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### PILE WEAVES

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# PILE WEAVES

Serial 513

Edition 1

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## CONSTRUCTION OF PILE FABRICS

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### INTRODUCTION

1. Cloths of the class of textiles known as **pile fabrics** are distinguished in their finished condition by having a large number of threads projecting almost vertically from the body of the cloth; this is technically known as the *pile* of the goods, from which the name pile fabrics is obtained. The pile is supported by a closely woven ground cloth, the face of which is usually entirely hidden through being covered by the pile. Pile fabrics are, of course, entirely distinct from those cloths having a napped surface produced by a finishing process of gigging, napping, or raising, such as blankets, Canton flannels, and fleece-lined goods, in which the nap is produced by loosening and brushing some of the fibers of the yarns forming the body of the cloth.

Pile fabrics are produced in great variety, some of simple structure and others involving intricate patterns and complicated interlacings of the various series of yarns. While produced in relatively small quantities, they are of great importance on account of their usefulness for various purposes or for the artistic effects that are produced. Most varieties of pile fabrics in their finished state are familiar to the average person, but their structure and design are comparatively unknown except to the more experienced designers. This is partially due to the fact that their production is not large and is confined to certain districts, and also because of the complicated structure of certain varieties

of these fabrics. To thoroughly understand them requires an excellent knowledge of cloth structure and of weaving mechanism.

The system of yarn that forms the pile of a pile fabric is spoken of as the *pile warp* or the *pile filling*, as the case may be, while the systems forming the foundation fabric are spoken of as the *ground warp* and the *ground filling*. The pile appears in different forms in different classes of goods. In some cases, it covers the entire surface of the ground fabric, appearing like a continuous brush of uniform height, as in velvets and plushes; in other cases, it forms cords with a distinct rounded formation, running lengthwise of the goods, as in corduroy fabrics. Sometimes the pile remains in a series of loops of uniform height covering the surface of the ground cloth, as in Brussels carpets, or with the same effect on both the face and back of the fabric, as in Turkish towels, although in the latter case the pile does not stand so erect nor is it so thick and close as in other pile fabrics. Still other varieties are produced by a combination of different forms of pile arranged to give a figured effect, as in mantle cloths and draperies.

The different varieties of pile fabrics may be classified in several ways, one of which is to make two divisions, one to include those fabrics in which the pile yarn is *uncut* and remains in the form of loops issuing from the body of the cloth, and the other to include those in which the pile is *cut* so as to form two individual ends of pile projecting from the face of the fabric. Since, however, this classification does not provide for those fabrics in which both cut and uncut pile is combined, it is not sufficiently definite. Another classification separates the different varieties of pile fabrics into two divisions, one of which includes those fabrics of a corduroy nature, in which the pile is arranged in cords running lengthwise of the fabric, while the other embraces those in which the pile extends uniformly over the entire face of the cloth. This classification also is not sufficiently comprehensive, since certain fancy or figured pile fabrics cannot correctly be placed in either class. Another system, and the

one adopted here, which admits of a definite classification of all pile fabrics, provides for two main classes, namely, **filling-pile fabrics**, in which the pile is formed of filling yarn, and **warp-pile fabrics**, in which the pile is formed of warp yarn.

2. In all pile fabrics, the pile yarn is uncut when the cloth is first woven. In the case of filling-pile fabrics, the cutting is the object of a special process performed after the cloth is taken from the loom. In cut warp-pile fabrics, the cutting usually takes place in the loom after a sufficient number of picks have been inserted to prevent the cut pile being pulled from the fabric; in some warp-pile fabrics, however, the pile is left uncut and standing in loops.

There is a certain similarity in warp- and filling-pile fabrics, since in each the weave is so arranged as to produce a substantial, closely woven foundation, or ground, cloth that is not disturbed during the cutting process; this serves to hold the pile in position and bind it after it is cut, so that the fabric will not fray easily or the pile be loosened from the cloth. In many filling-pile fabrics, it is customary to use only one size or quality of filling, which serves on certain picks as ground filling and on other picks as pile filling. When the ground filling is inserted in the cloth, the sheds are so formed as to cause it to interlace with the warp in such a manner as to form the ground cloth. When, however, the pile filling is inserted, all the warp is depressed with the exception of certain ends that are raised so as to allow the pile yarn to be bound to the ground cloth. The pile filling, therefore, floats over the ground cloth in long floats, the length of which depends on the length of pile desired; this is governed by the position of the ends that are raised over the pile pick to bind it to the ground cloth. The principle of construction of a filling-pile fabric closely resembles that of an ordinary backed cloth, with the exception that in the latter the extra, or backing, filling floats on the back of the cloth, while in a filling-pile fabric the extra, or pile, filling floats on the face of the fabric.

Owing to the fact that separate ground and pile warps are used for producing warp-pile fabrics, it is not customary in this case to have both the pile and ground warp of the same material, size, or quality. Usually the pile warp is a finer yarn and constructed of superior material. While it would be possible to make a warp-pile fabric on the same principle as a filling-pile cloth, namely, by allowing the warp to float on the surface of the cloth so that it may afterwards be cut in the same manner as in filling-pile fabrics, this method is seldom adopted. The usual method is to construct loops of pile by raising the pile warp and inserting a wire in the shed. The pile warp being depressed under the ground picks preceding and following the insertion of the wire results in a row of loops of pile yarn being formed across the cloth by the wire; the size of the wire governs the size of the loops. In case it is desired to make a cut-pile fabric, the top of the loop is cut with a knife either before or during the removal of the wire, while if the pile is to remain uncut, the wire is drawn out without any cutting operation, which leaves a row of loops across the fabric.

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#### FILLING-PILE FABRICS

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##### CORDUROYS

3. Perhaps the simplest pile fabrics are those in which the pile is formed with extra, or pile, filling; and of this class the construction of that variety known as *corduroy* is the easiest to understand. **Corduroys** are cotton fabrics characterized by brush-like cords of pile running in the direction of the length of the piece. These cords are formed by allowing certain picks of filling, called the *pile filling*, to float over the surface of the fabric, while certain other picks, called the *ground picks*, interlace with the warp in such a manner as to form a firm foundation, or ground, cloth. After the cloth is woven, the floats of pile filling are cut in such a manner as to form the series of ridges of pile running lengthwise of the cloth that is the distinctive feature of a

corduroy fabric. These ridges are rounded, with the longest pile in the center of the ridge and shorter pile on either side, so as to leave a well-defined groove between the cords; in fact, it is almost possible to distinguish the ground fabric between the ridges of pile, especially in the cheaper grades. In all corduroy cloths, it is possible to observe the ground cloth by bending the fabric so as to separate the ridges of pile.

The ground weave for this type of pile fabrics should be of simple structure, such as the plain weave, or basket or twill weaves, the latter being used when it is desired to introduce more filling into the ground cloth and thus make a closer and heavier fabric.

4. Fig. 1 shows one repeat in the ends and two repeats in the picks of a corduroy weave in which the ground is woven with the plain weave. The first pick of this weave is a ground pick, the second and third are pile picks, the fourth pick is a ground pick, and the fifth and sixth, pile picks. In this weave, the interlacings of the ground picks with the warp are shown by the filled black squares and the interlacings of the pile filling by the shaded squares. This method of showing filling-pile weaves is adopted here only for the purpose of allowing the interlacings

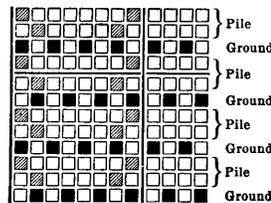


FIG. 1

of the pile and ground picks to be readily distinguished, and is not actually necessary, since all marked squares—whether black or shaded—represent the warp raised.

In constructing weaves for corduroy fabrics, after the number of ends and picks on which the weave is to be complete have been determined, the first step in representing it on design paper is to indicate the ground picks and place on them the desired ground weave, which in the case of Fig. 1 is the plain weave. The next step is to raise certain ends of the warp over the pile picks so as to bind them to the ground cloth. Thus, in Fig. 1, on the first pile pick, which is the

second pick of the weave, the second and seventh ends are raised, while on the second pile pick, which is the third pick of the weave, the first and eighth ends are raised; the fifth and sixth picks interlace with the warp exactly the same as the second and third, respectively. Two adjacent ends are thus alternately raised over the pile picks so as to fasten them to the foundation cloth.

These two ends do all the binding, since in a corduroy the binding points of the pile filling run lengthwise of the piece, in order to produce a series of floats running in the same direction to form the cord when cut. For binding the pile filling in corduroys, 2 ends are used instead of 1 end in order to make the cord of sufficient width to cover the ground well, and also so as to make the cloth more compact by allowing the ground picks to be placed closely together, since if all the pile picks were tied by 1 end, the intersections of the pile filling would tend to hold the ground picks apart. Moreover, if 1 end were used for tying purposes, that end would be considerably strained.

Since all filling-pile fabrics are woven with a large number of picks per inch, the ground picks will be forced together by the lay of the loom in beating up the filling and lie side by side; thus, in Fig. 1, the first, fourth, seventh, and tenth picks will be forced close together and form a plain ground cloth. This will cause the floats of the pile filling to be forced to the face of the cloth and float over the closely woven ground cloth except at those points where it is bound. Thus the second and third, fifth and sixth, eighth and ninth, and eleventh and twelfth picks will be very tightly compressed between the ground picks at those points where they are depressed under a single warp end, but at all other points will float over the surface of the ground cloth, thus forming ridges or lines of float lengthwise of the goods; these ridges are known as **races**.

Fig. 2 is a section of Fig. 1 showing the interlacings of the first four picks. The first pick, which is a ground pick, interlaces with the warp in plain order. The second is a pick of pile filling that floats over all the warp except the

second and seventh ends, which are lifted, according to the weave in Fig. 1, to bind the pile. The third is a pile pick bound to the ground cloth by being passed under the first and eighth warp ends. The fourth pick of Fig. 1 is shown in Fig. 2, and is the second pick of the plain ground weave.

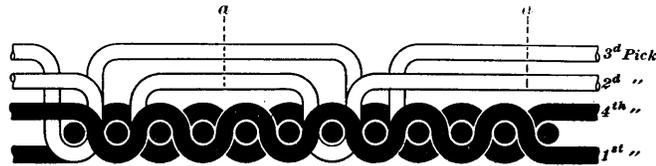


FIG. 2

If the fifth and sixth picks, which are pile picks, were shown, their interlacings would be like those of the second and third.

In order to form the characteristic corduroy cord, the races of pile filling are severed at the points of intersection with the lines *a*, Fig. 2, the severed ends rising and forming a cord the center of which will be midway between the dotted lines *a* at the point where the pile filling is bound into the cloth. As one pick of pile filling alternately floats over 4 and 6 warp ends, and the other alternately over 6 and 4 ends, after the floats are cut the length of the pile on each side of the binding point will vary slightly, and the longer

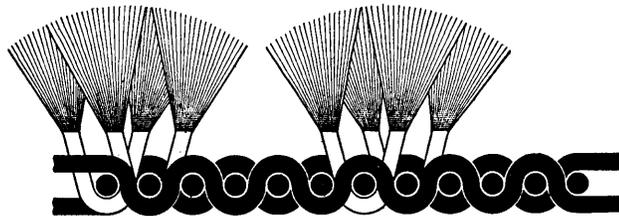


FIG. 3

pile will have a tendency to remain in the center of the cord, while the shorter pile will be on each side, thus giving the desired rounded appearance of the cord when finished. Fig. 3 shows the appearance of the section in Fig. 2 after the pile filling has been cut.

**5. Cutting Corduroys.**—The cutting of filling-pile fabrics is accomplished with a knife, shown in Fig. 4, having a sharp-pointed blade, on the end of which is a sheath that is brought to a point at its forward end. In operation, the point of the sheath is inserted in the race of floats formed on the surface of the cloth, shown in Fig. 2, and as the knife is pushed forwards the yarn is raised by the sheath *b* until it comes in contact with the sharp cutting edge of the knife *a* and is severed. The sheath is adjustable,



FIG. 4

in order to regulate the point at which the yarn comes in contact with the knife, so that the knife can be used to cut long or short floats of the pile filling, according to the cloth that is being made. When cutting the pile, about 2 yards of the cloth is stretched tightly on a frame and the operator, commencing at the right-hand side of the cloth, cuts each race of floats as he proceeds. The operation of cutting the pile on a filling-pile fabric is a laborious task, requiring some skill and adding materially to the cost of the fabric.

After the pile is cut, corduroy fabrics are brushed and singed in order to obtain a smooth, rounded cord, and are dyed usually dark shades of brown and drab. Corduroy fabrics possess excellent wearing qualities and are largely used for rough outdoor wear.

**6.** If the back of a cloth woven with the corduroy weave shown in Fig. 1 is examined, the appearance of plain cloth will be recognized. Those portions of the ground fabric between the ends that bind the pile filling are woven with the regular plain weave, but the binding ends do not interlace with the filling exactly as in a plain weave, although the difference can hardly be noticed, owing to the binding points being almost covered by the close structure of the fabric. Filling-pile fabrics that are woven with a plain ground weave are said to have a *plain back*, or, as it is sometimes termed in the textile trade, a *tabby back*. Although tabby backs are

frequently used, all corduroy fabrics are not constructed with a plain ground weave. When it is desired to produce a somewhat heavier ground cloth, a twill weave is often used for the ground weave, thus permitting more picks per inch to be inserted.

When a twill weave is used for the ground weave, it gives a distinctive appearance to the back of the fabric, which is then spoken of as a *twill back*.

The weaves most commonly used for this purpose are the prunelle and cassimere twills. Another name for the prunelle twill is the *jean twill*; from this is derived the term *jeanette back*, which is used

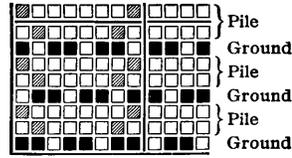


FIG. 5

when the ground fabric of a filling-pile cloth is woven with a prunelle-twill weave. Fig. 5 shows a jeanette-back corduroy weave, the ground weave being the prunelle twill. In

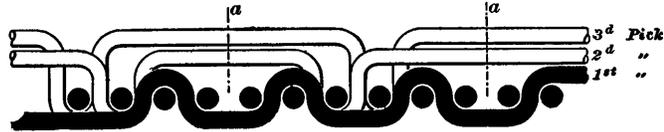


FIG. 6

this weave, 1 pick of ground filling alternates with 2 pile picks, the latter being bound to the cloth by being passed under certain warp ends in a similar manner to that employed

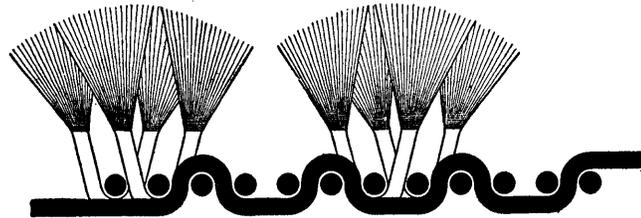
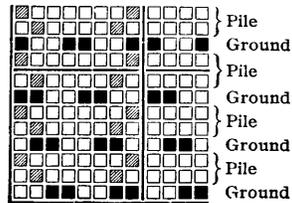


FIG. 7

in Fig. 1. Fig. 6 is a section of Fig. 5 showing the interlacings of the first 3 picks, the pile filling in this case being uncut. In Fig. 7 a section is shown of Fig. 5 in which the

pile filling has been cut so as to form the characteristic corduroy cord. Fig. 8 is another corduroy weave, but in this



case the cassimere twill is used for the ground weave; this weave closely resembles the one shown in Fig. 5, with the exception that a different ground weave is used—it will produce a twill-back corduroy.

FIG. 8

In the corduroy weaves that have been shown, 1 pick of ground filling has alternated with 2 picks of pile filling, but in some cases corduroy weaves are constructed in which 1 pick of ground filling alternates with 3 picks of pile filling.

Fig. 9 shows such a weave, in which the first pick is a ground pick and the next 3 picks pile picks bound to the ground cloth as indicated. The ground weave in this case is the 4-harness basket weave. Fig. 10 is a section showing the interlacings of the first 4 picks of Fig. 9; in this figure, the pile filling is shown cut so that the cord is formed as in all corduroy fabrics.

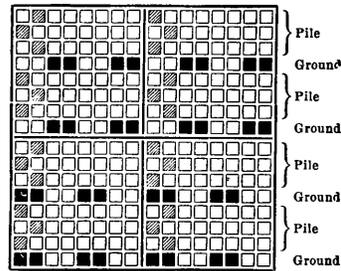


FIG. 9

In the weaves already described, each pile pick is bound to

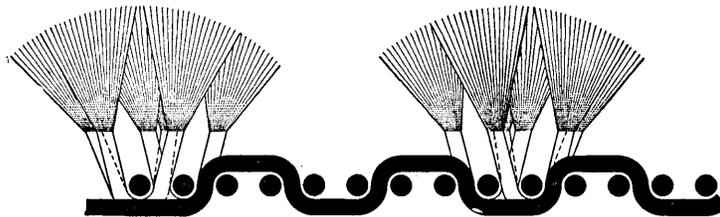


FIG. 10

the ground cloth by being passed under only 1 end of the warp, but in some varieties of filling-pile weaves the pile picks are bound more securely by being passed under one end, over

the next, and under the third, before floating, which causes the weave to require a larger number of ends in the repeat in order to obtain any given length of pile-filling float.

The proportion of pile picks to ground picks varies in different corduroy weaves, and although 2 picks of pile to 1 pick of ground is the usual proportion, these weaves are sometimes made with 2 of pile, 1 of ground, 1 of pile, 1 of ground, or 3 of pile, 1 of ground, 2 of pile, 1 of ground; and in special cases other combinations are used.

The number of ends over which the pile filling floats also affects the repeat of the weave. Those weaves already given represent the smallest floats that are generally used, but in order to make more pronounced cords it is not unusual to have the filling float over a larger number of ends—from 7 to 15, or even more. \_\_\_\_\_

#### VELVETEEN

7. Besides corduroy, in which the pile is distributed in lines running lengthwise of the goods, there is a filling-pile fabric—that known as **velveteen**—in which the pile is uniformly distributed over the entire surface of the cloth, producing a level pile that completely hides the ground cloth from view. Since the pile in this fabric is formed by an extra, or pile, filling, the name velveteen is used to distinguish it from the true velvet, which is formed with an extra, or pile, warp. As the object in a fabric of this description is to produce a pile over the entire surface of the cloth, every end at some point or points may be used to bind the pile filling; but more frequently every other end only is used for this purpose, the binding points occurring often on a twill and sometimes on a satin basis. In arranging the weave for a velveteen, the most important points to be provided for are the formation of proper races, or lines of floats, for the cutter, and a good method of binding pile picks.

The velveteen pile is cut in a somewhat similar way to the cutting of corduroy, except that the cutting knife runs diagonally across the cloth, whereas in corduroy fabrics it is run in a direction parallel to the warp. The number of traverses

to be made by the cutting knife for velveteens is much greater than for corduroys; frequently it must be run across several hundred times in order to cut the pile on 2 yards of fabric. The number of races for the cutting knife affects the expense of cutting velveteen, so that if the number of races can be reduced, the expense is lessened. The number of races, however, must not be reduced to such an extent as to produce a ridgy or corded effect, since a perfect velveteen should have an absolutely even surface. By arranging the binding points so as to produce only a sufficient number of races for the particular quality of fabric being produced, satisfactory results are obtained, and the number of traverses of the cutting knife reduced to a minimum.

8. One of the most common velveteen weaves is shown in Fig. 11, which gives four repeats of the weave.

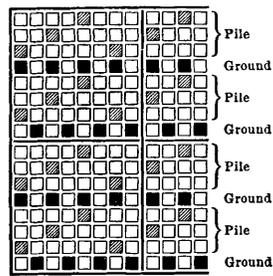


FIG. 11

weave is woven with 1 pick of ground filling and 3 picks of pile filling, the pile picks being tied to every alternate end of the ground fabric in twill order. The ground weave is the plain weave and the pile filling floats over 5 warp ends. The number of ends over which the pile filling floats is one of the features that govern the length of the pile on the face of the goods; thus it may float over 3 or 5 ends for a short pile, or over 7 or 9 ends for a longer pile. Fig. 12 is a section of the weave shown in Fig. 11, illustrating the interlacings

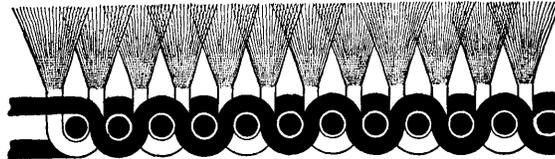


FIG. 12

of the first 5 picks; in this figure, the pile is supposed to have been cut.

Fig. 13 shows a weave for a velveteen that is very similar to the weave shown in Fig. 11, the chief difference being that in this weave 4 pile picks alternate with 1 ground pick, while in Fig. 11, 3 pile picks alternate with 1 ground pick; in this weave, also, the pile filling floats over 7 ground ends. In Fig. 14 is shown a weave for a velveteen that is similar

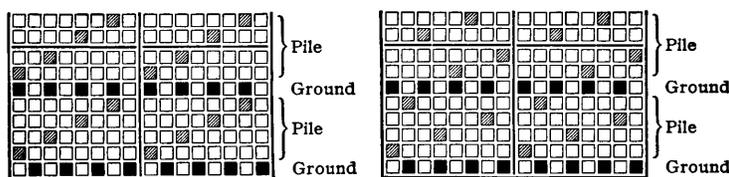


FIG. 13

FIG. 14

to Fig. 13, in that the ground weave is the plain weave, but in this figure the pile filling is bound to the ground cloth in 8-end satin order. This design will weave better than Fig. 13, because the interlacings of the pile picks are equally distributed over all the warp ends, but it will be more difficult to cut.

If a heavy, or thick, pile on the face of the fabric is desired, the picks per inch can be increased proportionately; while if a light, or thin, pile is desired, the picks per inch can be reduced.

Velveteens, like corduroys, may be made with twills or other simple weaves for ground weaves; Fig. 15 shows a weave made in this manner. The ground is the cassimere twill and the pile picks are tied to the warp in twill order. The weave is arranged 1 pick of ground and 3 picks of pile filling.

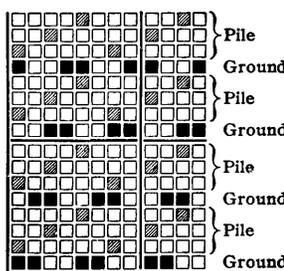


FIG. 15

9. In the velveteen weaves given so far, the pile filling, at each place where it is being tied to the ground, passes under a single warp end. By this method, however, there is some danger of the pile being pulled from the cloth in the cutting, especially if the cutting knife is a

little dull. To prevent the possibility of this happening, velveteen is often made with the pile pick interlacing with 3 warp ends, as shown in Fig. 16; that is, between each long cutting float the pile pick passes under a warp end, then over a single end, and finally under another end.

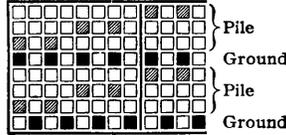


FIG. 16

Fig. 17 is a section of the weave in Fig. 16, showing the interlacings of the second, third, and fourth picks, which are pile picks, and the method of tying them into the ground; it will be seen that they are much more firmly tied by this method than when they are passed

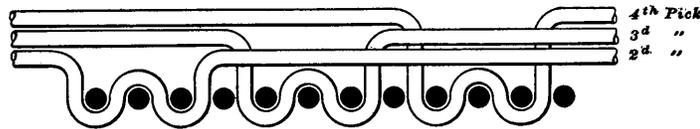


FIG. 17

under only 1 end of the warp. If it is necessary to secure the pile even more than in Figs. 16 and 17, the pile picks may be made to interlace with 5 ends of the warp instead of 3 ends.

Fabrics in which the pile is formed by an extra filling may, in general, be woven from one beam; and in cases where the pile filling is of the same yarn as the ground filling, in single-box looms. Sometimes, however, a different filling is used for the pile, in which case a box loom is necessary, and when a single pick of ground or an odd number of pile picks is placed in the cloth a pick-and-pick loom is required. In consequence of the pile filling floating on the face of the goods, a large number of picks per inch is required; in some cases, where a fine, thick pile is produced, there are as many as 400 picks. The harness and chain drafts for filling-pile fabrics are made exactly the same as for single cloth, and therefore need no further description.

**10.** The length and density of the pile in filling-pile fabrics may be easily altered when it is necessary to meet

some special demand. The length of the pile may be changed by allowing the pile filling to float over a greater number of ends, so that when the floats are cut the length of the pile will be increased. If, however, the length of the pile is increased and the number of picks per inch remains the same, the density of the pile will be reduced. For instance, suppose that the pile filling in a fabric was floating for  $\frac{1}{8}$  inch on the face of the cloth and that the length of the floats was increased to  $\frac{1}{4}$  inch; if the number of picks per inch remained the same, the density of the pile would be reduced one-half. In order to keep the same density of pile, therefore, the number of picks per inch should be doubled. A case like this may always be treated proportionately, and the number of picks per inch increased.

Whenever the fineness of the ground cloth is altered, there is a corresponding alteration in both the density and length of the pile. For instance, if more warp threads per inch are placed in the cloth, the pile picks in floating over the same number of ends will make shorter floats, which, of course, will shorten the pile. The density of the pile will be altered at the same time, since the binding points of the pile will be brought closer together. Any change in the number of picks per inch affects the density of the pile, but does not change its length.

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#### EXAMPLES FOR PRACTICE

1. Make a corduroy weave to be picked 1 ground and 2 pile, the ground weave to be plain and the pile filling to float over 5 and 7 ends.
2. Make a section of the above weave, showing the interlacings of the first 3 picks. The pile is to be shown uncut.
3. Make a corduroy weave to be arranged 1 pick of ground and 2 picks of pile filling, the ground to be the 4-harness twill. Arrange the tying places of the pile filling so that the pile will float over 6 and 8 ends.
4. Make a section of the above weave, showing the interlacings of the first 3 picks. Show the pile picks uncut.
5. Make an original weave for a velveteen cloth.
6. Make a weave for a velveteen, the ground weave to be the  $\frac{2}{4}$  twill and 3 picks of pile filling to alternate with 1 pick of ground filling.

## FIGURED FILLING-PILE FABRICS

11. Figured effects may be produced in connection with filling-pile fabrics by allowing the pile to be formed on the face of the ground cloth according to a given motive. When it is not desired to produce the pile, the pile filling is allowed to float at the back of the ground fabric. In this manner any figure may be produced in pile on a plain or twilled ground.

In Fig. 18 (a) a motive is shown for a filling-pile figure to be placed on a plain ground cloth, while in Fig. 18 (b) the complete design is shown. In Fig. 18 (a) the shaded squares represent the method of allowing the pile filling to float on the surface of the fabric, but in Fig. 18 (b) the shaded squares represent warp raised over the pile filling. This design is arranged 3 picks of pile filling and 1 pick of ground; therefore, the

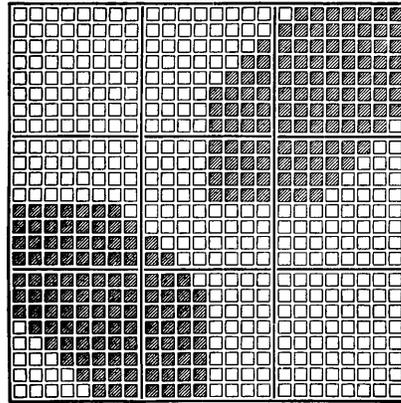


FIG. 18 (a)

complete pattern occupies 24 ends and 96 picks, since the motive is complete on 24 ends and 24 picks. The construction of this design should be carefully studied, since although this is a small and comparatively simple pattern, all designs of this class are constructed on the same principle. It will be noticed that where the figure occurs the construction of the design is the same as a simple velveteen weave, but where the ground of the fabric is to be plain all the warp is raised, allowing the pile filling to float on the back of the cloth, and enabling the ground picks to be forced together to form the ground fabric. This waste yarn is afterwards cut from the back of the fabric. Thus, pile is formed only where the figure occurs. Great

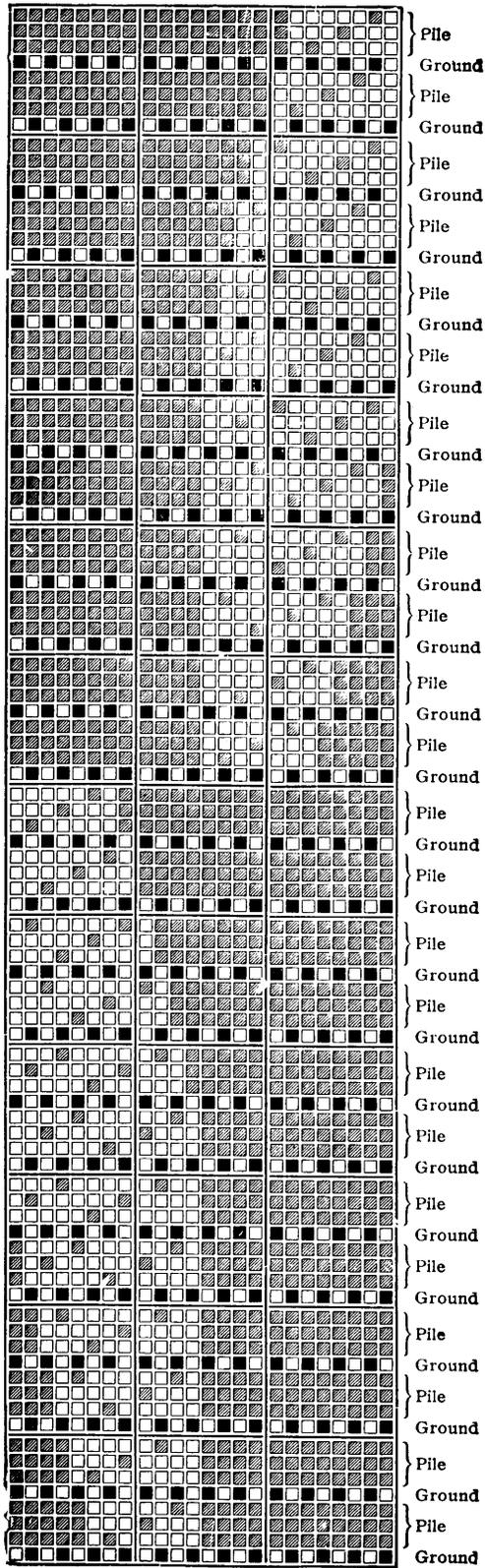


FIG. 18 (b)

care must be taken in arranging the binding points of the pile filling where the figure occurs, so that proper races may be formed for the cutting knife, especially in the more complicated patterns.

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#### WARP-PILE FABRICS

**12.** Warp-pile fabrics, although similar to filling-pile fabrics, are constructed in a slightly different manner, as the pile effect is obtained by means of an extra, or pile, warp; two warps are therefore necessary—one for the ground cloth and another for the pile. There are two effects obtained with warp pile—one in which the pile yarn is uncut and forms upright loops on the surface of the fabric, and another in which the pile is cut to form a brush-like surface on the goods; in the former case the pile is known as *terry pile*, while in the latter case a true *velvet*, or *plush, pile* is formed.

**13.** In the production of warp-pile fabrics, the pile is produced by raising the pile warp over a wire and then depressing it to interlace with the ground again. When the pile shed is formed in the loom, the wire is inserted; and as the shed closes on the wire and the lay beats up, the wire is forced up on the surface of the cloth, thus forming the loops. The pile warp should be down on the picks preceding and following the wire. It is not necessary to raise all the pile warp when each wire is inserted, since a better distribution of the pile may often be obtained by raising every alternate end of the pile warp over one wire and then raising the other ends over the next wire. The thickness of the wire regulates the size of the loops made by the pile warp, and consequently the length of the pile. Where the pile is disposed in loops, as in a Brussels carpet, the wire is smooth; but when it is cut, as in velvet, a knife at the end of the wire cuts the loops of pile when the wire is withdrawn.

In power looms, the wires are inserted automatically when the pile shed is formed and are often withdrawn automatically, although they are sometimes drawn out by the weaver,

either cutting the pile or leaving it in loops, according to whether or not there is a knife on the end of the wire.

Fig. 19 is a view of a wire knife designed to be inserted under the pile and withdrawn automatically. The knife of the wire is shown at *b*, while at *a* the portion on which the mechanism of the loom operates is shown. The wire is withdrawn by means of a hooked lever that engages with the head *a*, and is actuated by a cam placed at the side of



FIG. 19

the loom. The wires are not withdrawn immediately after being inserted in the pile shed, but are allowed to remain in the cloth until they are a short distance from the fell of the cloth, since if the wire were withdrawn immediately, the tension of the warp would pull the pile ends from the cloth if the pile was cut, or pull down the loops if it was not cut.

Many of the most beautiful and costly plushes and velvets are woven on hand looms, even today, in Europe. In this case, a different method is employed for cutting the pile. The wire used is flattened or elliptical in section, and has a groove cut in it so that its section appears as shown in Fig. 20. This wire is inserted by hand when the pile shed is formed, and before it is withdrawn a knife, or *trevet*, is drawn along the groove in the wire, thus neatly severing the loops of pile. When the pile is not to be cut an ungrooved wire is inserted.



FIG. 20

14. The weave in Fig. 21 shows several repeats of a simple warp, or true, velvet arranged, in the warp, 2 ends of ground and 1 end of pile and, in the filling, 3 picks of ground and 1 shed with the wire inserted instead of a pick of filling. This weave is complete on 3 ends and 4 picks, but for the purpose of illustration several repeats are shown. If this

weave is analyzed carefully, it will be seen that the ground weave is virtually plain, but that when the pile warp is lifted over the wire, as shown by the shaded squares, 2 ground

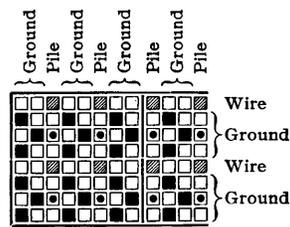


FIG. 21

2 picks are placed in 1 shed, and the pile warp is raised over the wire between them. Therefore, as these 2 picks are forced up by the lay, the wire will be forced to the surface of the fabric, carrying the pile warp with it and thus forming the loops of pile, the size of which will depend on the diameter of the wire.

The pile warp is also raised over a ground pick, as shown by the dotted squares, for the purpose of binding it to the ground more firmly. The section in Fig. 22, which shows the interlacings of the third, or pile, end of Fig. 21 with the filling and wires, illustrates this point more clearly. The wire is elliptical in section; thus, when the reed is brought against it, the wire is raised on the surface of the cloth with its longer axis vertical, thus

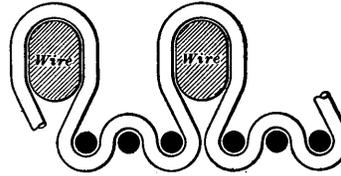


FIG. 22

gaining the requisite length of pile without forcing the adjacent ground picks apart. When the wires are withdrawn, terry pile will be formed if there is no knife on the end of the wire, and velvet pile if the loops are cut.

Warp-pile fabrics are woven with two warps, the tension on the ground warp being fairly tight so as to give the ground the requisite firmness, and the tension on the pile warp being slack in order that the wires may be easily forced to the surface of the cloth and the pile thus formed.

**15.** In drafting a weave similar to that shown in Fig. 21, it is customary to separate the pile and ground harnesses in the same manner as the face and back harnesses are separated when drafts are made for double cloth, the pile warp being drawn on the front harnesses. The harness and chain drafts

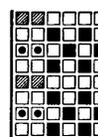
for Fig. 21, constructed in this manner, are shown in Fig. 23 (a) and (b). In order that the ends may not be crowded on the harnesses, since a large number of ends are necessary for a warp-pile fabric, these drafts are shown on 6 harnesses, although they could be made on 3 harnesses.



(a)

VELVETS

16. Velvet fabrics, for which Fig. 21 is a weave, are usually made with either a cotton, linen, or silk ground warp and filling and a silk pile warp; it is only in the more costly fabrics that silk is used for the ground, cotton or linen being generally employed. The ground weave is usually either the plain weave or a small rib, basket, or twill weave. The proportion of pile warp and ground warp, as well as the length of the pile, varies with different qualities of fabrics. Velvets are often classified as 2-pick, 3-pick, etc., the terms referring to the number of ground picks inserted between the wires; the design shown in Fig. 21 would be known as a 3-pick velvet.



(b)

FIG. 23

Fig. 24 shows a very common velvet, known as the 2-pick; the warp ends are arranged 1 ground, 1 pile, and 1 ground; the ground weave is the plain weave. In Fig. 25 a similar design is shown, with the exception that the ground is a rib

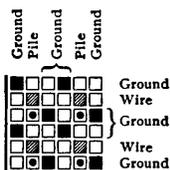


FIG. 24

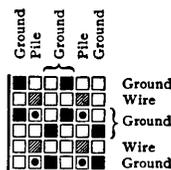


FIG. 25

weave. The method of interlacing the pile warp should be noticed in connection with these two designs. Although it was stated that the pile warp should be depressed on the pick preceding and on the pick following the wire, an

exception is sometimes made to this, as in the case of Figs. 24 and 25, where the pile warp is raised over the pick preceding the wire. However, although it is not always possible to depress the pile warp on the pick preceding the wire, after being raised over the wire it must always be depressed under the pick following, in order to force the wire to the surface. In these two designs the pile is only bound into the fabric by being passed under 1 pick; it would therefore be more liable to be pulled out than the pile in Fig. 21, which is interlaced with 3 picks.

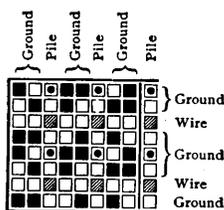


FIG. 26

When it is desired to insert more picks per inch, a twill is often used for the ground weave of warp-pile fabrics. In Fig. 26 a weave of this description is given; the ground weave in this instance is the warp prunelle twill.

17. Sometimes only a portion of the pile is lifted over one wire, while the remaining portion is lifted over the next wire, thus forming an alternate distribution of the pile, which covers the ground better in some instances. In Fig. 27 a weave for

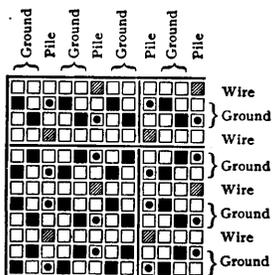


FIG. 27

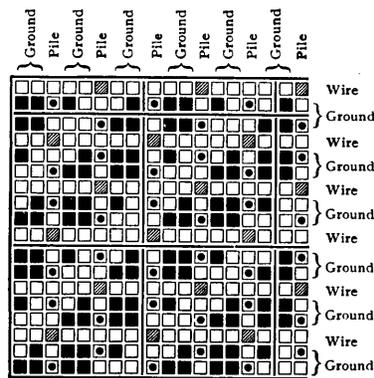


FIG. 28

what is known as *Utrecht velvet* is shown; when the first wire is inserted every alternate end of the pile warp is raised over it, and when the next wire is inserted those ends

that were depressed under the first wire are raised, while those that were previously raised are depressed. The ground weave in this instance may be considered as a plain weave with 2 picks in a shed or as a small rib weave. The weave in Fig. 28 is of the same type as that in Fig. 27, with the exception that the ground weave in the latter design is the  $\frac{4}{2}$  twill. In order to effect the alternate distribution of the pile over the wires, it is necessary to have an even number of ground picks between the wires, while with all the pile warp lifted on each wire the pile can be best arranged with an odd number of ground picks between the wires.

Fig. 29 is a section of the weave in Fig. 28 and shows the interlacings of the first and second pile ends with the filling,

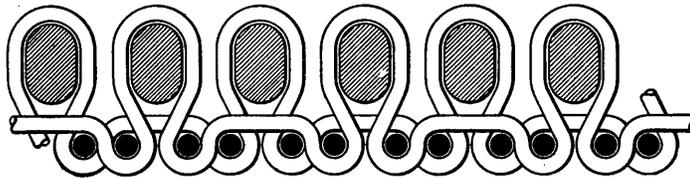


FIG. 29

and also the alternate interlacing with the wires. The interlacings of the ground ends are not shown.

The density and length of the pile in warp-pile fabrics may be altered to suit the requirements of the designer. The density may be increased by introducing more wires or by using more pile and ground ends. The length is, of course, regulated by the size of the wires inserted in the pile shed.

#### DOUBLE PLUSHES

18. By the system of weaving warp-pile fabrics known as the **double-plush**, two plush fabrics are formed in the loom face to face, being connected by the pile, which passes from one cloth to the other. After the filling is inserted, the two cloths are wound on separate cloth rollers, the pile between being cut by a knife, thus leaving a pile face on each fabric. The knife is set between two rollers and is

given a reciprocating motion by means of a cam at the side of the loom; thus, when the cloth is drawn forwards, the pile connecting the fabrics is neatly severed. By this method, plain velvets and plushes may be manufactured and perfect fabrics obtained, but the process does not lend itself so readily to fancy figured effects. The main advantage, of course, is the large production that may be obtained by this method.

The weave in Fig. 30 illustrates one method of producing double-plush weaves. This weave is complete on 5 ends;

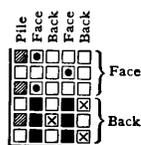


FIG. 30

2 ends are face ground ends and weave the ground for the top fabric, while 2 ends are back ground ends and produce the ground for the bottom fabric. The pile end passes from one ground cloth to the other, thus producing the pile on the surface of each cloth when they are cut apart. This weave is complete on 6 picks; 3 picks are backing picks and interlace with the bottom fabric, while 3 picks are face picks and interlace with the top fabric.

In Fig. 31 a section of the weave in Fig. 30 is shown. The method of interlacing the pile warp with both ground cloths will be understood by carefully comparing the section with the weave. In order to show the interlacings of the pile warp more thoroughly, two repeats are shown in Fig. 31; the dotted line shows where the fabrics would be cut apart,

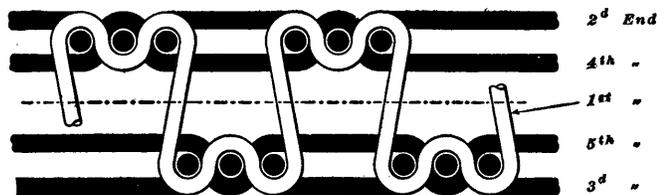


FIG. 31

thus forming two perfect plush fabrics. It will be noticed in this figure that the picks in each fabric are shown in sections of three; this is only to show the interlacings of the ends more clearly; the lay, of course, would actually beat the picks up to each other and make two closely woven fabrics.

## TERRY TOWELS

**19.** Besides the double-plush method, which produces a cut pile on the fabric, there is another method of producing a pile fabric without the use of wires, which is commonly used in the production of what are known as **terry towels**; in this case the pile is uncut, being produced by an especially constructed loom.

These towels are produced in the loom by means of two warps—a ground and a pile warp—as is the case with all warp-pile fabrics, but the method of producing the pile is different. The ground warp is arranged with a heavy tension, while the beam of the pile warp, which is placed above the loom, is weighted very lightly, just enough friction being applied to prevent its turning too easily; this friction is regulated by a pattern chain. For 2 picks, the pile warp is held tight; but on the third the friction is taken off. The reed is so arranged that the first 2 picks are not forced up to the fell of the cloth but are left a short distance from it; the distance being regulated by the length of the pile desired. When the third pick is placed in the cloth, however, all 3 picks are forced home to the body of the cloth; and as the pile warp is lightly weighted on this pick it will be pushed out in loops more or less evenly distributed on each side of the towel. Since the ground warp is heavily weighted, it does not come forwards with the pile warp, but the 3 picks slip on it and are carried to the body of the cloth.

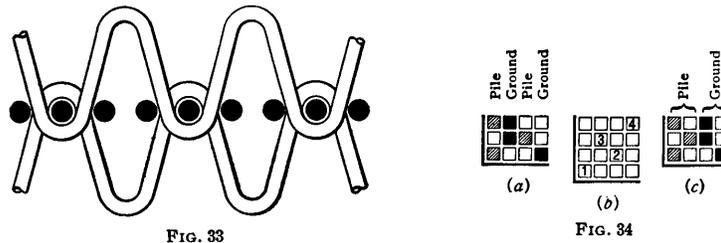
**20.** In Fig. 32 is shown a section that illustrates the interlacings of the pile warp with 3 picks of filling. This section is shown as it would appear if the filling did not slip



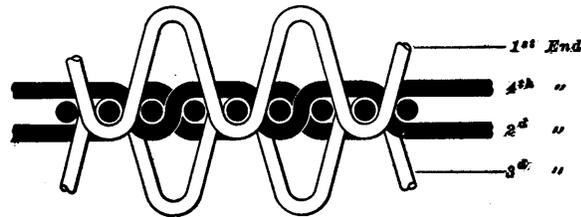
FIG. 32

on the ground warp, but in Fig. 33 is shown a section in which the picks have been forced home and the loops of pile warp formed on each side of the towel. The weave for

producing the standard terry towel, of which Figs. 32 and 33 are sections showing the interlacings of the first and third, or pile, ends, is shown in Fig. 34 (a). The harness draft with the pile warp drawn on the first two harnesses is shown



in Fig. 34 (b), while in view (c) the corresponding chain draft is shown. It should be noted that the ground ends in Fig. 34 (a) are interlaced with the picks situated between the upper and lower pile loops to prevent the filling from



being forced out with the loops of pile warp. This will be more clearly understood by referring to the section in Fig. 35, which illustrates not only the interlacings of the pile ends in Fig. 34 (a), but also of the ground ends.

21. It must always be borne in mind that the production of terry towels requires a special loom. These looms often have attachments by means of which the pile can be produced as desired, since there is in some towels a space at each end devoid of pile. Most towel looms also have a fringing motion, so that no filling is placed in the warp for a space of about 6 inches between the towels, so that when the towels are cut apart each has a fringe 3 inches in length at either end.

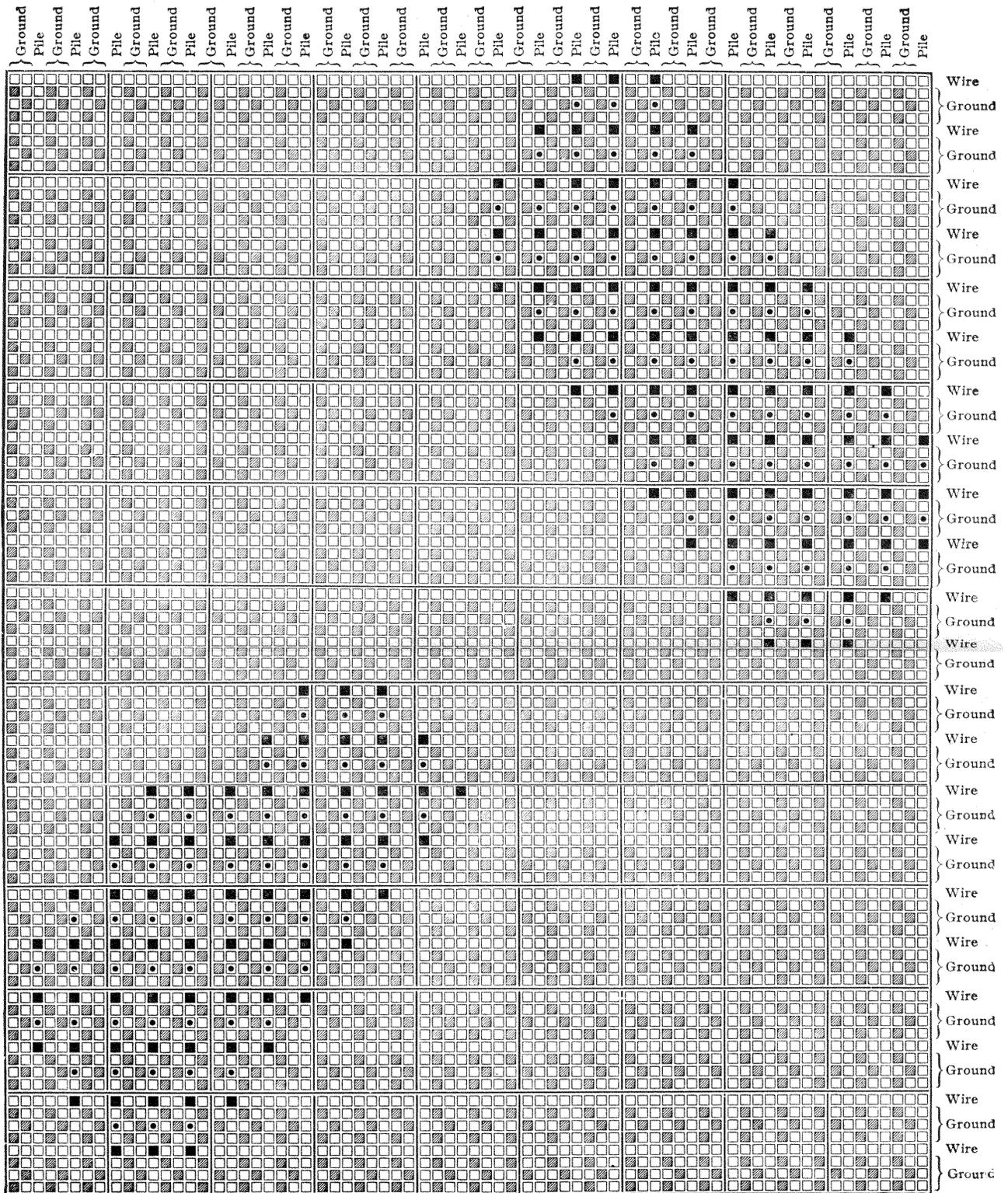


FIG. 36 (b)

*Note: This figure appears in the book as a two-page spread with the printing running all the way into the binding. It has been rotated 90° clockwise and reduced for presentation here.*

EXAMPLES FOR PRACTICE

1. Make a section showing the interlacings of the first 3 ends of Fig. 24.
2. Make a velvet weave having the  $\frac{2}{2}$  twill for a ground weave. Employ the alternate system of raising the pile warp.
3. Make a section of the weave in Fig. 27 showing the interlacings of the third and sixth ends.
4. Make a weave for a warp-pile fabric, employing the  $\frac{2}{3}$  twill as a ground weave and raising the entire pile warp for the insertion of the wires.
5. Make a section of the above weave showing the interlacing of the pile warp.
6. Make harness and chain drafts for Fig. 28, the pile warp to be drawn on the front harnesses.

FIGURED WARP-PILE FABRICS

22. Figured warp-pile fabrics are constructed in many ways; and in many cases, when constructed with elaborate patterns and expensive yarns, rank among the most costly fabrics woven. A simple method of producing a figured warp-pile fabric is to produce a figure in pile, either cut or uncut, according to a given motive, on the surface of an ordinary fabric. This is performed in a manner similar to that employed in producing a filling-pile figure, except that the warp-pile construction is used for the figure instead of the filling-pile. In Fig. 36 (a) is shown a design of this description; it is arranged 2 ends of ground and 1 end of pile in the warp, and 3 picks of ground and 1 shed for inserting the wire in the filling. The pile warp is depressed under both

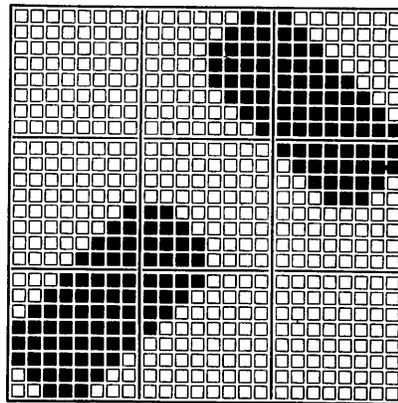


FIG. 36 (a)

the ground warp and the filling. The pile warp is depressed under both

the ground picks and the wires, except where it is desired to have the figure formed in pile; in order to show the design more clearly, the ground is indicated by shaded squares and the pile by solid black squares. The motive for this design is shown in Fig. 36 (*a*).

The ground weave used may be considered as a small rib weave or as a plain weave with 2 picks in every alternate shed. The pile warp is raised to form the figure in the same manner as in Fig. 21, and since the ground weave is also the same, the construction of the figure is really a true velvet; the ground weave only appears on the ground of the design, the pile warp floating underneath when not used to form the figure. This waste yarn is afterwards cut off in the finishing of the fabric.

**23. Tapestry Carpets.**—What is known as tapestry carpet is one of the simplest of figured warp-pile fabrics. Its construction is very similar to an ordinary warp-pile fabric with the exception that an extra warp is used for thickening and strengthening the fabric. The loops of pile warp are uncut and the entire surface of the fabric is uniformly covered with the pile. The pattern is produced by printing the design on the pile warp so that it will be formed by the pile on the surface of the cloth. When this pattern is printed, due consideration must be given to the take-up of the pile warp, according to the length of the pile being formed. If this item is known, it is comparatively easy to print a certain length of pile warp a certain color, so that the pile will be formed of that color for a certain distance in the cloth, and then change to another color, according to the pattern. It is not possible, however, to gauge the length of printed yarn with exact accuracy, since there are so many disturbing factors, as the take-up, length of pile, etc.; consequently, there is a certain indefinite or misty appearance to the pattern, which is one of the distinguishing features of a tapestry carpet.

The structure of the cloth itself is comparatively simple, as shown in Fig. 37, which is a design for an ordinary

tapestry carpet. This weave is complete on 4 ends and 6 picks. The ends are arranged 2 ground, 1 center warp, and 1 pile warp, while the picks are arranged 2 ground and 1 shed for inserting the wire. The center warp, which is simply a wadding warp, passes between the ground picks and does not interlace with the fabric; this is accomplished by depressing every other ground pick under the center warp; the pile warp is raised on this pick. The center warp has the same function in this fabric as a system of wadding yarn in a backed or double cloth. The construction of Fig. 37 will be understood by comparison with Fig. 38, which shows the interlacings of several repeats of the weave.

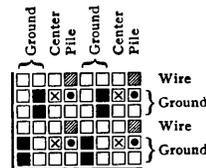


FIG. 37

The designing of a tapestry carpet is a comparatively simple matter, as the weave has nothing to do with the pattern. These goods are generally made 27 inches wide and contain 216 pile ends. The pattern is first painted out

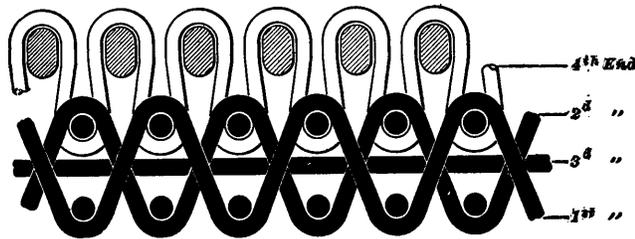


FIG. 38

in solid color on a sheet of design paper containing 216 ends, or 27 squares with 8 ends in a square, and then printed on the pile warp.

**24. Brussels Carpets.**—The structure of a Brussels carpet is entirely different from that of a tapestry carpet, and in its production the designer is allowed the widest scope of taste and ingenuity, while the patterns that are produced are brilliant and sharply defined. In this fabric, the pattern is formed by lifting solidly colored pile threads

to form pile on the surface of the fabric as required to make the pattern, each pile-warp end remaining in the interior of the fabric when the pattern does not call for its color on the surface. In a Brussels carpet the ground, or, as it is sometimes called, the *binder warp*, is woven from a beam, but the pile ends, owing to the difference in their take-up because of their varying interlacings with the wires, are each wound on separate spools, which are placed in frames. These spools are arranged so that friction can be applied to them in order to obtain the necessary tension of the pile ends.

The terms *3-, 4-, 5-, and 6-frame carpets* refer to these frames in which the spools of pile warp are placed and designate the number of colors in the pattern of the carpet, since generally only one color is placed in each frame. The creels, or frames, that take the place of beams also denote the number of pile ends in the fabric, since each frame is designed to hold 256 spools, each carrying 1 end of the pile warp.

The complicated interlacings of the pile ends in a Brussels carpet require the use of a jacquard to produce the proper sheds. The reeding of the fabric is controlled by the colors or frames of the pile warp; thus, if a 3-frame carpet is being made, each dent will contain 5 ends, 1 end of each color of pile warp and 2 ground ends; if a 5-frame carpet is being made, each dent will contain 5 pile and 2 ground ends.

In weaving, a row of loops is formed across the cloth at the insertion of each wire, for which purpose a given number of pile ends are raised on each pick; in this case 256 ends are raised. The pile threads that are not required for the pattern are disposed in the body of the cloth as wadding, or thickening, ends. The bulk of the fabric, therefore, in a Brussels carpet is made of as good yarn as the face and is not obtained by an extra thickening warp of cheaper material, as in a tapestry carpet.

The ground weave that is used for these fabrics is the 4-harness basket  $\frac{2}{2}$  so arranged that 2 successive picks are placed in a shed, but separated by the pile warp. This will be understood, as will also the statement that the pile

warp lies in the body of the fabric except when wanted on the face, by referring to Fig. 39, which is a section of a 3-frame Brussels carpet showing the 2 ground, or binder-

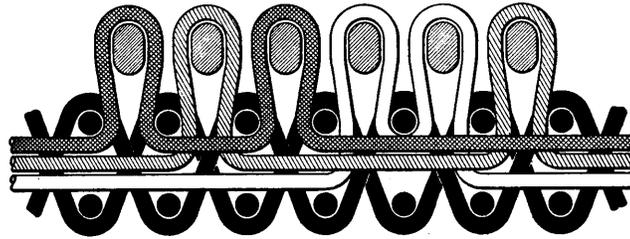


FIG. 39

warp, ends and the 3 differently colored pile-warp ends. The ground picks are alternately passed over and under the pile ends, so as to bind them into the cloth.

**25.** The method of producing designs for Brussels carpets is quite simple. The pattern is first painted in solid color on design paper, 3 colors being used for a 3-frame carpet, 4 for a 4-frame, etc. The design is then made, being dressed 2 ends of ground and 3 ends of pile for a 3-frame, or 4 ends of pile for a 4-frame, etc., and being picked 2 picks of ground and 1 shed for the wire. The pile warp is raised over each wire according to the previously prepared and painted pattern. To illustrate the method of making the weave for a carpet of this description, as it would be impossible to give a large flowered design here, let it be supposed that Fig. 40 represents a small portion of a large pattern for a 3-frame Brussels carpet. In this figure, the different marks represent 3 colors of pile warp with which the design is to be formed. As a 3-frame carpet is arranged 2 ground and 3 pile, 40 ends will be taken to weave the color effect, and as these fabrics are picked 2 of ground and 1 shed for the wire, 24 sheds will be required to form the pattern; 16 sheds are for the insertion of the ground picks and 8 sheds for the wires.

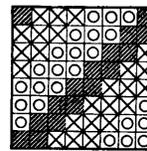


FIG. 40

Fig. 41 shows the complete weave for the effect shown in Fig. 40 arranged for a Brussels carpet. As the weave is for a 3-frame carpet, it is arranged with 3 pile ends in a section, each section being separated by 2 ground, or binder-warp, ends. The different marks on the pile ends denote the different colors, corresponding to the marks in Fig. 40. If the lifting of these pile ends over the wires is carefully noted, it will be seen how the design in Fig. 40 is formed in

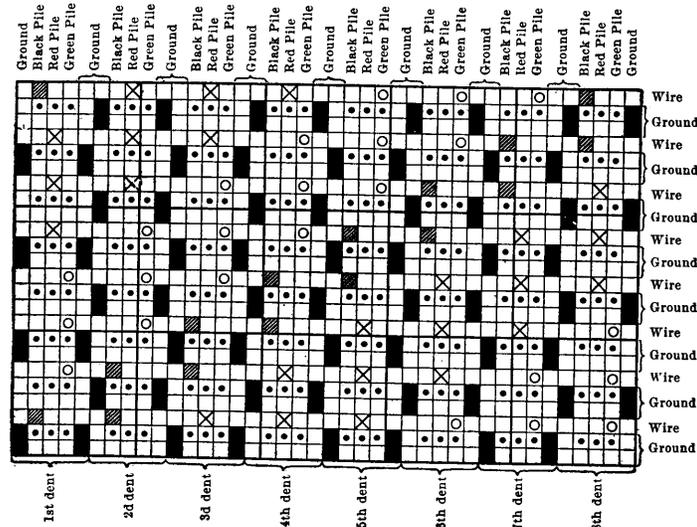


FIG. 41

pile in Fig. 41. For instance, suppose that the shaded squares in Fig. 40 represent black, the crosses red, and the circles green. On the first pick of Fig. 40 there are 2 black, 3 red, and 3 green. By referring to Fig. 41 it will be seen that this is exactly the manner in which the pile is formed over the first wire. The pile is lifted over the second wire according to the second pick of Fig. 40, and so on.

A 4-frame carpet is designed in the same manner as a 3-frame carpet, except that 4 colors and 4 pile ends are used. In a 3-frame carpet one-third of the pile warp is raised over each wire, and in a 4-frame, one-fourth is raised. The ends that are raised may be of any color, according to the design.

The other two-thirds or three-fourths of the pile ends, as the case may be, lie embedded in the body of the fabric, as explained in connection with Fig. 39. In order that these ends shall pass to the center of the fabric only and not to the back it will be noticed, by the dot marks, that all the pile ends are lifted on every alternate ground pick, thus throwing 1 ground pick on the back of the cloth to cover the pile warp.

**26.** What are known as **Wilton carpets** are constructed in practically the same manner as a Brussels carpet, except that in the former the loops of pile are cut, while in the latter they remain uncut. The pile warps in carpets are generally made of worsted.

#### VARIETIES OF PILE FABRICS

**27.** The leading features that produce differences in pile fabrics and, consequently, the use of different names are the material or materials used in each fabric—including the material used for the ground warp, the material used for the ground filling, and the material used to form the pile—the length of the pile, and the appearance of the back of the fabric, in addition to the weave used, the series of threads that form the pile, and the mechanisms employed for forming and cutting the pile. Four classifications of pile fabrics are commonly made from the appearance of the pile on the fabric—*fustian*, *velvet*, *plush*, and *terry*.

**28.** **Fustian** is a general term that has long been used and includes all the heavier filling-pile fabrics of the corduroy style, also embracing velveteens. Fustians are usually understood to be heavy cotton fabrics with a short pile, and besides the regular corduroys and velveteens include fabrics of a similar nature frequently known by special names, such as round-top cords, constitutional cords, cable cords, thickset cords, etc.

**29.** Velvets and plushes are distinguished by the relative length of the pile; the weaves, and in some cases the materials used, are similar, but silk fabrics having a smooth pile surface with a pile not exceeding  $\frac{3}{8}$  inch in length are known

as velvets, while plush fabrics have a pile exceeding this length. A true velvet not only has this short pile, but is composed of silk alone and is a warp-pile fabric. Like many other words applied to textile fabrics, the term velvet has been misapplied, and consequently fabrics with a silk ground warp and cotton ground filling, or even with a ground of both cotton warp and filling, or linen warp and filling, etc., are sometimes spoken of as velvets. For this reason it is not sufficient to use the word velvet alone when describing a fabric manufactured exclusively of silk, but the term *silk velvet* should be used and only applied to velvets that are entirely manufactured of that material. When the ground is composed of cotton or linen it should be spoken of as a cotton-backed velvet or a linen-backed velvet, respectively.

Plush fabrics are manufactured in great variety, the pile varying in length but in general being of greater length than in velvets. The pile yarn of a plush fabric is generally silk, worsted, mohair, or some other animal fiber, while the ground fabric may be cotton, linen, or jute, which is used not only to cheapen the fabric, but to give it the required stiffness and strength.

Among the various kinds of plush may be mentioned those intended to imitate the skins of animals—such as sealskin plush, made with a pile surface of silk, imitation dogskin, made with a curled pile, etc. Mohair plushes are woven with a cotton, linen, or jute ground cloth, while the pile is formed of yarn spun from mohair. Silk plushes are made with a silk pile; the ground cloth is usually composed of cotton.

**30.** Uncut warp-pile fabrics, whether woven with wires or not, are called terry fabrics. Strictly speaking, the term originated with the warp-pile fabrics woven with a wire, but owing to their similarity certain towel fabrics that are woven by a special loom without wires are also classified as terry. The word terry is not applied to uncut fabrics of the filling-pile class, such as those woven on the fustian principle but used without being cut; these are simply spoken of under the trade name or as *uncut fustians*.