WEAVING (from *weave*, AS. *wefan*, Ger. *weben*, to weave). The art of making cloth on a loom (q.v.) which in its simplest form is merely a frame to hold the warp threads parallel and regular, and enable sheds to be formed through which the wefts can move freely in a straight line without the necessity of passing over and under, as in plaiting, or in making lace (q.v.) on the pillow.

The three fundamental steps in weaving after the loom has been warped are: (1) pulling the lisses or healds to form the new shed; (2) passing the weft (usually called filling in machine weaving) through the shed; (3) pressing home the weft.

The three fundamental weaves are plain, twill, and satin. All others are merely variations and complications of these.

In plain weave the warp is divided into only two systems, the odd threads being attached to one set of lisses, the even threads to another. The passes of the weft to the left are through a shed that has the odd warps next to the weaves; the passes of the weft back to the right are through a shed that has the even warps next the weaver.

In twill weave the warp is divided into at least three systems, and there is not complete alternation of warp and weft as there is in plain weave. In a two-one twill the first weft passes over warp one, under warps two and three, over warp four, under warps five and six, etc.; the second weft over warps two, five, eight, etc., and under the others; the third weft passes over warps three, six, nine, etc., and under the others. This of course leaves only half as much weft as warp on the surface, and forms the diagonal ribs or ridges that are characteristic of twills.

In satin weave, which demands small silky threads, and which is primarily a silk weave, the warp is divided into at least five systems, and the weft is so passed that not more than one-fourth as much weft as warp remains on the surface, also the points where the weft comes to the surface are placed irregularly to avoid twill or diagonal effects. The result is that the wefts are practically negligible, and the surface appears to consist entirely of short lengths of parallel warps, thus giving the glossy effect characteristic of satin.

Figs. 1, 2, and 3 illustrate plain, twill, and satin weaves as plotted for a machine loom. In *A* the horizontal lines represent the healds or

loom harness with the disposition of the warp threads; the weave is shown at *B* written out on squared design or cross-section paper, each section representing the crossing of a warp and filling thread and the X marks showing that the warp is above the filling at the point they appear; the blank sections show that the filling is above the warp; the threads as interlaced are shown at *C*, and a section of the fabric cut through the warp is shown at *D*.

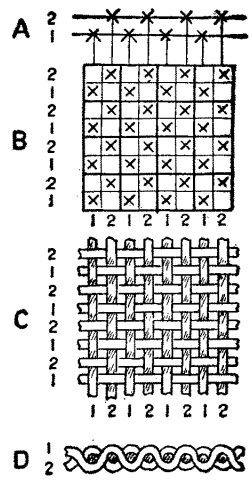

FIG. 1. PLAIN WEAVE.

The plain weave (Fig. 1) is the simplest form of weaving, requiring but two different movements of the warp threads. Four repeats of the weave in warp and filling are shown. From an examination of the several diagrams it will be seen that the movements of threads marked 1 are identical and of threads marked 2, while all alike, are exactly opposite to the movement of the former; this makes it possible to arrange the warp for the loom on the harness frames, as at *A*, and by raising No. 1 and depressing No. 2 the shed is formed while the first pick, or shot, of the filling is passed through, then harness No. 1 is depressed and No. 2 raised and the second filling thread is passed through the new shed; the third shed is like the first, the fourth like the second, and the weave repeated forms the fabric with the plain weave. Patterns in this weave can only be produced by the use of threads of different colors or material. It is not only the simplest but the firmest and strongest of weaves.

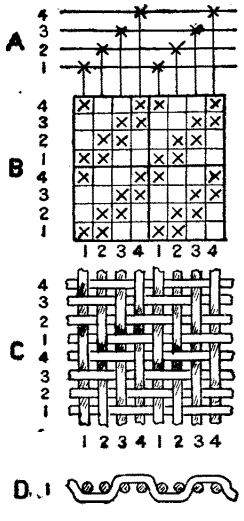

FIG. 2. TWILL WEAVE.

The twill weave, as illustrated in Fig. 2 by one of the simplest forms, is a weave in which the filling threads pass over or under two or more adjacent warp threads at a time, at least once in a repeat, each of the picks being alike except that each is stepped one thread to the right or the left of the one preceding it. The simplest twills may be woven on three harness and are technically "one up and two down," $\frac{1}{2}$, or "two up and one down," $\frac{2}{1}$, twills, the former being a filling-face and the latter a warp-face weave as the warp or filling predominates on the face. The next twills are the four harness twills, $\frac{3}{2}$, $\frac{1}{3}$, which are warp-face and filling-face weaves respectively, and $\frac{2}{2}$, which is even-sided; the twill used in the diagrams under Fig. 2 is a $\frac{2}{2}$ twill. The twill weave is distinguished by having a distinct wale or diagonal pattern, and by changing the number of threads taken up a great variety of twill weaves may be produced. Twill weaves are designated as right twills and left twills, as the diagonal, when traced from the bottom of a piece of cloth held lengthwise, leads to the right or left respectively. The twill shown in Fig. 2 is a right twill. By various arrangements of the twill weaves, curved twills or weaves may be formed instead of plain diagonals. By drawing the warp threads in different ways on the loom harness fancy weave effects are produced, such as the herringbone, where a section of right twill and a section of left twill alternate.

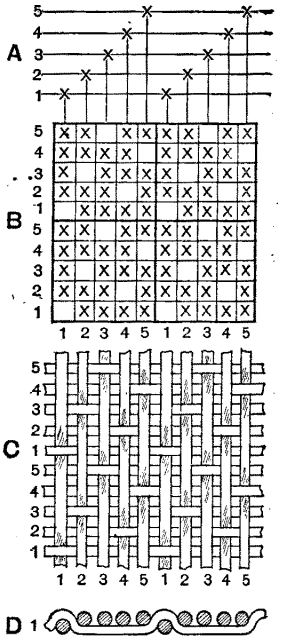

FIG. 3. SATIN WEAVE.

The simplest satin weave is produced with five harness and is illustrated in Fig. 3. An examination of the diagram shows that the stitching of the warp threads to the filling is so distributed that no two intersections are adjacent; and in order to make a smooth surface the warp threads stitch down to but one filling thread in a repeat of the weave. The weave as shown produces a fabric with warp satin face and filling satin back.

Rep and Taffeta Weaves. The simplest forms of plain weave have warp and weft threads of equal size and equal number to the inch, and showing equally on the surface, as in hard-spun etamines or rough-spun burlaps. Increasing the size and hardness of the warps, and decreasing the size while increasing the number and softness of the wefts, and pressing the wefts home hard, buries the warps entirely and produces a ribbed surface consisting entirely of wefts, the ribs marking the position of the hidden warps. This is the so-called rep weave, except that usually on the shuttle loom the warps are fine and the wefts are coarse, and the result is a warp rep instead of a weft rep. When the weft rep on a bobbin loom is figured by blocking in the colors with short passes, instead of sending the weft the full width of the warp as on the shuttle loom, the result is real tapestry. (See TAPESTRY.) On the other hand, if on a shuttle loom we have coarse wefts with fine warps, but the warps are so few that instead of covering the wefts they serve merely as binders, the result is taffeta. If the warps are numerous, but the wefts are inserted in satin weave, then the result will be warp satin on one side and will look like taffeta on the other.

Damasks and Brocades. These, like satins, are primarily silk weaves developed on the shuttle loom in China, the home of silk, just as twills and tapestries were developed in wool on

the bobbin loom in Flanders. Damask is a weave with warp satin ground and weft satin, twill, or taffeta figures, or vice versa. Brocade, derived from the Spanish for brocaded, and ultimately from the broche, i.e., the pointed bobbin of the high-warp loom, originally meant the combination of bobbin and shuttle effects; in other words, figures inserted with bobbins during the process of weaving a shuttle fabric. Ancient shuttle silks containing gold are usually called brocades, because the gold thread was inserted from bobbins, even in what would otherwise be damasks. Nowadays the brocaded effects, even on many hand looms, are usually inserted with extra shuttles. Of brocaded figures in general it may be said that they are weft effects, apt to be small and detached and in relief and in color, as contrasted with most damask figures that are large and flat and usually in the same color as the ground, but with contrasting tone produced by the contrast of weaves. The technical term for damask with ground of different color from the figures is "lampas." Brocatelle is a damask with large satin figures that are forced out into bold relief by the coarseness of the linen or cotton weft. Light-weight brocaded silks are usually called *soies brochées*, by way of distinction from the rich and heavy brocades based upon ancient cloths.

Velvet. Velvets are also primarily a silk weave, corresponding in wool to the hand-knotted Oriental rugs. (See RUGS, ORIENTAL.) Brussels and Wilton carpets (see CARPETS AND RUGS), and their printed imitations called tapestry carpets and velvet carpets, are merely the velvet weave applied to floor coverings of wool. Corduroys and velveteens are fabrics with pile surface, formed by bringing weft threads in loops to the surface and then cutting the loops. The primitive form of these can be seen in the Coptic velvets with uncut woolen weft pile, of which there are several important examples in the New York Metropolitan Museum of Art. The pile of modern velvets is produced not by extra wefts, but by extra warps that loop over wires which are withdrawn after the passage of the binding weft. When the velvet is to be cut velvet, the wires often have knives on the end that do the cutting automatically as the wires are withdrawn. Plain velvets are often woven double, with a common pile the cutting of which produces two complete velvets, one facing up and the other down. Velvets are figured by using several systems of warps of different colors, as in Brussels and Wilton carpets; by leaving part of the surface without pile and in satin or twill or taffeta; by contrasting surfaces of cut pile with surfaces of uncut pile; and by contrasting pile of two different heights. The more elaborate and complicated effects have never been produced in America, and in Europe on hand looms only. Terries and Turkish toweling are woven plain with uncut loops.

In gauze and other crossed weaves the warps twist over each other back and forth producing embroidered effects as in lappets, or openwork effects as in lenos and woven laces. In plain gauzes the warps twist in pairs around the filling threads, and produce a structure that, though light and open, is comparatively firm. A fair comparison is that between madras and crete, the former having a gauze and the latter an etamine ground. Leno is muslin with gauze effects introduced at regular intervals. The introduction of crossing threads that differ in color or count from the rest, as well as variation in the number of threads that cross and in the weft threads that are crossed, and the combination of gauze with twill, satin, brocade, or velvet weaves, produces some of the most delightful and unconventional stuffs that are known. In lappets the surface of a plain or gauze fabric is diapered with simple embroidery effects, by drawing with the lappet needle extra warp threads back and forth from point to point, binding them with the weft only at the outlines of the figures, and floating them loosely between.

Swivel weaving is accomplished by a special attachment described in the article LOOM. The swivel introduces a special filling to form figures on the face of the fabric—usually at a distance one from another—and while the result is similar to that secured by lappet weaving, much more elaborate effects can be produced, as the warp threads may be manipulated to bind the filling in a weave which, while causing it to predominate on the face of the fabric, does not make it float as in the lappet weave, where the figuring thread is bound down only at the right and left sides of the figure to be produced, with no intermediate stitches. By the use of a tier of shuttles in the swivel attachment several colors may be introduced in the figure, as when weaving a fabric where the ground may be figured in an all-over pattern of leaves or vines produced by the regular warp and filling, and the flowers are scattered over the surface and blended of two or three different colored threads by the swivel attachment. The great advantage of producing figured effects by lappet or swivel weaving over the use of a regular warp or filling is that in the latter the warp or filling floats from figure to figure on the back of the fabric, there being as many floating threads as there are threads in the figure; and these threads must be trimmed off after weaving, causing a great waste of material, while in the former mode of weaving the special warp or filling floats from figure to figure in but a single thread.

As the space in the power loom usually limits the number of harness frames to 24, great ingenuity is displayed by designers in the effort to produce complicated warp movements simply. A simple illustration of this feature of weaving

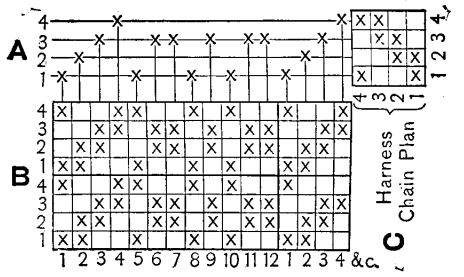

FIG. 4. DRAWING-IN DRAFT AND HARNESS—CHAIN PLAN.

is shown in Fig. 4. The weave *B* repeats itself on 12 threads and could be woven on 12 harness, but the number of harness may be reduced to four by drawing all threads which have like movements on the same harness as designated at *A*. The same principle is applied to more elaborate patterns where the weave may repeat on 100 or more warp threads and could be reduced, by the special drawing-in, to a number of harness which can be handled in the loom. In the harness looms the movements of the various harness

are governed either by cams or a pattern chain which is so arranged that as it passes over a small intermittently revolving cylinder the bars of the chain, which are supplied with a roll or small cam for each harness that is to be raised, act on certain levers which control the harness and raise or lower them according to the arrangement of the harness chain. Diagram *C* in Fig. 4 is the plan for the harness chain to produce the weave *B* when the warp is drawn in the harness as at *A*.

For patterns where the warp threads interlace with so many different movements that the weave may not be reduced as above, the patterns must be produced in a loom supplied with the Jacquard machine, which is a special head motion or harness motion, described in the article LOOM.