that are multiple). Fabrics which have multiple units in only one direction will not have a balanced appearance although the 'count' (usually of units rather than of component threads) may be the same for both warp and weft. Modifications (predominance of warp or weft, ribbing, etc.) are effected as in any *plain weave*.

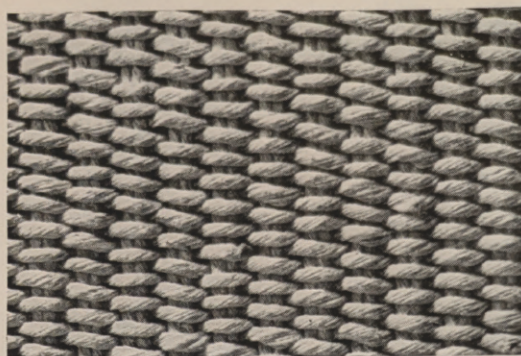


FIG. 88 *Plain weave with paired warps and predominant wefts* (sometimes called 'half-basket' weave).



FIG. 89 *Plain weave with paired warps and wefts* (sometimes called 'basket' or 'matt' weave).



FIG. 90 *Plain weave with tripled warps and wefts* (sometimes called '3/3 basket' or '3/3 matt' weave).

As long as the same groups of elements are maintained as units, the weave cannot be said to be affected by the number of elements in the unit any more than it is by the size and make-up of elements that are used singly. Elements of either or both sets

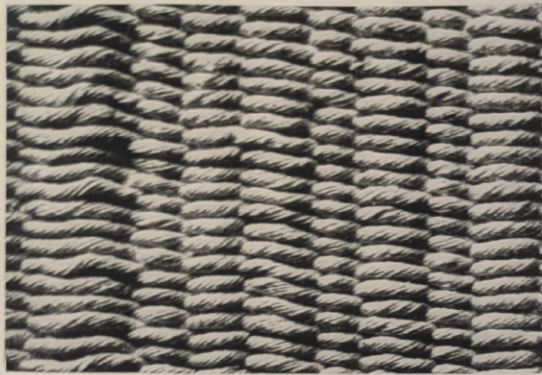


FIG. 91 *West-faced plain weave*, with warp units composed of numerically different groups of elements.

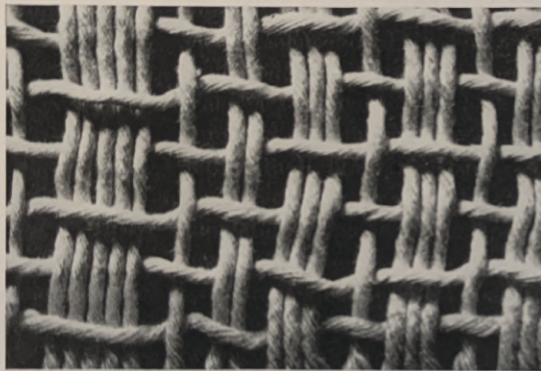


FIG. 92 Diagrammatic construction of fig. 91.

can be grouped in different-sized units arranged in any order desired (figs. 91 and 92). Resulting fabrics may have marked differences in appearance and be called by different fabric names, but a real difference in *weave structure* is only effected by a change in the order of interlacing. If the order of interlacing is constant alternation, the structure is *plain weave*.

NOTE: that most *simple-weave* constructions (i.e. those having one set of wefts interlaced with one set of warps) are subject to all the same modifications of relationship between warp and weft (predominance of one or the other, openness or closeness of weave, grouping of elements into units, etc.) as *plain weave*, with comparable modifications of appearance, texture, and often of fabric name, without variation of the weave structure.

VARIANT USE: *Tapestry weave*

The word *tapestry* is used in many different ways. It may refer to a specific textile technique, to the

technique only when used for pictorial patterning, or to such pictorial patterning only when it is designed for mural decoration. Then again it may be used entirely without technical implication — to refer to any pictorial patterning in fabric form. The term *tapestry weave* is also variously defined and applied, but it usually refers specifically to mosaic-like patterning with discontinuous wefts in a *west-faced* weave (see p. 88).

Areas of solid color are easily produced in any weave in which one set of elements (warp or weft) entirely conceals the other; but areas of solid warp color are usually restricted in shape to vertical stripes, since warp color is arranged when the warp is set in place and is subject to only slight rearrangement during the weaving process. Weft-wise bands of solid weft color, on the other hand, can be produced at will as the weaving progresses because wefts are interworked one passage ('pick' or 'shot') at a time. A change of weft color that will result in a loom-width transverse color margin only entails substitution of a weft of a different color. If one weft is interworked only part way across the web and others are successively substituted to fill out the row, solid color or texture areas (of easily varied size and shape) can be created by working each weft back and forth in its own area. This simple procedure permits great flexibility in patterning and is the basis of *tapestry weaving*.

Tapestry weaving generally involves two fundamental principles: hiding the warp with closely packed wefts to secure solid color, and weaving independent wefts back and forth each in its own pattern area. *Tapestry weave* is usually *west-faced plain weave* (and so understood unless otherwise stated) but the same two principles are similarly applied, and mosaic-like patterns of solid color areas similarly produced, in other weaves such as *twill* (e.g. Kashmir 'shawls'), *weft-twining* (e.g. Chilkat 'blankets'), and *weft-wrapping* (e.g. Soumak rugs). Since the principles of patterning are the same, terms like *twill tapestry* and *twined tapestry* are often used to designate these tapestry-like fabrics in other than *plain weave*. When the principle of discontinuous wefts is applied in open or *balanced* instead of *west-faced* weaves, changes in weft color will still serve to create pattern areas, although muted by unvarying warp color.

In *warp-faced* weaves, patterns of solid color in other than vertical stripes can be produced by a use of discontinuous warps that is analogous to the use