Technology of Textile Design

By

E. A. Posselt

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Technology of Textile Design.

Being a Practical Treatise on the Construction and Application of Weaves for all Textile Fabrics, with minute reference to the latest Inventions for Weaving.

Containing also

An Appendix showing the Analysis and giving the Calculations necessary for the Manufacture of the various Textile Fabrics.

—BY—

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Head Master Textile Department Pennsylvania Museum and School of Industrial Art, Philadelphia, Pa.; Author of "The Jacquard Machine analyzed and explained, the Preparation of Jacquard Cards, and Practical Hints to Learners of Jacquard Designing."

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PREFACE.

An experience of several years as Principal of The Textile Department of the Pennsylvania Museum and School of Industrial Art, has shown the author of this work the necessity and value of a Text-book on Textile Designing and Weaving. The absence of any such guide to the study has induced him to prepare this work, which he trusts will be useful not only to the student as a Text-book, but also to the manufacturer as a book of reference. The results arrived at by the completion of this work, will be greatly enhanced in their value to practical men, when assured that a life-time of actual service in the mills of this country and Europe has been enjoyed by the author, and that the ripe experience of such practical knowledge has been closely interwoven with the results herein fully set forth.

The favor so generously accorded his previous book entitled "The Jacquard Machine Analyzed and Explained; the Preparation of Jacquard Cards, and Practical Hints to Learners of Jacquard Designing," greatly encouraged him in the preparation of this work, and it is sent forth with the earnest desire that it may likewise win the approval of the public and aid in developing and extending a deeper interest in the subject.

While much indebted to his many friends for their kindly hints and suggestions, he more particularly acknowledges the services of Mr. Theodore C. Search, who has been so unremitting in his zeal for the advancement of the work, and through whose generous assistance the author has been enabled to reach a more speedy termination of his labors.

Philadelphia, Pa., November, 1888.

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APPENDIX.

Divisions of Textile Fabrics According to Their Construction.

Every fabric, commonly classified as "woven," is composed of two distinct systems of threads (warp and filling) which interlace with each other at right angles. The arrangement of this interlacing is technically known as the "weave." All woven fabrics, as to their general principle of construction, can be graded in two great divisions:

Fabrics in which one system of parallel threads is interlaced at right angles with a second system of parallel threads. (For illustration see diagram, Fig. 1.)

Fabrics in which threads of one of the before-mentioned two systems of threads, the warp, in addition to the interlacing, are twisted with threads of its own system. (For illustration see diagram, Fig. 2.)

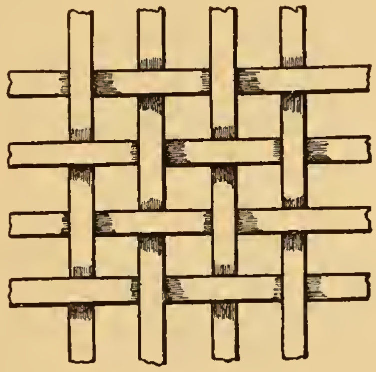


Fig. I.

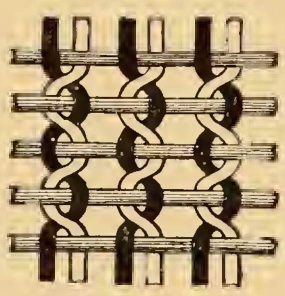


Fig. II.

The first mentioned system of fabrics is divided into the following sub-divisions:

Single cloth, double cloth, and three or more ply cloth, pile fabrics.

Before commencing with the construction of the weaves, as required for the various textile fabrics, it is necessary to give an explanation of the purpose and use of the

Squared Designing Paper for the Different Textile Fabrics,

and its relation for indicating the method of interlacing warp and filling.

In this □ designing paper each distance between two lines, taken in vertical direction, represents one warp-thread, see Fig. 3; and each distance between two lines, taken in a horizontal direction, represents one filling-thread, see Fig. 4.

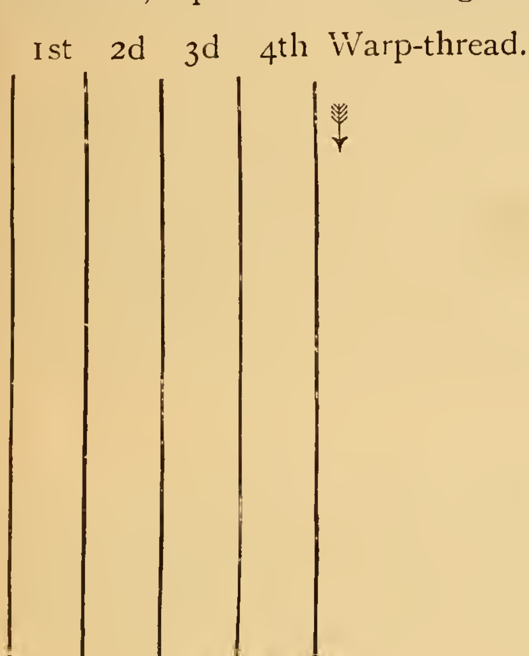


Fig. 3.

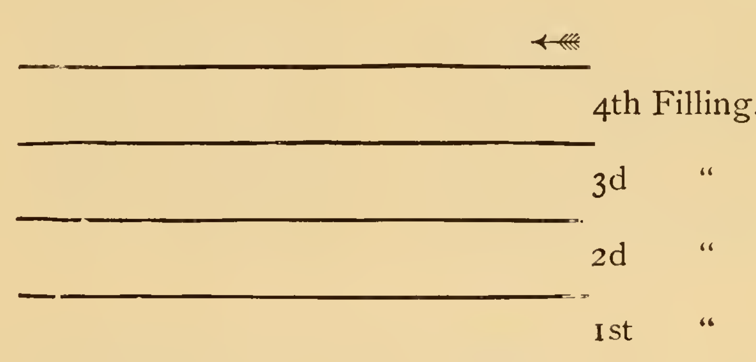


Fig. 4.

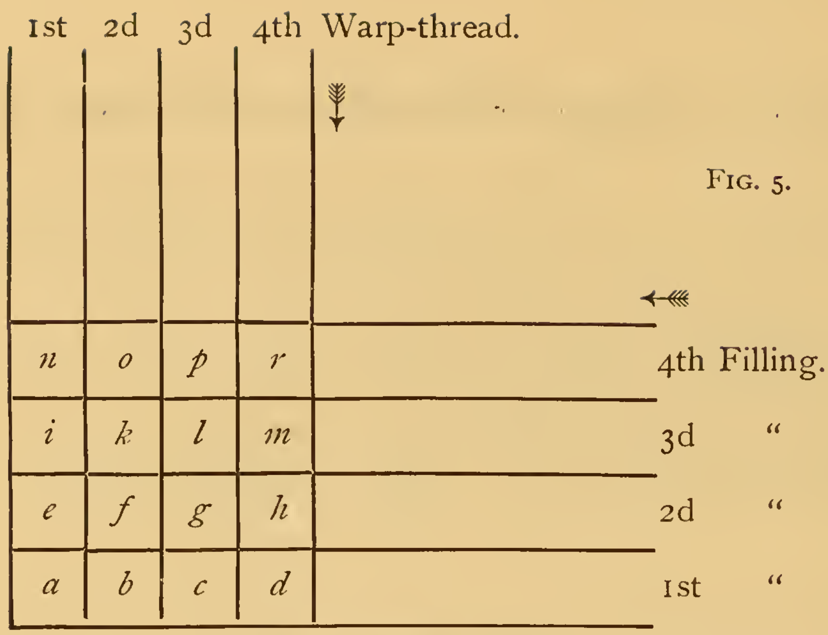


Fig. 5.

It will readily be seen by the student that the different small rectangles illustrate the place where a certain warp-thread meets with a certain filling-thread. Thus in our illustration, Fig. 5, the rectangle marked *a* will indicate the meeting of warp-thread 1 and filling 1. Rectangle marked *b* will indicate the meeting of warp-thread 2 and filling 1. Rectangle marked *c* will indicate the meeting of warp-thread 3 and filling 1. Rectangle marked *d* will indicate the meeting of warp-thread 4 and filling 1.

Rectangle marked *e* will indicate the meeting of warp-thread 1 and filling 2.
" " *f* " " " " " 2 " " 2.
" " *g* " " " " " 3 " " 2.
" " *h* " " " " " 4 " " 2.
" " *i* " " " " " 1 " " 3.
" " *k* " " " " " 2 " " 3.
" " *l* " " " " " 3 " " 3.
" " *m* " " " " " 4 " " 3.
" " *n* " " " " " 1 " " 4.
" " *o* " " " " " 2 " " 4.
" " *p* " " " " " 3 " " 4.
" " *r* " " " " " 4 " " 4.

The classifying of the □ designing paper is done by enclosing a number of small rectangles, horizontal and vertical, within a certain distance by a heavy line. Such enclosures are known in practice as "*squares*."

In mentioning a certain kind of □ designing paper, the warp dimension is indicated first, and a design paper having eight rectangles vertical, with eight horizontal, is variously read and indicated as 8 by 8, 8 x 8 or $^8/_8$; a design paper having eight rectangles vertical, with ten horizontal, is read and indicated as 8 by 10, 8 x 10 or $^8/_{10}$. Diagrams Fig. 6 represent some styles of □ designing paper frequently used. The size of the square may vary in each kind of paper, and must be selected according to the fabric. For example, there are two different styles of 8 x 8 □ designing paper illustrated: one forming ½ inch heavy squares and one forming ¾ inch heavy squares. These sizes may still be varied. The principle of these two kinds of □ designing paper is identical, the size preferred being left to the pleasure of the designer. Certainly it will be understood by any student that in preparing a design or weave with a large number of threads for repeat, it will be advantageous to use a design paper containing the smallest sized rectangles practical to use.

Practical Use of the Heavy Square in Designing Paper.

The heavy square serves as a unit of measurement, as well as a means of calculation, and shows readily and exactly the size of the weave or design. The eye becomes accustomed to grasping the meaning of this large square, and comprehends at a glance the situation. For instance:

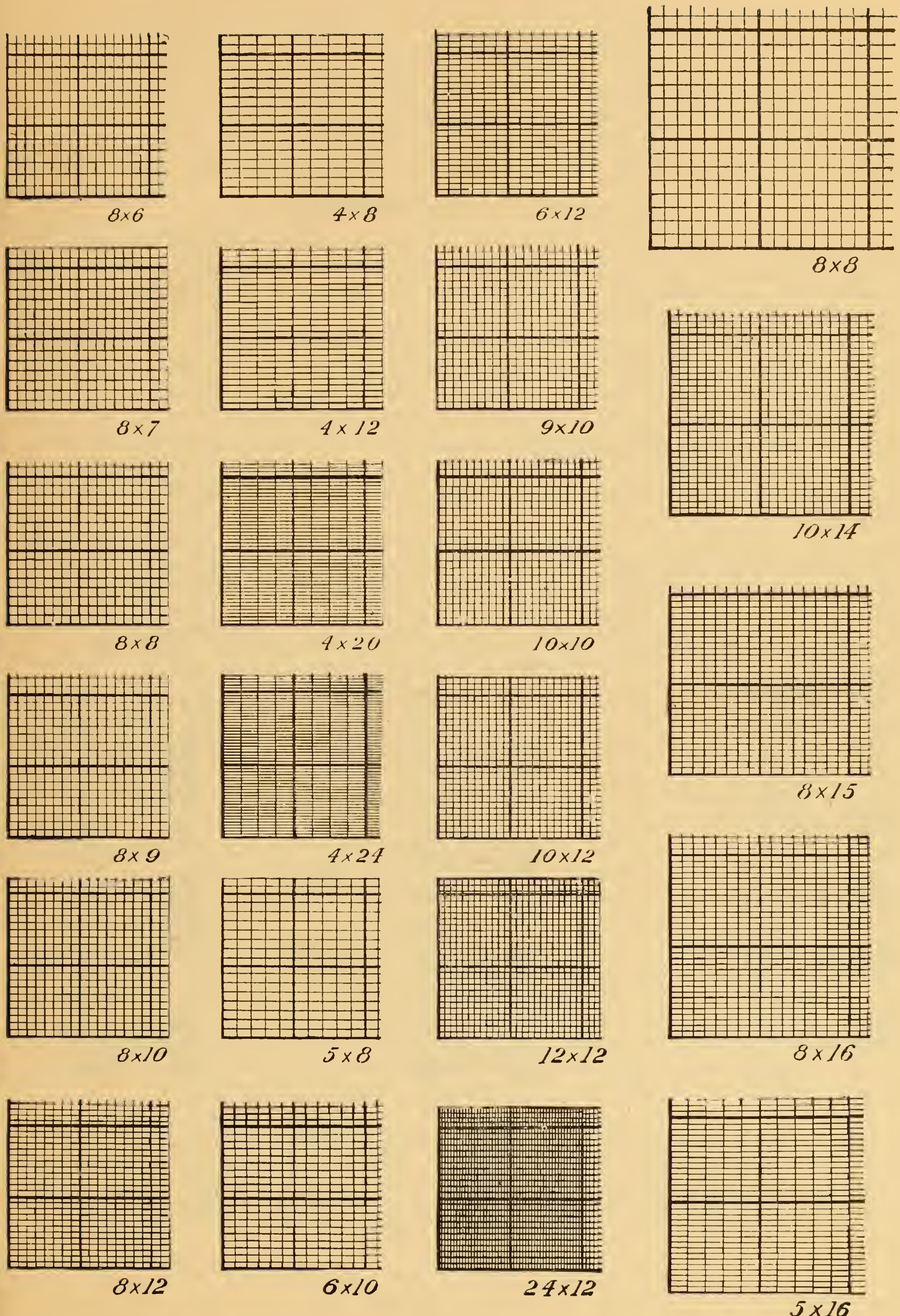

8x6
4x8
6x12
8x8
8x7
4x12
9x10
10x14
8x8
4x20
10x10
8x9
4x24
10x12
8x15
8x10
5x8
12x12
8x16
8x12
6x10
24x12
5x16

Fig. 6.

On 8 x 8 paper 3 squares mean 3 x 8, or 24 rectangles each way; on 10 x 10 paper 3 squares mean 3 x 10, or 30 rectangles each way, etc.

In designing for regular harness work we generally use □ designing paper containing the same number of rectangles each way; thus even paper, as 8 x 8, 10 x 10, 12 x 12, etc., without taking into consideration the texture the fabric is constructed by. On the other hand the entire variety as shown are used, and accordingly selected from for the designing of textile fabrics requiring the Jacquard machine for their construction. For such fabrics we give a rule for

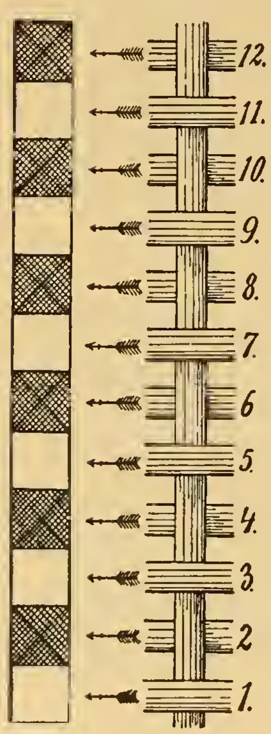
Selection of Designing Paper.

The proper character oi the designing paper is ascertained by the number of warp and filling threads required per inch in the finished fabric. For example: a fabric with a texture when finished of $^{80}/_{120}$ (80 ends warp and 120 picks per inch) will require a designing paper of corresponding proportion, or as 80 is to 120,$=8 \times 12$.

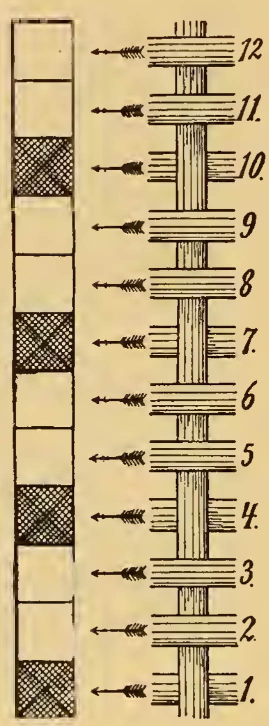
Diagram Fig. 5, and its previously given explanations, clearly illustrated the object of the small rectangles, *i. e.*, the places of meeting for certain warp and filling threads. Two ways for interlacing of warp and filling in a fabric are possible: either we raise the warp-thread, thus allowing the filling to go under it, or lower the warp-thread and allowing the filling to cover it. In the first case the warp will be visible, prominent on the face of the fabric; in the other, the filling. Through this exchanging of warp and filling as visible on the face of the fabric, technically known as "Raisers or Sinkers," we form the interlacing of both systems of threads, known as "the Weave."

Rule: Indications of any kind in a certain rectangle inside the repeat of the weave upon the designing paper mean "warp up" in its corresponding place in the fabric. Rectangles left empty inside the repeat of the weave upon the designing paper mean "filling up" in its corresponding position in the fabric.

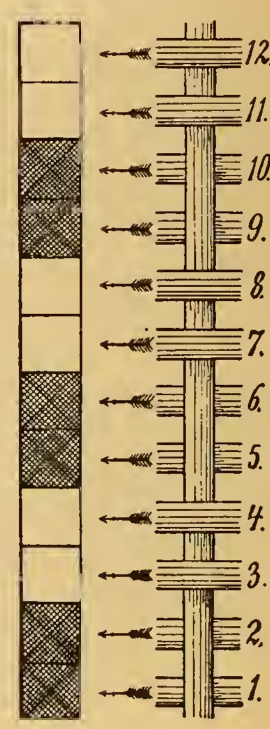
Figs. 7, 8 and 9 are designed for illustration of the preceding rule and explanations.



A. *B.*
Fig. 7.



A. *B.*
Fig. 8.



A. *B.*
Fig. 9.

Fig. 7 shows under *A* the enlargement of a warp-thread taken from a regular designing paper, and containing in its repeat 12 picks in rotation. A careful examination of the diagram, and commencing to read from the bottom, illustrates the warp-thread alternately down and up; also at *B* the reproduction of the warp-thread and necessary picks from a fabric.

Fig. 8 illustrates the design and working of a similar warp-thread with the same number of picks in repeat, but with the arrangement:

One up two down, four times repeated=twelve picks.

Fig. 9 illustrates the design and working of a similar warp-thread as used before with the same number of picks in repeat, but interlacing with the arrangement:

Two up two down, three times repeated.

The interlacing of both systems of threads, or, in other words, the different weaves are generally divided into 3 distinct main divisions (Foundation weaves):

The Plain,

The Twills,

The Satins; forming the foundation of all the other sub-divisions of weaves classified as "*derivative weaves.*" New weaves are also formed by the combination of weaves from the various sub-divisions, etc., thus forming a field impossible to cover in detail as respects each particular weave or special fabric; but we will, however, by means of our future lectures, impart the principles for their construction, thus giving the student sufficient knowledge to master any and every combination required.

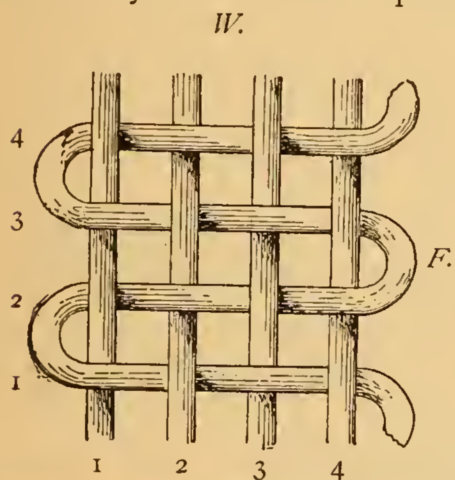


Fig. 10.

Foundation Weaves.

I. THE PLAIN OR COTTON-WEAVE.

Fig. 10 represents a fabric constructed with the weave technically known as "*the plain*" or "*the cotton-weave.*" In this diagram two distinct sets of threads, crossing each other at right angles and interlacing alternately, are visible. The threads running longitudinally (marked *W*), or lengthways in the fabric, are the *warp-threads*; the traverse threads are the filling (indicated by F in diagram.)

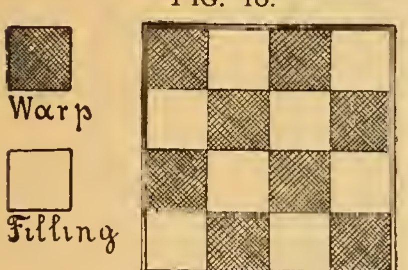


Fig. 11.

Fig. 11 shows the *design or pattern*, executed correspondingly to fabric sample, Fig. 10. The shaded squares indicating warp up; the empty squares representing filling up.

Fig. 12 is the section-cut of a fabric woven on "plain" weave, showing one warp-thread light (1), the other shaded (2). The filling is represented in full black.

Fig. 12.

An examination of Fig. 10 will convince the student that this weave produces a very firm interlacing of the two systems of threads employed, in fact it is the most frequent exchanging of warp and filling possible. The fabric produced with this weave will be strong, as each thread, by reason of the interlacing, supports the others to the utmost.

This frequent exchanging of warp and filling in the "*plain*" weave will also produce a fabric more or less perforated. These perforations are regulated by the size of the threads used in the construction of a fabric, and by the twist employed in the manufacture of the yarns.

Rule: *1st.* The thicker in size the threads are, as used in the construction of the fabric, the larger the perforations will be.

2d. Soft twisted threads reduce the perforations to a lower point than hard twisted threads of equal size and direction of twist.

3d. The perforation will again be reduced by employing a twist for warp and filling, which, when both are interlaced, runs in the same direction.

To illustrate this last rule Figs. 13, 14, 15 and 16 are constructed.

Fig. 13. Fig. 14.

Fig. 13 represents a thread twisted from the right towards the left, which is called technically "*left*" twist.

Fig. 14 shows us a thread twisted in the opposite direction, or from the left towards the right, which in turn is classified as "*right*" twist.

Fig. 15 illustrates a fabric, woven on "*plain*," in which the direction of the twist is opposite in warp and filling when interlaced, thus larger perforations will appear than in Fig. 16 which illustrates the same fabric, but having, when interlaced, the same direction of twist in both systems of threads.

The *plain* weave is very extensively used in the manufacture of fabrics composed of all kinds of materials, as cotton, wool, worsted, silk, hair, wire, glass, etc.

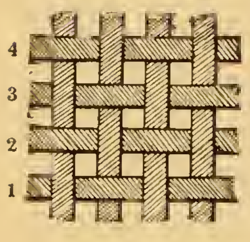


Fig 15.

Fancy Effects Produced with the Plain Weave.

The first move towards figuring a fabric constructed with the plain weave is made by varying the thickness of the threads in the warp or filling, or in both systems at the same time; for example, in "repp" cloths as used for ladies' dress goods, and also for decorative purposes. In these fabrics either one kind of warp and two kinds of filling (one pick heavy, one pick light) or two kinds of warp (one thread heavy to alternate with one thread light) and the before mentioned two kinds of filling are used.

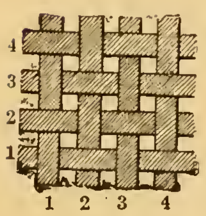


Fig. 16.

These changes of heavy and light threads are also used for forming borders, as observed in some cambric handkerchiefs or similar fabrics. Fig. 17 is given to illustrate one corner of such a fabric.

Another step towards figuring in *plain* weaving is made by *the arrangement of colors.*

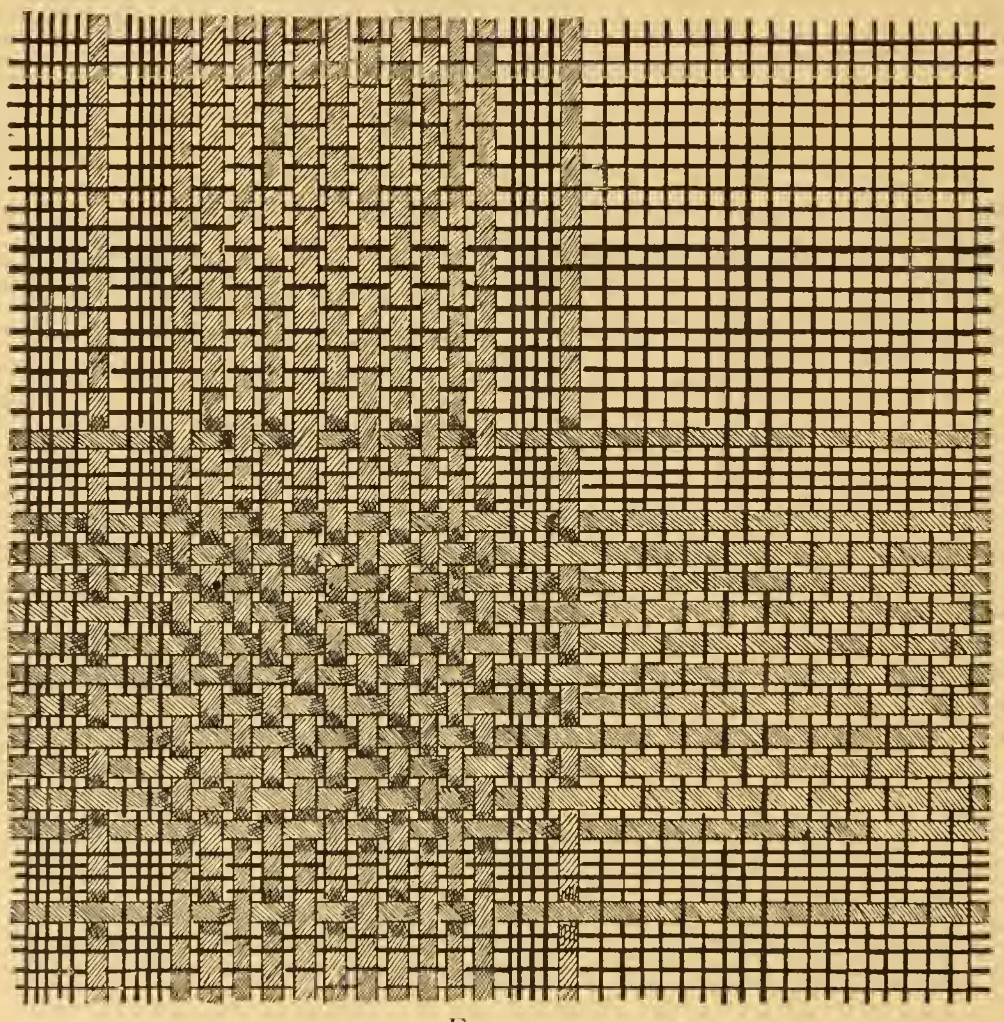


Fig. 17.

These effects are used to a large extent in the manufacture of ginghams, ladies' all-wool dress goods, as well as in the lightest qualities of fancy cassimeres. It will be easily understood by any student that a fancy color arrangement (dressing) of the warp will, in connection with one-color filling, produce corresponding stripes; therefore we will devote the attention at once towards the fancy color arrangement for warp and filling.

Among the simpler effects may be found what is technically known as a "hair-line" effect, and is derived through an alternate arrangement of 1 end light, 1 end dark in warp and filling. Each filling must cover its own color. Therefore when the shed of the warp is formed by the dark set of threads up, the light set of threads down, the light-colored filling must be interwoven. Again, if the dark set of threads are down and the light set of threads up, the dark-colored filling has to be thrown through the shed.

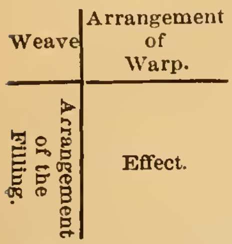


Diagram for explaining figs. 18, 19, 20, 21, 22, 23 and 24.

Fig. 18 illustrates the effect as produced by this arrangement. If the interweaving of the filling, as explained in fig. 18, is changed to the other pick, we get the stripe effect across the fabric or in the direction of the filling. This effect, known as "imitation tricot," is illustrated in Fig. 19. By combining, alternately for certain spaces, the hair-line effect with the tricot effect, "checkerboard" effects are obtained. It will be readily seen, that the regular arrangement of repeating 1 light, 1 dark, will produce either one of the before-mentioned styles. Therefore, by allowing, in a distance of a certain number of ends (according to the size of the effect), 2 ends from one color to be used, we will change from one effect to the other.

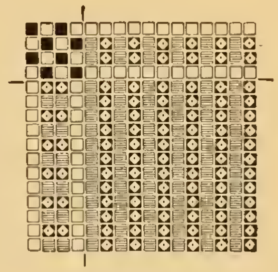


Fig. 18.

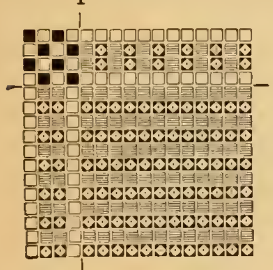


Fig. 19.

Fig. 20 illustrates one of the many styles possible to be derived. There are 9 ends of warp and filling for each effect, therefore 18 ends for the repeat.

Figs. 21, 22, 23 and 24 illustrate a few more of the many different effects which may be obtained. The principle observed in exchanging the two main or foundation effects (hair-line and tricot) is left undisturbed.

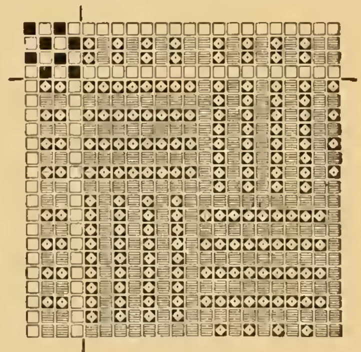


Fig. 20.

In Fig. 21 the arrangement of warp and filling is 2 ends light, 1 end dark, forming the "broken-up" effect.

Fig. 22 is constructed of 2 ends light, 2 ends dark, in the repeat of its color arrangement, and forms a "star" effect.

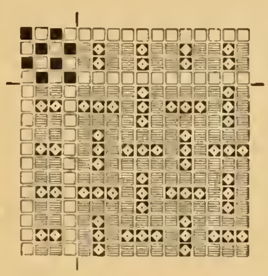


Fig. 21.

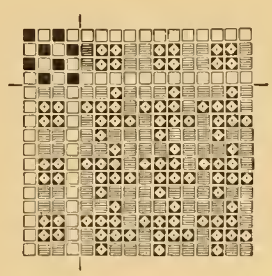


Fig. 22.

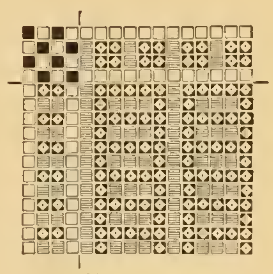


Fig. 23.

Fig. 23 is constructed as follows:

Arrangement of warp,	1 end light,
	2 ends dark,
	3 ends in the repeat.
Arrangement of the filling:	1 pick light,
to alternate with	1 pick dark,
	2 picks in the repeat.

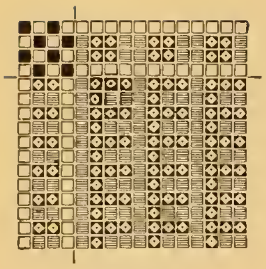


Fig. 24.

Fig. 24 is constructed as follows:

Arrangement of the warp, 2 ends light,
2 ends dark,
—
4 ends in the repeat.

Arrangement of the filling: 1 pick light,
to alternate with 1 pick dark,
—
2 picks in the repeat.

Similar effects upon the plain weave, as illustrated in Figs. 18 to 24 inclusive, can also be arranged for 3 to 4, or more colors in warp or filling, or for both systems combined, for producing one effect.

II. TWILLS.

In twill weaves (or tweel from the French *tuaille*) the warp and filling threads do not interlace alternately as in the plain weave, but only the third, fourth, fifth, etc., thread is used. The peculiarity of the twill weaves consists in having every successive pick interlace correspondingly with its successive warp-thread, thus: If the first pick ties in the first warp-thread, the second pick must interlace in the second warp-thread, the third pick must interlace in the third warp-thread, etc. Continuing to design in this manner until all the harness required to be used are taken up will give us the "*repeat.*" This manner of interlacing warp and filling will produce a distinct pattern upon the cloth, *i. e.*, lines running in a diagonal direction across it.

Comparing the twill weaves with the plain weave in respect to thickness of the cloth to be produced, will show that the twill weaves permit of the introduction of more material into the fabric, thus making it closer in its structure than the plain weave. The reason for it is found in the fact that in twill weaves the warp and filling interlace only at intervals of two, three or more threads, thus permitting the warp and the filling to lie closer together.

We mentioned before that the twill weaves form diagonal lines on the cloth. These lines can be arranged to run from the left to the right or from the right towards the left. It will be the clearest visible to the eye in the fabric by using the twill in the weave the same direction of twist the warp-thread has.

Twills commence with the 3-harness, and can after this be made on any number of harness.

Various methods are in practical use in classifying common twills. The most proper course will be to divide the general system into two divisions:

A. Uneven-sided twills, or twill weaves in which more or less warp-up indications appear on the design, compared with filling-up indications, or the amount of indications balance but the general arrangement is different in one compared with the other. For example: $\frac{2}{3}\frac{2}{1} = \frac{4}{4}$, but differently arranged for each side. (For indicating this division of twills the letter *u* is used throughout the chapter.)

B. Even-sided twills, or twill weaves in which the *amount* and *arrangement* of warp up and filling up is completely balanced. (For indicating this division of twills the letter *e* is used throughout the chapter.)

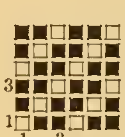


Fig. 25.

3-harness twill.

$\frac{2}{1}$ *u.*

Warp for face.

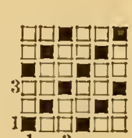


Fig. 26.

3-harness twill.

$\frac{1}{2}$ *u.*

Filling for face.

Commencing the designing of twills on *3-harness*, we find one twill possible to be made upon it, which is the *u* twill: 1 down 2 up or 1 up 2 down; also technically represented with warp face $_{1}$——^{2}, filling face ^{1}——$_{2}$, and weaves shown in Fig. 25 and Fig. 26.

Fig. 27 illustrates the plan of the fabric obtained with weave Fig. 26.

Fig. 28 represents the longitudinal section cut of fabric shown in Fig. 27. Numbers as used on weave, fabric and section cut are selected correspondingly. *A* in section cut indicates warp-thread No. 1 in plan.

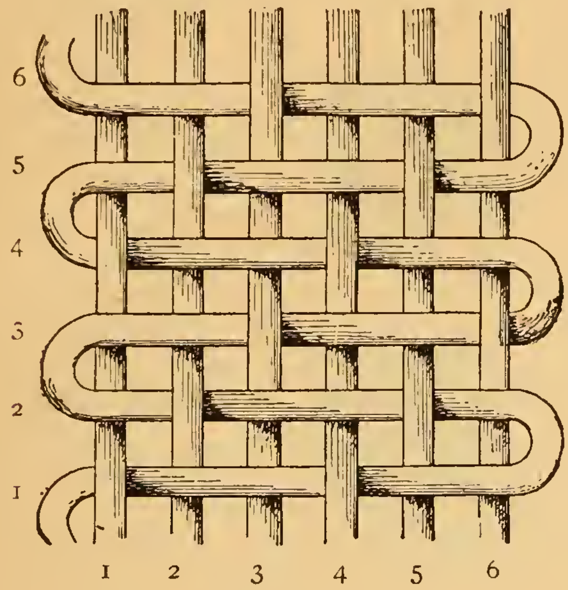


FIG. 27.

FIG. 28.

4-Harness Twills.—Examining four, we find 2 kinds of twills possible to be obtained: 1 down 3 up (*u*), or 1 up 3 down (*u*), and 2 up 2 down (*e*), this being the first even-sided twill obtained.

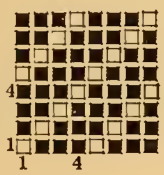


FIG. 29.

4-harness twill.

$\frac{3}{1}$ *u.*

Warp for face.

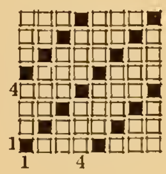


FIG. 29*a*.

4-harness twill.

$\frac{1}{3}$ *u.*

Filling for face.

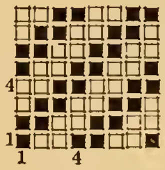


FIG. 30.

4-harness twill.

$\frac{2}{2}$ *e.*

Warp and filling equal.

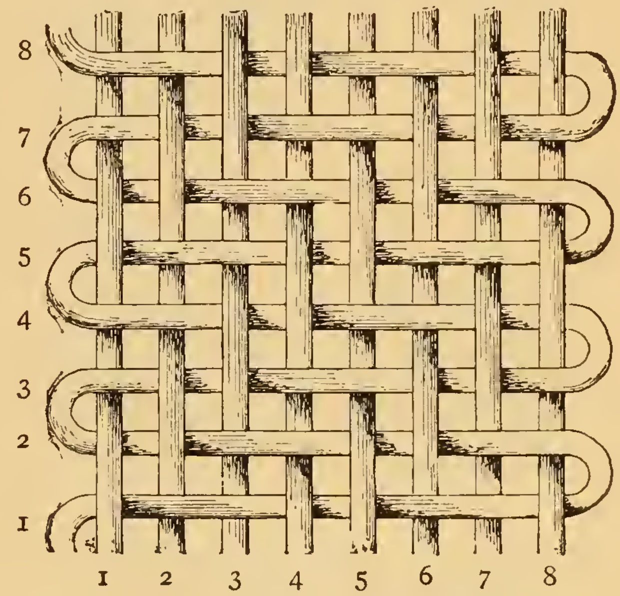


FIG. 31.

FIG. 32.

Fig. 31 illustrates the fabric obtained with weave Fig. 30.

Fig. 32 represents the longitudinal section cut of fabric shown in Fig. 31. *A* = warp-thread No. 1.

5-Harness Twills.—In five-harness we find three different kinds of twills, as follows:

Warp Face.		*Filling Face.*
1 down 4 up (*u*),	or	1 up 4 down (*u*).
3 up 2 down (*u*),	"	3 down 2 up (*u*).
1 down 1 up, 1 down 2 up (*u*),	"	1 up 1 down, 1 up 2 down (*u*).

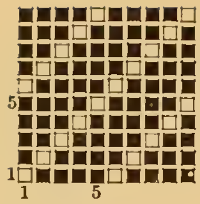


FIG. 33.

5-harness twill. $\frac{4}{1}u.$

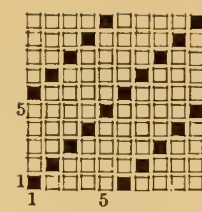


FIG. 34.

5-harness twill. $\frac{1}{4}u.$

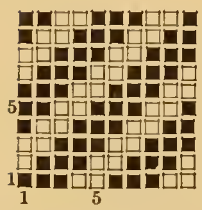


FIG. 35.

5-harness twill. $\frac{3}{2}u.$

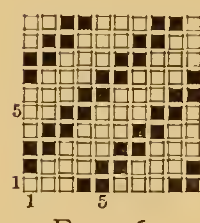


FIG. 36.

5-harness twill. $\frac{2}{3}u.$

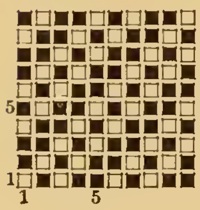


FIG. 37.

5-harness twill. $\frac{1\quad 2}{1\quad 1}u.$

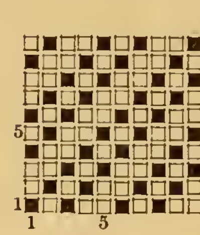


FIG. 38.

5-harness twill. $\frac{1\quad 1}{1\quad 2}u.$

6-Harness Twills.—On six-harness five different twills are found:

Filling Face.		*Warp Face.*
1 up 5 down (*u*),	or	1 down 5 up (*u*).
2 up 4 down (*u*),	"	2 down 4 up (*u*).
1 up 1 down, 1 up 3 down (*u*),	"	1 down 1 up, 1 down 3 up (*u*).

Warp and Filling equal.

3 up 3 down (*e*).
2 up 1 down, 1 up 2 down (*e*).

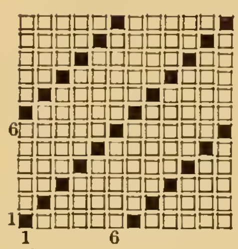


FIG. 39.

6-harness twill. $\frac{1}{5}u.$

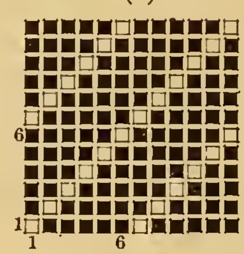


FIG. 40.

6-harness twill. $\frac{5}{1}u.$

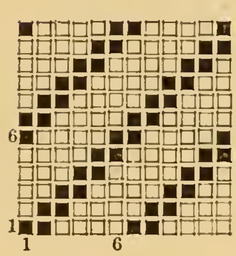


FIG. 41.

6-harness twill. $\frac{2}{4}u.$

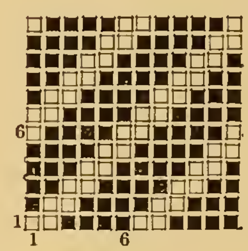


FIG. 42.

6-harness twill. $\frac{4}{2}u.$

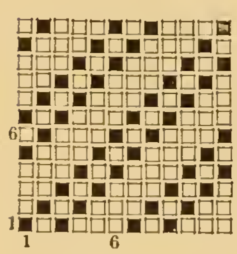


FIG. 43.

6-harness twill. $\frac{1\quad 1}{1\quad 3}u.$

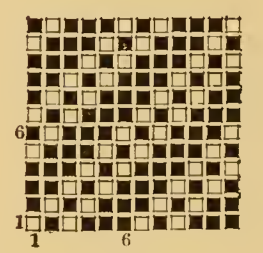
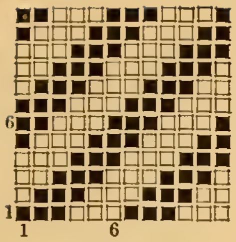


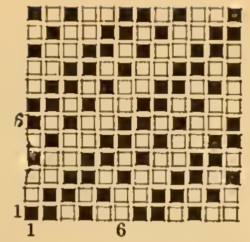
FIG. 44.

6-harness twill. $\frac{1\quad 3}{1\quad 1}u.$



6-harness twill. $\frac{3}{3}$ *e.*

Fig. 45.



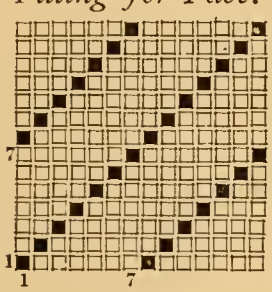
6-harness twill. $\frac{2\quad 1}{1\quad 2}$ *e.*

Fig. 46.

7-Harness Twills.—On 7-harness eight different kinds of twills are found, all uneven-sided.

Filling Face.		*Warp Face.*
1 up 6 down	or	1 down 6 up,
2 up 5 down	"	2 down 5 up,
3 up 4 down	"	3 down 4 up,
1 up 1 down 1 up 4 down	"	1 down 1 up 1 down 4 up,
2 up 1 down 1 up 3 down	"	2 down 1 up 1 down 3 up,
2 up 2 down 1 up 2 down	"	2 down 2 up 1 down 2 up,
1 up 3 down 1 up 2 down	"	1 down 3 up 1 down 2 up,
1 up 1 down 1 up 1 down 1 up 2 down	"	1 down 1 up 1 down 1 up 1 down 2 up.

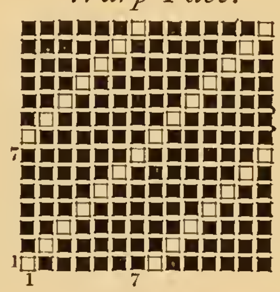
Filling for Face.



7-harness twill. $\frac{1}{6}$

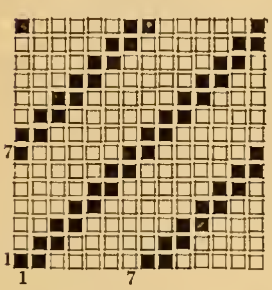
Fig. 47.

Warp Face.



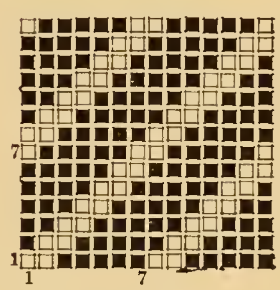
7-harness twill. $\frac{6}{1}$

Fig. 48.



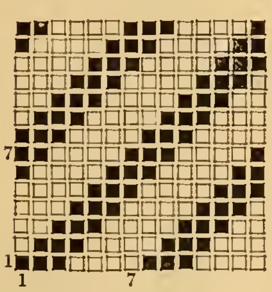
7-harness twill. $\frac{2}{5}$

Fig. 49.



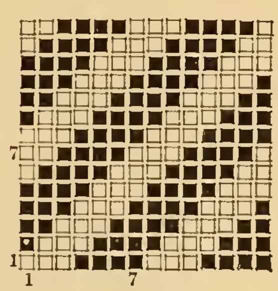
7-harness twill. $\frac{5}{2}$

Fig. 50.



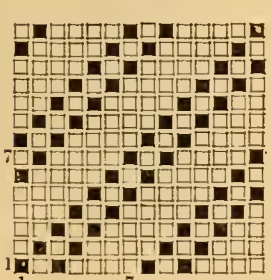
7-harness twill. $\frac{3}{4}$

Fig. 51.



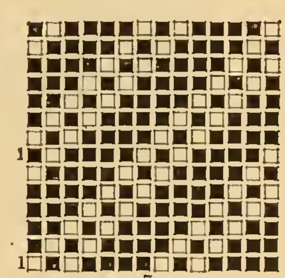
7-harness twill. $\frac{4}{3}$

Fig. 52.



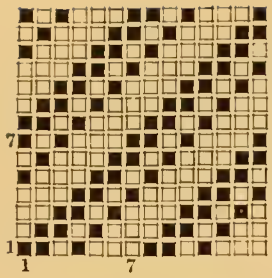
7-harness twill. $\frac{1\quad 1}{1\quad 4}$

Fig. 53.



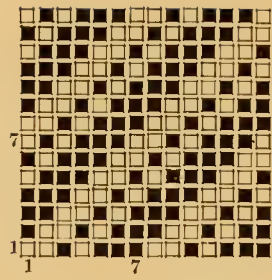
7-harness twill. $\frac{1\quad 4}{1\quad 1}$

Fig. 54.



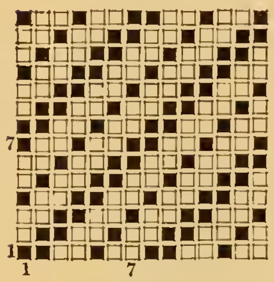
7-harness twill. $\frac{2 \quad 1}{1 \quad 3}$

FIG. 55.



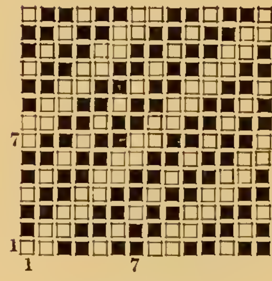
7-harness twill. $\frac{1 \quad 3}{2 \quad 1}$

FIG. 56.



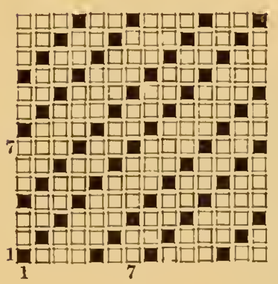
7-harness twill. $\frac{2 \quad 1}{2 \quad 2}$

FIG. 57.



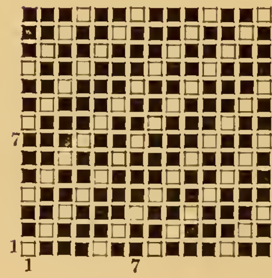
7-harness twill. $\frac{2 \quad 2}{2 \quad 1}$

FIG. 58.



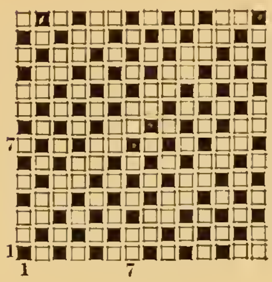
7-harness twill. $\frac{1 \quad 1}{3 \quad 2}$

FIG. 59.



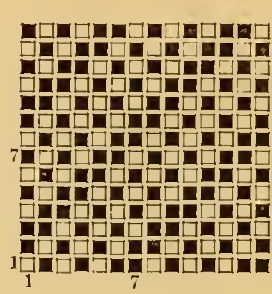
7-harness twill. $\frac{3 \quad 2}{1 \quad 1}$

FIG. 60.



7-harness twill. $\frac{1 \quad 1 \quad 1}{1 \quad 1 \quad 2}$

FIG. 61.



7-harness twill. $\frac{1 \quad 1 \quad 2}{1 \quad 1 \quad 1}$

FIG. 62.

For 8-harness, we find the following *twills:*

Filling Face.

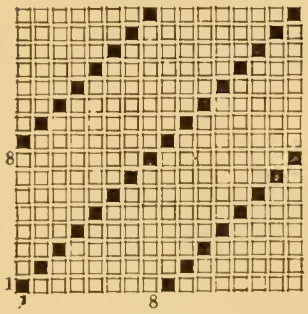


FIG. 63.

$\frac{1}{7}$ *u.*

Warp Face.

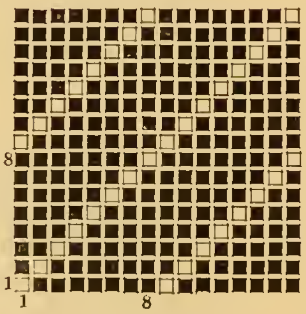


FIG. 64.

$\frac{7}{1}$ *u.*

Filling Face.

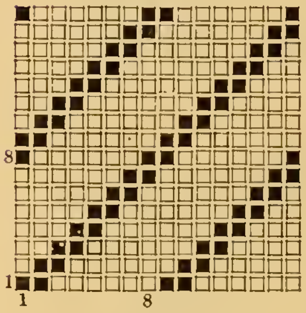


FIG. 65.

$\frac{2}{6}$ *u.*

Warp Face.

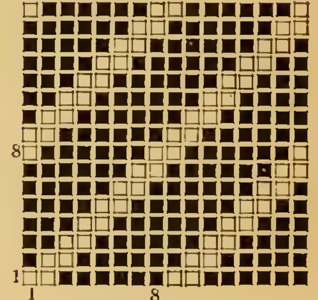


FIG. 66.

$\frac{6}{2}$ *u.*

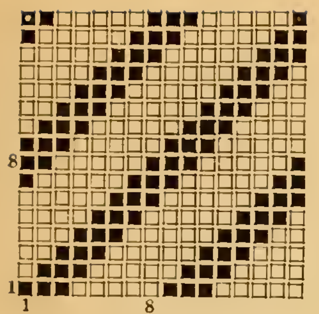


FIG. 67.

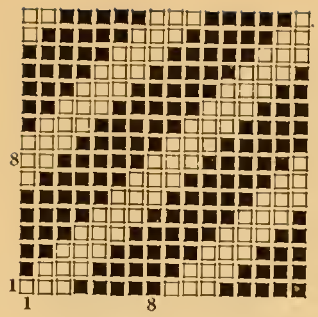


FIG. 68.

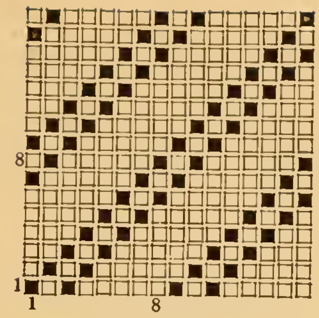


FIG. 69.

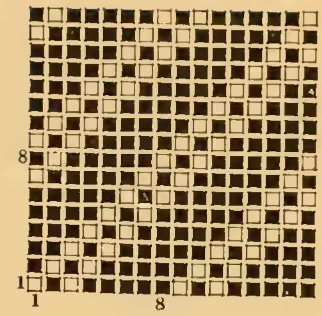


FIG. 70.

$\frac{3}{5}$ *u.* $\frac{5}{3}$ *u.* $\frac{1\quad 1}{1\quad 5}$ *u.* $\frac{1\quad 5}{1\quad 1}$ *u.*

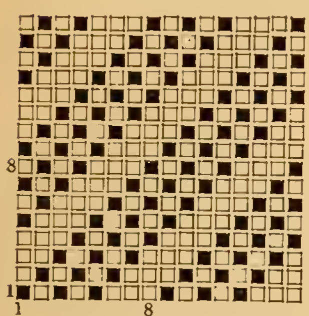


FIG. 71.

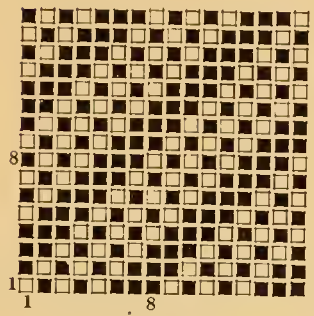


FIG. 72.

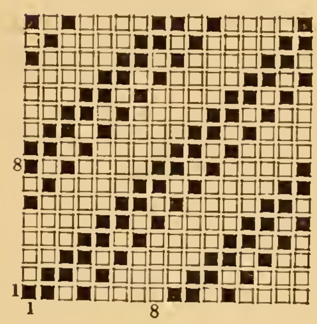


FIG. 73.

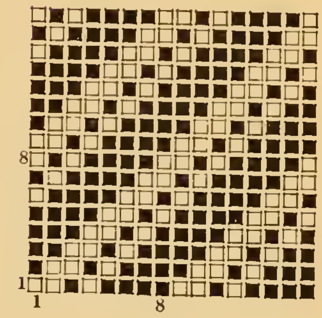


FIG. 74.

$\frac{1\quad 1\quad 1}{1\quad 1\quad 3}$ *u.* $\frac{1\quad 1\quad 3}{1\quad 1\quad 1}$ *u.* $\frac{2\quad 1}{1\quad 4}$ *u.* $\frac{1\quad 4}{2\quad 1}$ *u.*

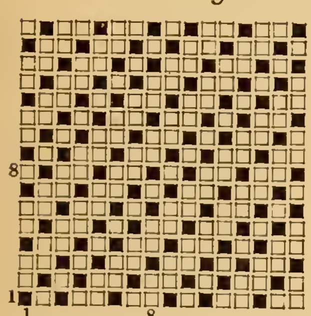


FIG. 75.

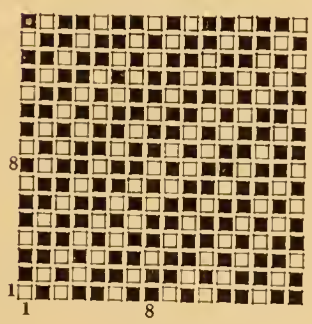


FIG. 76.

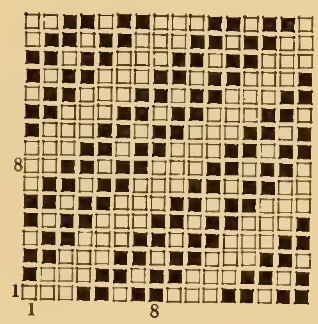


FIG. 77.

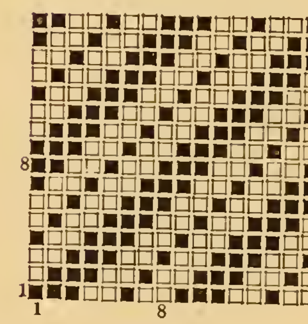


FIG. 78.

$\frac{1\quad 1\quad 1}{1\quad 2\quad 2}$ *u.* $\frac{1\quad 2\quad 2}{1\quad 1\quad 1}$ *u.* $\frac{2\quad 2}{3\quad 1}$ *u.* $\frac{3\quad 1}{2\quad 2}$ *u.*

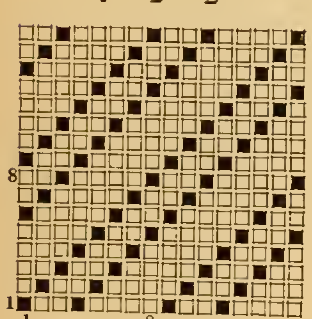


FIG. 79.

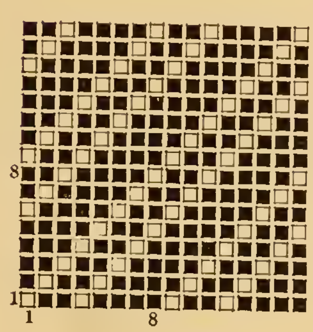


FIG. 80.

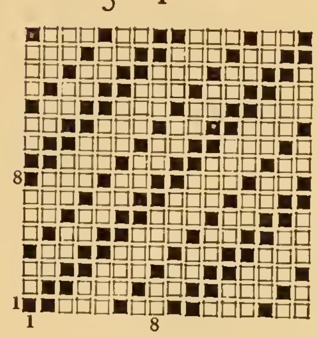


FIG. 81.

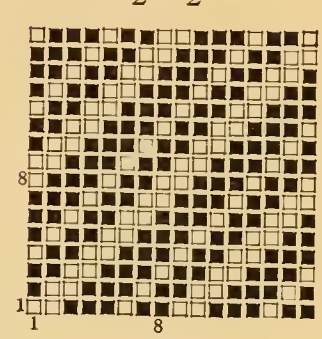


FIG. 82.

$\frac{1\quad 1}{2\quad 4}$ *u.* $\frac{2\quad 4}{1\quad 1}$ *u.* $\frac{2\quad 1}{3\quad 2}$ *u.* $\frac{3\quad 2}{2\quad 1}$ *u.*

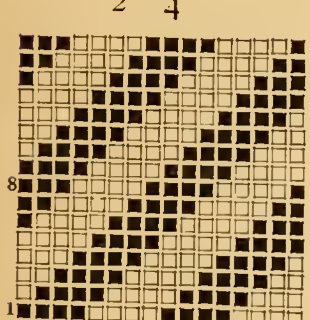


FIG. 83.

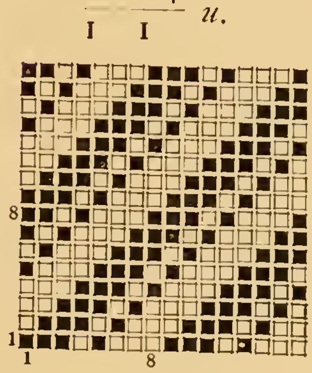


FIG. 84.

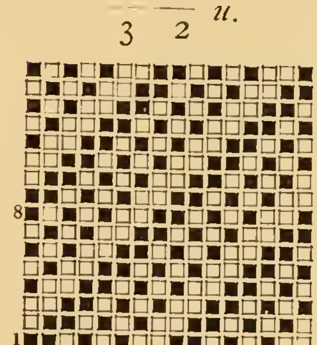


FIG. 85.

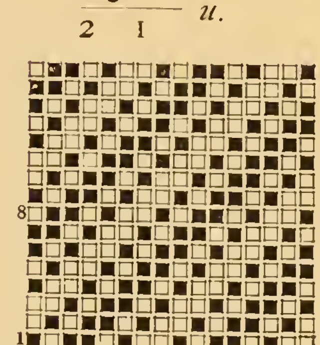


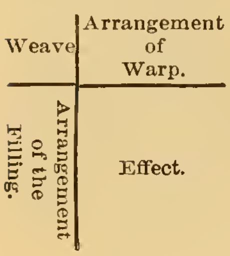
FIG 86.

Figs. 83 to 86 inclusive are the even-sided twills on 8-harness.

The same method observed in designing every common twill possible from 3 to 8 warp-threads in repeat, as shown, is continued for twills of any higher number of harness repeat. The more harness we can use, the larger the variety of twills which may be obtained.

Combinations of two or more Colors for Producing different Effects upon Fabrics interlaced on the "Twill" System.

In this system of weaves an endless variety of effects are produced by the different arrangements of colors. The same are extensively used in the manufacture of ladies' dress goods, fancy cassimeres, fancy worsteds and similar textile fabrics.



In Fig. 87 is illustrated the 3-harness twill $\frac{2}{\quad 1}$ applied to 2 ends light

1 end dark

3 ends in the repeat for the color arrangement of warp and filling. The interlacing of the different color threads is arranged so that each color, in filling, covers its own color in the warp; hence the dark filling must be interwoven in the shed, which has all the dark warp-threads in the lower part, and all the light warp-threads raised. The effect represents what is technically known as "hair line."

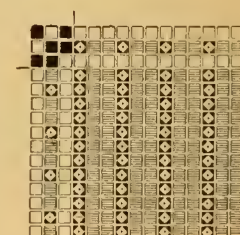


Fig. 87.

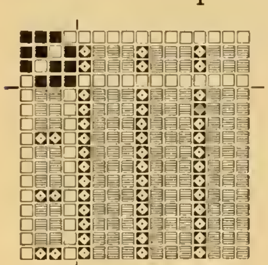


Fig. 88.

Weave Fig. 88, illustrating the 4-leaf twill $\frac{3}{\quad 1}$, can also be used for producing a "hair-line" effect by using for the color arrangement of the warp and filling

3 ends light,

1 end dark,

4 ends in the repeat.

The dark filling has again to cover its own color in the warp to produce the required effect. This weave, ($\frac{3}{\quad 1}$), can also be used in an arrangement ot 2 ends light, 2 ends dark, in the warp and filling, for producing a "line" equally as heavy as the ground in the direction of the warp for effect.

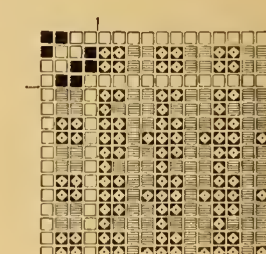


Fig. 89.

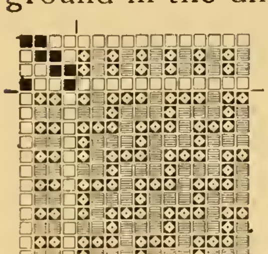


Fig. 90.

Fig. 89 illustrates the effect of

2 ends dark,

2 ends light,

4 ends in repeat of color arrangement for warp and filling, upon a fabric having the 4-harness even-sided twill for weave. The placing of the colors as represented in the latter effect, will prevent the filling from showing more prominently, than the warp. The principle observed is, to place one of the light picks in the shed formed by light color down dark color up; the other light pick is to be interwoven when half of the light and half of the dark warp-threads are up, and the remaining one-half of each are down.

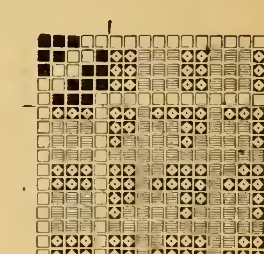


Fig. 91.

Fig. 90 illustrates a "zig zag" arrangement for effect, as produced upon a fabric interwoven upon the 4-harness even-sided twill with a color arrangement of

1 end light,

1 end dark,

2 ends in repeat for the warp and filling.

Fig. 91 represents a "spot effect" obtained upon a fabric interlacing with the 5-harness $\frac{3}{\ \ 2}$ twill. Color arrangement for warp and filling to be 2 ends dark, 3 ends light.

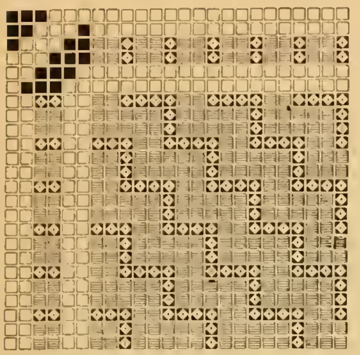


Fig. 92.

Fig. 92 illustrates a "zig zag" arrangement for effect, as produced upon a fabric interwoven with the 6-harness $\frac{3}{\ \ 3}$ even-sided twill and a color arrangement of 2 ends light,

1 end dark,

3 ends in repeat for the warp and filling.

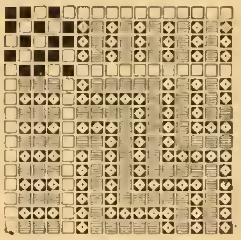


Fig. 93.

Figs. 93, 94 and 95 illustrate similar effects produced on a warp and filling arrangement of

1 end light,

1 end dark,

2 ends in the repeat.

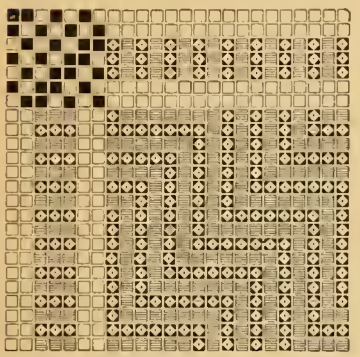


Fig. 94.

Fig. 93 illustrates the fabric produced with the 5-harness $\frac{2\ \ 1}{\ \ 1\ \ 1}$ twill.

Fig. 94 calls for the 7-harness $\frac{2\ \ 1\ \ 1}{\ \ 1\ \ 1\ \ 1}$ twill, and Fig. 95 for the 9-harness $\frac{2\ \ 1\ \ 1\ \ 1}{\ \ 1\ \ 1\ \ 1\ \ 1}$ twill.

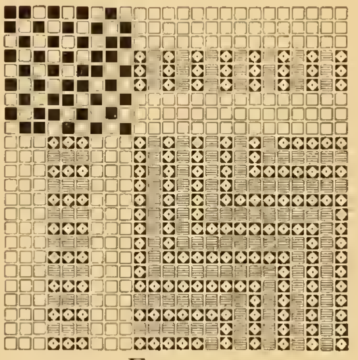


Fig. 95.

In diagrams Figs. 96, 97, 98 and 99, four specimen effects of three-color arrangements in warp and filling are given. Such combinations find extensive use in the manufacture of fancy cassimeres and fancy worsted suitings.

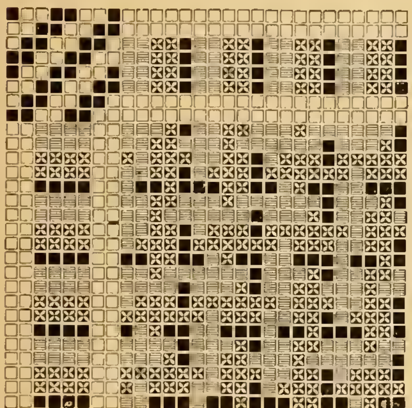


Fig. 96.

Fig. 96 illustrates the effect derived from the even-sided 4-harness twill, by the following arrangement of warp and filling:

2 ends light,	or,	color No. 1.
2 ends medium,		" No. 2.
1 end dark,		" No. 3.

5 ends repeat in color arrangement; thus, $5 \times 4 = 20$ threads, repeat of effect.

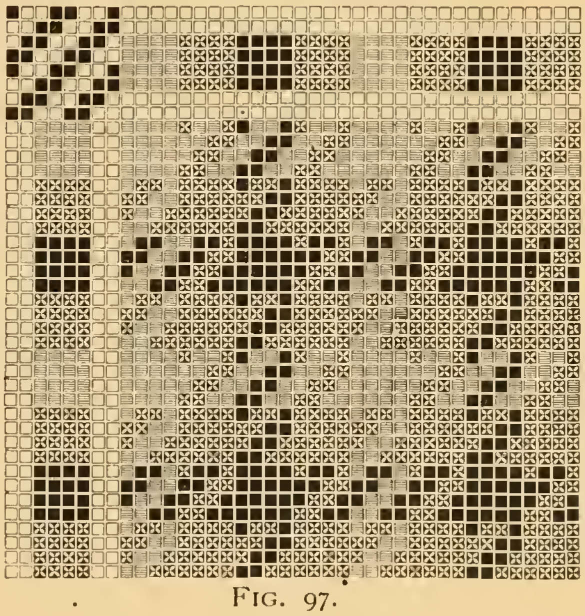


Fig. 97.

Fig. 97 illustrates the effect derived from the same weave as used in the foregoing example, with the following arrangement for warp and filling:

4 ends light,	or,	color No. 1.
4 ends medium,		" No. 2.
4 ends dark,		" No. 3.
4 ends medium,		" No. 2.

16 ends repeat in color arrangement, and as 16 is a multiple of 4 (repeat of weave), 16 threads are also the repeat of the effect in addition to color arrangement.

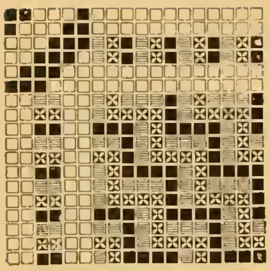


Fig. 98

Diagram Fig. 98 illustrates the effect derived from the $\frac{3}{3}$ 6-harness even-sided twill, by the following color arrangement:

1 end light, } color No. 1.
1 end medium, } or, " No. 2.
1 end dark, } " No. 3.

3 ends repeat in color arrangement, the same repeating twice in one repeat of the weave, also, one repeat of effect in fabric.

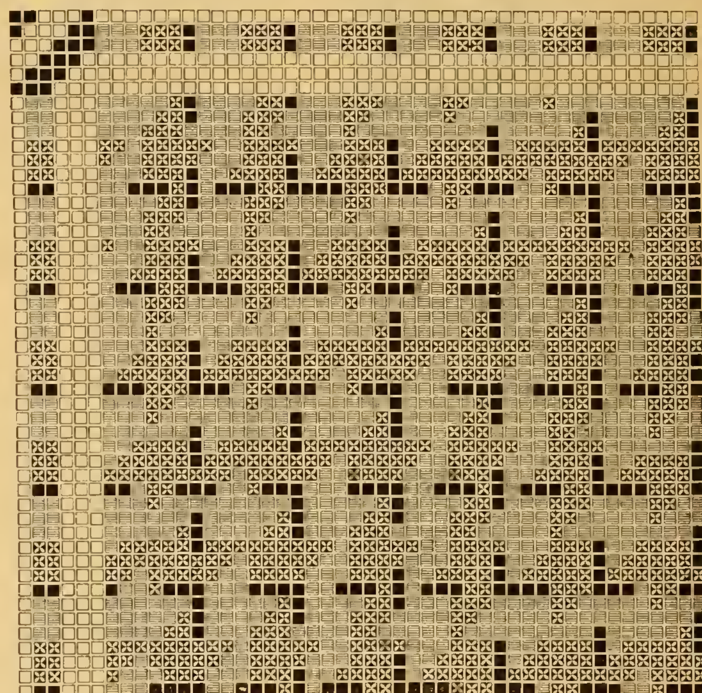


Fig. 99.

Fig. 99 illustrates the same weave as used in Fig. 98, arranged for

3 ends light, } color No. 1.
3 ends medium, } or, " No. 2.
1 end dark. } " No. 3.

7 ends repeat in color arrangement, and as this 7 is no multiple of the 6 (repeat of weave) or vice versa, $7 \times 6 = 42$ threads in warp and filling are required for one repeat of the effect.

In diagram Fig. 100, a specimen example is given of 3 colors arranged in warp and filling upon the $\frac{3}{1}$ 4-harness twill for producing a hair-line effect, as used in the manufacture of woolen and worsted trouserings, etc.

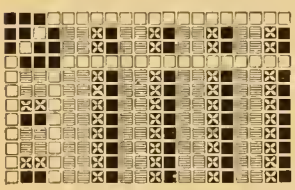


Fig. 100.

Arrangement of warp and filling:

2 ends light, } color No. 1.
1 end medium, } or, " No. 2.
1 end dark, } " No. 3.

4 ends in repeat.

In placing the filling in this present sample as well as similar effects, *each individual color in filling must cover the same color in the warp*, according to rules given for producing effects with two colors.

It will be seen by the student that these effects, until now produced with two or three colors in each example, can readily be extended to effects with four or more colors in warp, or in filling, or in both systems combined at the same time.

The effects shown in Figs. 90, 92, 93, 94, 95, 96, 97, 98 and 99 are designed on the basis of equality of texture in warp and filling, as also of similar thickness of thread for both systems; therefore, any changes in one or the other will have a corresponding influence on the effect.

Satin Weaves.

Satin weaves, also technically called satins, are without the prominent lines which are identical with the regular twills; consequently satins are characterized by a smooth face. In twill weaves the points of intersection follow consecutively, but in satin weaves this is not the case; they being arranged to interlace at intervals of one, two, three, four or more threads. The principles for the construction of satins are to arrange as much as possible distributed stitching, and to have it done at the same time, as regular as possible. The more scattered we can arrange the interlacing of the warp and filling the less these points of intersection will be visible in the fabric. The lowest satin that can be produced is found in the five-harness satin; after this the same can be made "regular" on any number of harness, with the exception of six. The four-leaf broken-twill is also sometimes classified as a "satin," but against the rules of construction for these weaves, as on two successive picks the interwoven threads are next to each other (see Fig. 101). The points of intersection of the numerous satins are found by the following *rule*:—

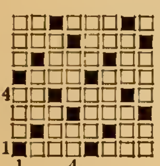


Fig. 101

Divide the number of harness for the satin into two parts, which must neither be equal nor the one a multiple of the other; again it must not be possible to divide both parts by a third number. After finding this number (which is technically known as "counter"), add it, commencing to count from one until all threads or harness are taken up. For example: Find satin weave for five-harness (5 equals 2 plus 3); commencing to count with one and adding always two points we find:

$\mathbf{1} + 2 = \mathbf{3} + 2 = \mathbf{5} + 2 = 7$ or $\mathbf{2} + 2 = \mathbf{4} + 2 = 6$ or 1 giving the points for intersection in the weave as 1, 3, 5, 2, 4, which means:

The first	pick intersects	with the	1st	warp-thread	(1st	harness up).
" second	"	"	3d	"	(3d	").
" third	"	"	5th	"	(5th	").
" fourth	"	"	2d	"	(2d	").
" fifth	"	"	4th	"	(4th	").

This construction is illustrated by

Fig. 102, in its principle (arrow S indicating the rotation of picks, arrow O indicating the counting off of warp-threads for each successive pick).

Fig. 103 illustrates the same, applied to the regular designing-paper, being filling up or filling for face.

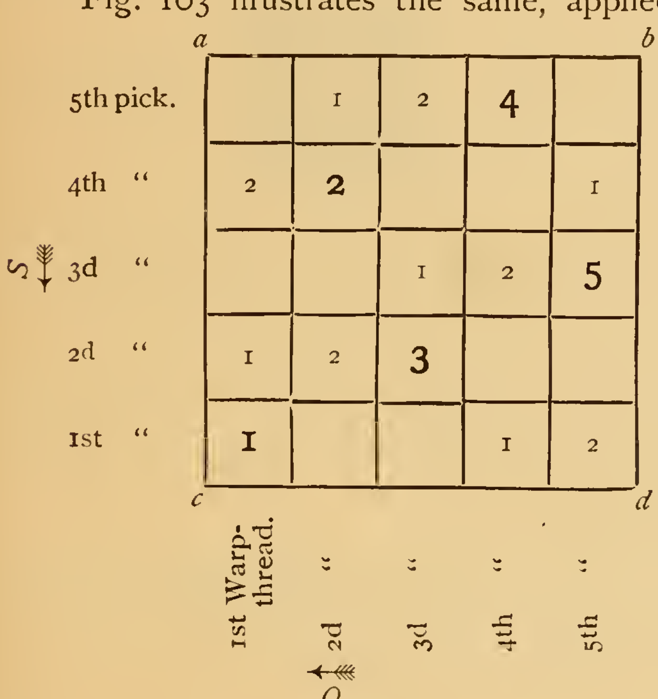


Fig. 102.

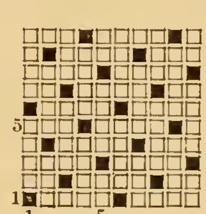


Fig. 103.

Fig. 104 illustrates the same changed to warp up or warp face, by simply exchanging "sinkers" (down) to "raisers" (up).

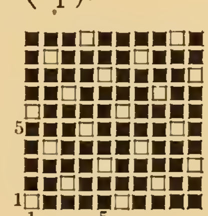


Fig. 104.

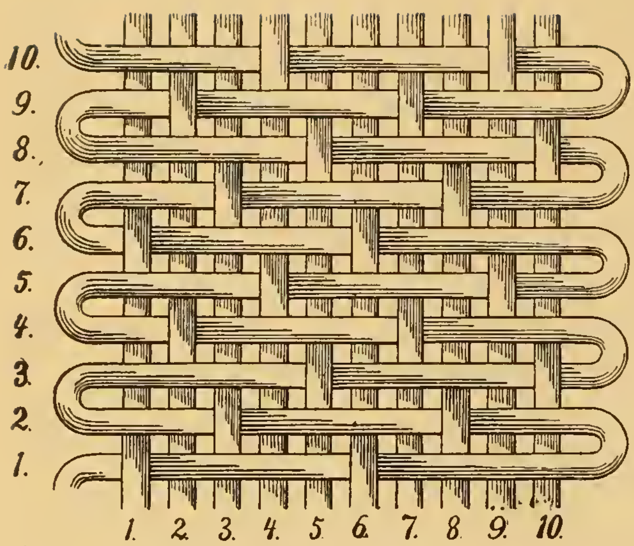


Fig. 105.

Fig. 105 illustrates (enlarged) a fabric interlaced in the 5-harness satin, constructed as explained before.

The 5-harness satin, as well as other satins produced with any number of harness, can also be obtained by constructing the design lengthwise; in this case (taking the 5-harness for example) we find

The first warp-thread must stitch in the 1st filling,
" second " " " " 3d "
" third " " " " 5th "
" fourth " " " " 2d "
" fifth " " " " 4th "

This construction of the 5-harness satin is illustrated by

Fig. 106, in its principle (arrow S indicating the rotation of warp-threads, arrow O indicating the counting off of warp-threads for each successive pick).

Fig. 107, the same, applied to the regular designing paper.

Fig. 108 is the same satin warp up or warp for face.

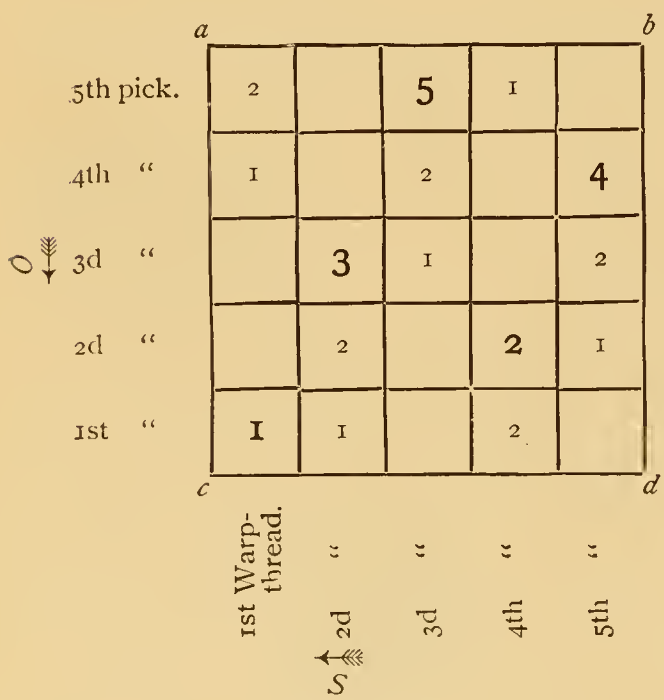


Fig. 106.

Filling for face.

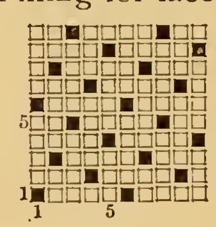


Fig. 107.

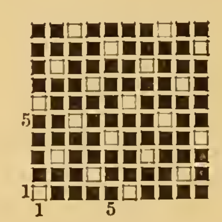


Fig. 108.

A careful examination of Figs. 103 and 107 will show, as the only difference, the "satin twill" (which later on will be more particularly described), but taken in a general technical point of view, for constructing weaves both are identical. The first-mentioned rule, counting off the picks in rotation and the harness (or warp-threads), according to the "counter" obtained, is in general use.

Design shown in Fig. 107 would also have been obtained by the first rule in using the other part the 5 is composed of, namely, the 3 for counting off, thus

$$\mathbf{1} + 3 = \mathbf{4} + 3 = 7 = \mathbf{2} + 3 = \mathbf{5} + 3 = 8 = \mathbf{3} + 3 = 6 = 1,$$

or the stitch as 1, 4, 2, 5, 3.

For *6-harness* (6 warp-threads for repeat), as already mentioned, no regular satin is found, as 6 can only be divided in 2 plus 4 or 3 plus 3, which numbers are against the rules for constructing satin weaves. Being sometimes compelled to use a satin on 6-harness we must use the next best to a perfect satin as found in 1—3—5—2—6—4, illustrated in Fig. 109, filling for face; Fig. 110, warp for face.

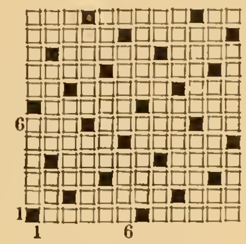


FIG. 109.

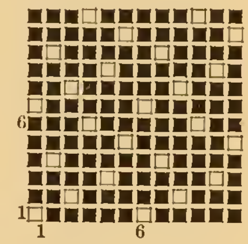


FIG. 110.

For *7-harness* two regular (perfect) satins are found by dividing 7 into 2 plus 5 and 3 plus 4.

Counting off for the first kind we get by using the 2 for counter: **1** + 2 = **3** + 2 = **5** + 2 = **7** + 2 = 9 = **2** + 2 = **4** + 2 = **6** + 2 = 8 = 1, or 1, 3, 5, 7, 2, 4, 6, and illustrated in Fig. 111, filling for face; Fig. 112, warp for face.

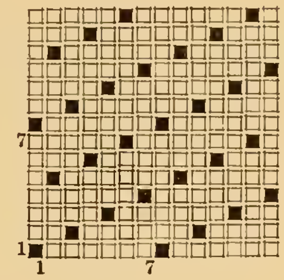


FIG. 111.

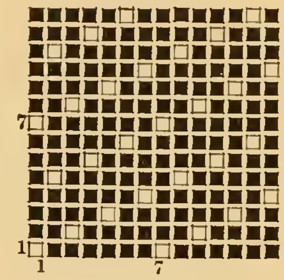


FIG. 112.

In the construction of the other satin for 7-harness and using the 3 for counting off we get **1** + 3 = **4** + 3 = **7** + 3 = 10 = **3** + 3 = **6** + 3 = 9 = **2** + 3 = **5** + 3 = 8 = 1, or 1, 4, 7, 3, 6, 2, 5, illustrated in Fig. 113, filling up; Fig. 114, warp up.

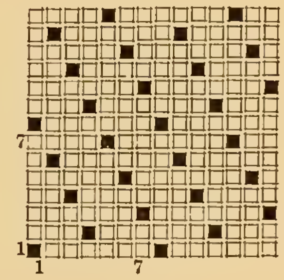


FIG. 113.

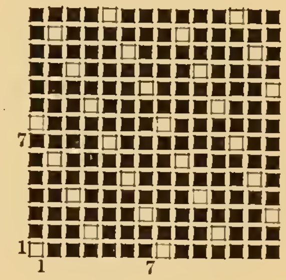


FIG. 114.

For 8-harness we find only one perfect satin as the 8 can only be divided into 3 plus 5. The counting off for the design, always adding 3, will be as follows:

1+3=**4**+3=**7**+3=10=**2**+3=**5**+3=**8**+3=11 =**3**+3=**6**+3=9=1, or 1, 4, 7, 2, 5, 8, 3, 6, illustrated in Fig. 115, filling for face; Fig. 116, warp for face.

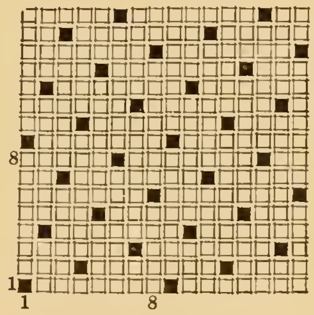


FIG. 115.

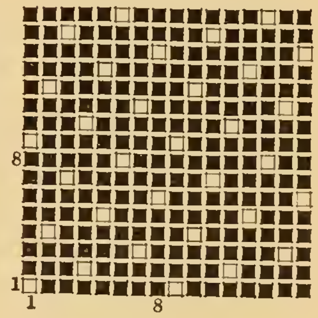


FIG. 116.

Upon 9-harness, we can design two different satin weaves, for the number 9, in accordance with the rules, can be divided into 2 plus 7 and 4 plus 5.

Commencing to count off with 2 for producing the first kind of satin we get: 1, 3, 5, 7, 9, 2, 4, 6, 8, which is illustrated in filling for face in Fig. 117. If requiring warp for face read this as well as any of the following designs, illustrated in succession up to 16-harness, ◻ for raisers (up), ■ for sinkers (down).

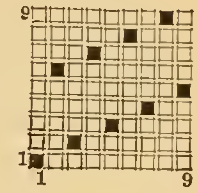


FIG. 117.

Commencing to count off for the second kind of satin weaves on 9-harness, using the 4 for counter, we get: 1, 5, 9, 4, 8, 3, 7, 2, 6, which is illustrated in Fig. 118.

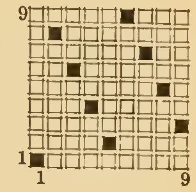


FIG. 118.

For 10-harness one regular satin is derived by dividing 10 into 3 plus 7. Counting off with 3 gives 1, 4, 7, 10, 3, 6, 9, 2, 5, 8, as points for intersecting.

The design for it is illustrated in Fig. 119.

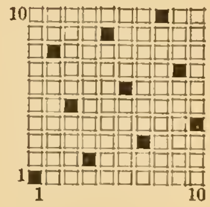


FIG. 119.

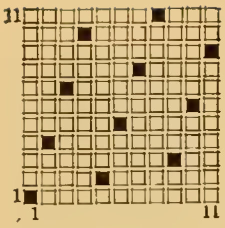


FIG. 120.

For 11-harness four different perfect satins can be designed, by dividing the 11 in 2 plus 9, 3 plus 8, 4 plus 7, 5 plus 6.

The "*counter*" most frequently used for the 11 harness is 4, giving the points for intersecting as follows: 1, 5, 9, 2, 6, 10, 3, 7, 11, 4, 8.

The design for it is illustrated in Fig. 120.

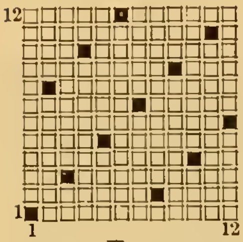


FIG. 121.

For 12-harness only one perfect satin is found by dividing the 12 into 5 plus 7. Counting off with 7 gives the points for intersecting as follows: 1, 8, 3, 10, 5, 12, 7, 2, 9, 4, 11, 6.

The design for it is illustrated in Fig. 121.

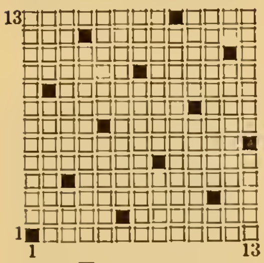


FIG. 122.

For 13-harness we find five different perfect satins by dividing the 13 into 2 plus 11, 3 plus 10, 4 plus 9, 8 plus 5, 6 plus 7.

Counting off with (the number most frequently used) 5, we find the intersecting points to be 1, 6, 11, 3, 8, 13, 5, 10, 2, 7, 12, 4, 9.

The design for it is shown in Fig. 122.

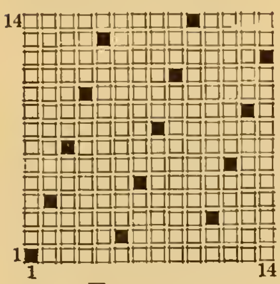


FIG. 123.

For 14-harness we find two perfect satins by dividing the 14 into 3 plus 11, and 5 plus 9.

The design most frequently used for this number of harness, and which is illustrated in Fig. 123, is derived by counting off with 5, as follows: 1, 6, 11, 2, 7, 12, 3, 8, 13, 4, 9, 14, 5, 10.

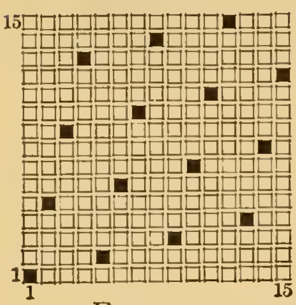


FIG. 124.

For 15-harness three different regular satins can be made, as 15 can be divided into 2 plus 13, 4 plus 11, 7 plus 8.

The number most frequently employed for counting off is 4, which gives the points for intersection as 1, 5, 9, 13, 2, 6, 10, 14, 3, 7, 11, 15, 4, 8, 12.

The design for it is found in Fig. 124.

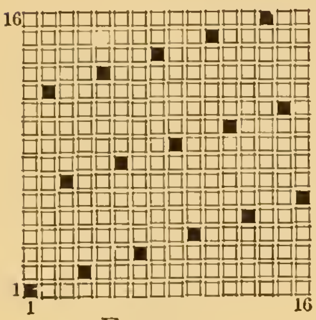


FIG. 125.

For 16-harness three different satin weaves can be designed by dividing the 16 either in 3 plus 13 or 5 plus 11 or 7 plus 9.

Using the number most frequently employed for counting off the points for intersecting warp and filling, which is 3, we find 1, 4, 7, 10, 13, 16, 3, 6, 9, 12, 15, 2, 5, 8, 11, 14, as represented in design Fig. 125.

After the method given thus far for finding the different satins from the lowest number of harness (the 5-harness) up to the 16-harness, it will be easy for any student to find the different satins for any number of warp-threads in repeat (harness) that may be required. Those given in our lecture will comprise those most frequently used.

Table for finding the Satin Weaves most frequently used.

Number of Harness.	Succession of Stitches.																Number for Counting Off.
5-harness...	1.	3.	5.	2.	4.												2.
6 " ...	1.	3.	5.	2.	6.	4.											0.
7 " ...	1.	3.	5.	7.	2.	4.	6.										2.
8 " ...	1.	4.	7.	2.	5.	8.	3.	6.									3.
9 " ...	1.	3	5	7.	9.	2.	4.	6.	8.								2.
10 " ...	1.	4.	7.	10.	3.	6.	9.	2.	5.	8.							3.
11 " ...	1.	5.	9.	2.	6.	10.	3.	7.	11.	4.	8.						4.
12 " ...	1.	8.	3.	10	5.	12.	7.	2.	9.	4.	11.	6.					7.
13 " ...	1.	6.	11.	3.	8.	13.	5.	10.	2.	7.	12.	4.	9.				5.
14 " ...	1.	6.	11.	2.	7.	12.	3.	8.	13.	4.	9.	14.	5.	10.			5.
15 " ...	1.	5.	9.	13.	2.	6.	10.	14.	3.	7.	11.	15.	4.	8.	12.		4.
16 " ...	1.	4.	7.	10.	13.	16.	3.	6.	9.	12.	15.	2.	5.	8.	11.	14.	3.

Fig. 126.

Influence of the Twist of the Yarn upon Fabrics interlaced with Satin Weaves.

To produce certain effects on fabrics interlacing on a satin weave the same may require a certain twist of the warp or the filling, or in both systems. Fabrics made on a satin weave may for their effect require the satin twill to be more or less visible; again it may be desired to see none at all. Therefore in all cases, before deciding as to the direction and amount of twist to be put in the yarn for any kind of a fabric to be made with a satin weave, we must consider whether the face is to be formed by the warp or the filling and whether the satin twill is to be visible or not.

For example: Take a fabric to be made with the 5-harness satin. If we have to use warp for face and want the satin-twill effect distinct, we must use the design shown in Fig. 104 with a warp yarn twisted to the left. If we want to produce a fabric requiring a smooth face, as doeskin, kersey, beaver, etc., and have the warp yarn twisted towards the left, we must use the design illustrated by Fig. 108.

Arrangement for Commencing the Satin Weaves for Special Fabrics, such as Damask Table Covers, Towels, etc.

In fabrics where "warp up" and "filling up" satins are figured as in previously mentioned fabrics, we have to change the commencing of the weave from the beginning with one, so as to get a perfect joining, respectively cutting off from the warp effect to the filling effect.

In this class of fabrics the weave must commence in the following manner: The last warp and filling thread of one effect must work in an opposite direction to the commencing of the first warp and filling thread of the other effect. Hence the 5-harness satin for such fabrics will be 4, 1, 3, 5, 2 (see Fig. 127). The 8-harness satin will read 3, 8, 5, 2, 7, 4, 1, 6 (see Fig. 128). The 10-harness satin 7, 10, 3, 6, 9, 2, 5, 8, 1, 4 (see Fig. 129), etc., etc.

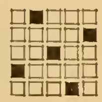


Fig. 127.

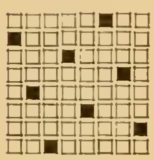


Fig. 128.

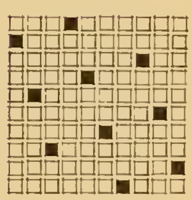


Fig. 129.

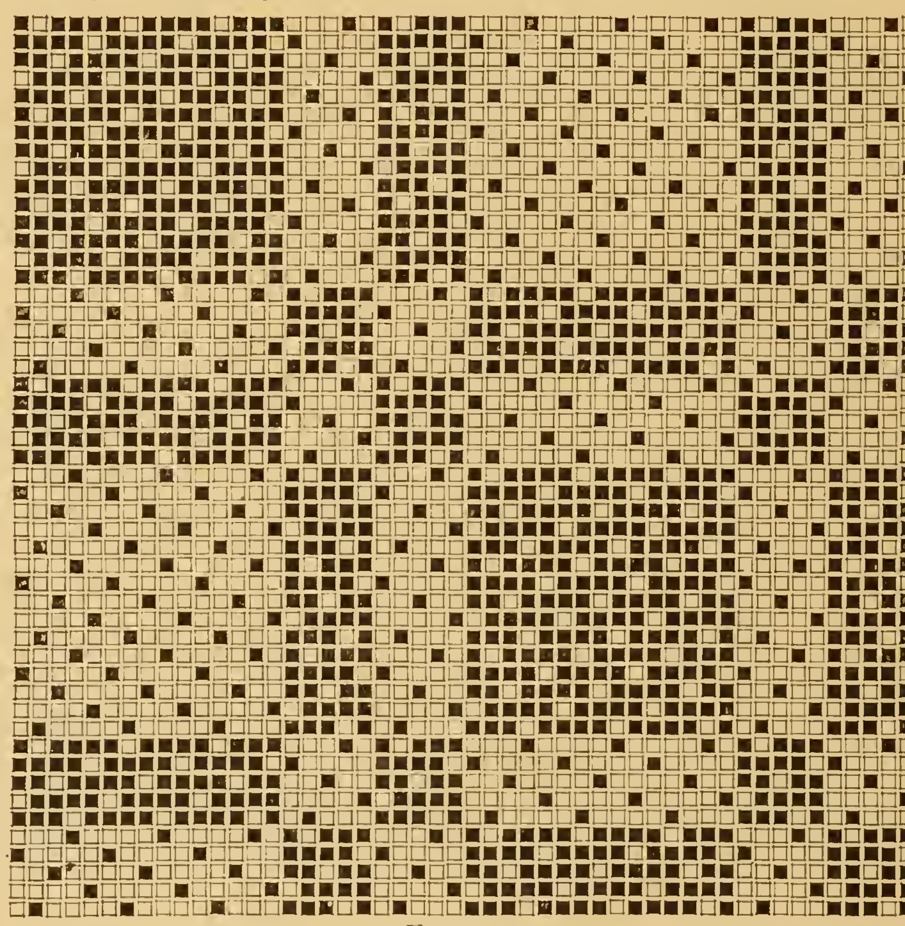


Fig. 130.

Fig. 130 is designed to illustrate a fabric figured with the 5-harness warp and filling satin, and Fig. 131 is designed to illustrate the figuring applied to the 8-harness warp and filling satin.

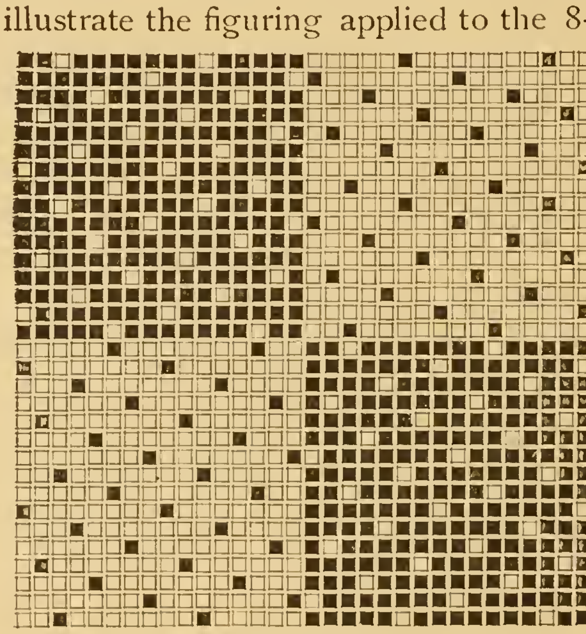


Fig. 131.

Before proceeding with the construction of weaves (derivative weaves from the previously explained foundation weaves), we will next treat of drawing-in drafts, followed by drafting of weaves and reed calculations.

"Drawing in the Warp in its Harness," and the preparation of the drawing-in drafts.

Description of the operation—Methods used for making out a proper drawing-in draft—Different systems of drawing in drafts.

Drawing the warp-threads in the Heddles (which are adjusted to the different Harness frames) forms the beginning of the practical part in weaving; the making out of the order (or arrangement) in which this has to be done, constitutes one of the first lessons in the theory of weaving and designing.

THE HARNESS.

The harness, or harness shaft, also termed a shaft, (see Fig. 132) consists of a "*Frame*" (marked *A*), and the *iron rod* (*B*) for holding the *heddles* (*C*). Through the *eyes* (*D*) of the heddles the warp-threads are drawn as illustrated by *E*.

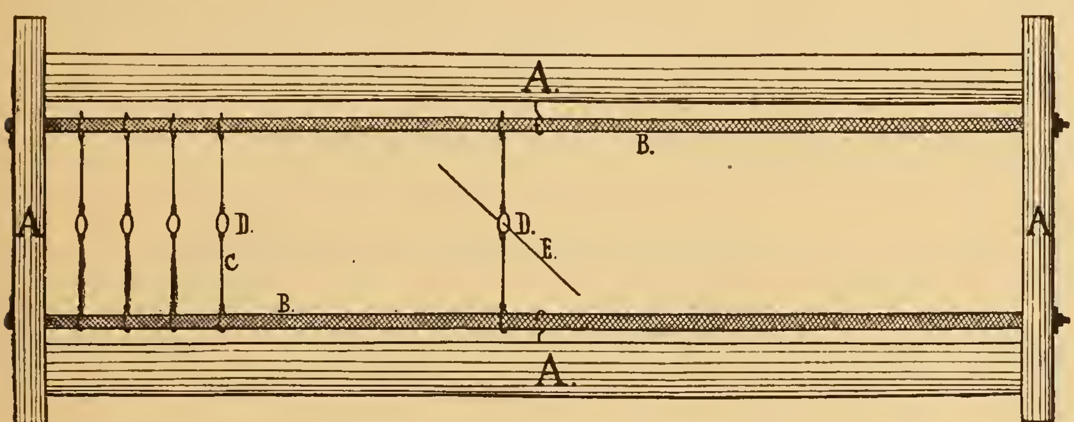


FIG. 132.

For drawing in a warp in its "set of harness," two persons are required. The "*drawer-in*" inserts his "*drawing-in hook*" through the eye of the heddle, towards the second person called the "*hander-in.*" The latter inserts one of the warp-threads in the "*eye* of the hook," which in turn is pulled out of the heddle-eye by the first-mentioned person.

Two different systems are used for drawing-in:

1st. Indicating the harness nearest to the warp beam as the first, the nearest to it as the second, and so on until all harness are used. This method is technically known as "drawing-in from back to front" and is clearly illustrated by Fig. 133.

2d. Indicating the harness nearest the reed as number one, the nearest to it as the second, and so on until all harness are used. This method is technically known as "drawing-in from front to rear," and is illustrated by Fig. 134. (This is the system most generally used in this country).

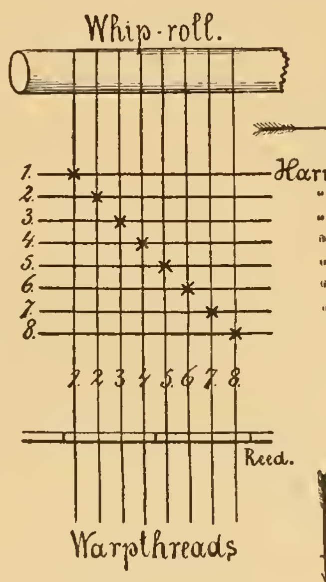


FIG. 133.

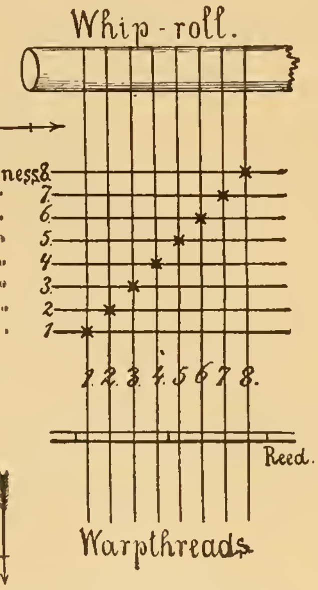


FIG. 134.

Principles of a Drawing-in Draft.

The drawing-in draft must clearly indicate the rotation for drawing the warp-threads in the heddles on the different shafts. This arrangement must be made in accordance with one other of the following methods:

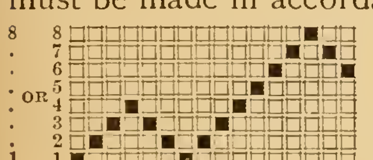


FIG. 135.

A.—It may be made by using common designing paper and indicating the rotation by marks. In employing this method the rotation of the harness must be shown either by numbering the horizontal rows of squares which indicate the harness on the left side of the draft (see Fig. 135), or by placing the word "Front" on the proper place so as to avoid any misunderstanding (see Fig. 136).

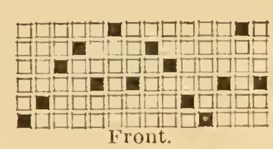


FIG. 136.

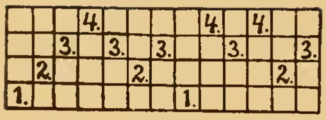


Fig. 137.

B.—Another method is by using the same paper as before for the draft but, in place of the marks, employing numbers indicating the harness to be drawn on (see Fig. 137).

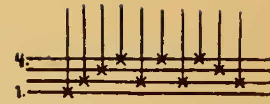


Fig. 138.

C.—A third method is by using horizontally ruled paper for indicating the harness, and drawing vertical lines indicating the warp-threads on the former. The stopping of the vertical lines on one of the different horizontal lines indicates the drawing of the different warp-threads on one of the different harness. The horizontal lines must be numbered (see Fig. 138).

Different Divisions of Drawing-in Drafts.

Drawing-in drafts are in general governed by the different weaves for which they are used, and are divided into "Straight Drawing-in Drafts" and "Fancy Drawing-in Drafts."

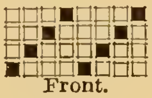
Straight drawing-in drafts are those in which the heddles of the different number of harness the "set" contains are used in rotation; and after the last is used the first is employed over again until all the warp-threads are taken up. For example, in 4-harness we commence to draw in:—

The first	warp-thread	on the	1st	heddle	on the	1st harness.
The second	"	"	1st	"	"	2d "
The third	"	"	1st	"	"	3d "
The fourth	"	"	1st	"	"	4th "
The fifth	"	"	2d	"	"	1st "
The sixth	"	"	2d	"	"	2d "
The seventh	"	"	2d	"	"	3d "
The eighth	"	"	2d	"	"	4th "
The ninth	"	"	3d	"	"	1st "

and so on, until every warp-thread the warp contains is taken up.

Fig 139 illustrates the double repeat of a 4-harness straight drawing-in draft.

Fig 140 illustrates the double repeat of a 6-harness straight drawing-in draft.



Front.

Fig. 139.

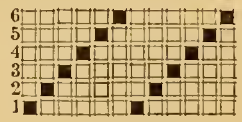


Fig. 140.

Fancy drawing-in drafts are generally used for reducing the number of harness necessary (repeat) for producing a certain kind of weave in a fabric. In looms constructed for certain classes of goods (mostly in cotton) and which can be operated only on plain and common twills with regard to their motion for raising the harness, the fancy draws will often become a necessity.

The method of making out fancy drawing-in drafts for certain weaves, technically known as "drafting," will be dealt with later on.

Sub-Divisions of Fancy Drawing-in Drafts.

A. Broken draws.
B. Point draws.
C. Section-arrangement draws (1st, plain, 2d, double).
D. Skip draws.
E. Mixed draws (cross draws).

A.—Broken Draws.

Drawing-in drafts, graded under this division, have their method of drawing arranged (similar to the principle of the satin weaves) as much as possible broken up, scattered, yet regularly distributed over the repeat of the draft. We also classify under the present division of drawing-in drafts such as are necessary for producing broken-twills, *i. e.*, in which we draw for a certain number of threads from front to rear; next arrange the draw to miss one-half the number of harness, and draw a certain number of threads (as required by the design) from rear to front; next miss again one-half the number of harness, and commence again to draw from front to rear. For example: Fig. 141 illustrates a broken draw for 8-harness. Commence to draw harness 1 to 8 straight through from front to rear twice over, next miss one-half the number of harness = 4, thus: 8 — 4 = 4; commence on harness 4, to be followed by 3, 2, 1, 8, 7, 6, 5, 4, 3, 2, 1, 8, 7, 6, 5; next miss again four harness, giving you harness 1 for starting, to commence to draw from front to rear over again (repeat in the present example).

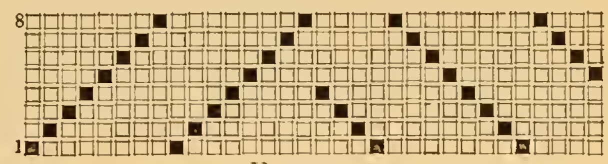


Fig. 141.

The present division of drawing-in drafts finds extensive use in the manufacture of fancy worsted, woolen and cotton goods. On looms known as "roller-looms," "cam-looms," this system of drawing-in drafts forms the only means for weaving satins, corkscrews and similar popular weaves.

Fig. 142 illustrates a broken draw for 4-harness.
" 143 " " " " 5 "
" 144 " " " " 8 "

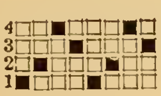


Fig. 142.

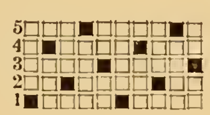


Fig. 143.

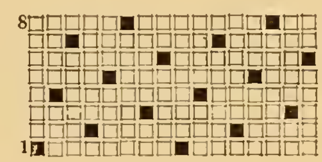


Fig. 144.

B.—Point Draws.

In regular point draws, we draw from front to rear once straight through the entire set of harness, and afterwards draw from rear to front and repeat. For example see Fig. 145. Commence to draw in from the first harness straight through to the last, *A* to *B*, and back again, *B* to *C*. Designs for these drawing-in drafts must be arranged so as to repeat forwards and backwards respectively in the centre.

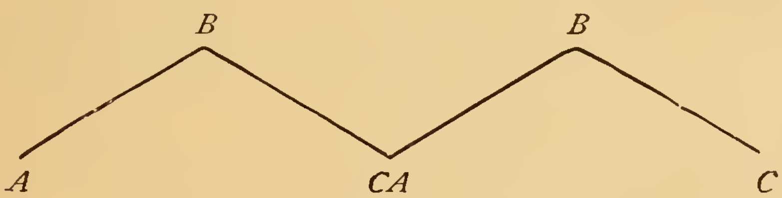
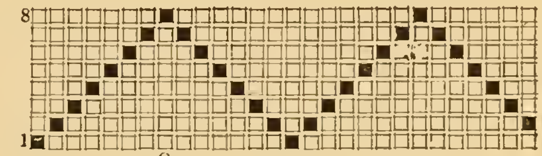


Fig. 145.

Such a weave will run upwards, at a given angle, to a definite point; then it will return by the same angle in an opposite direction until it reaches the base from which it originally started. In these kinds of drawing-in drafts the "point-harnesses" are only once drawn on, while the other harnesses are used twice in one repeat of the weave. Hence an 8-harness regular point draw will require 14 warp-threads for one repeat; a 12-harness regular point draw will require 22 warp-threads for one repeat, and so on; always giving the double number of harness less 2 as the number of warp-threads in one repeat.

Fig 146 illustrates a double repeat of a regular 8-harness point draw. Warp-threads 1, 8, 15, 22 are the point-threads or the warp-threads which are drawn in the heddles on the point harnesses.



Point Warp-threads.
Fig. 146.

A change from the regular point draw, but belonging in its principle of construction to it, are drawing-in drafts in which we draw in one or the other direction (front to rear or rear to front) continually for two, three, four or more times before changing to the other direction.

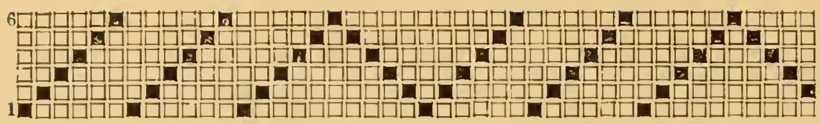


Fig. 147.

Fig. 147 illustrates a specimen of these kind of drafts to be made with 6-harness. An examination will show us a drawing straight three times from front to rear with an additional from rear to front (two repeats shown in draft). A second sub-division of the point draws are point draws containing the effect of a zigzag which are used to a great extent in weaves for fabrics imitating Jacquard work.

Fig. 148 illustrates such a specimen drawing-in on 12-harness.

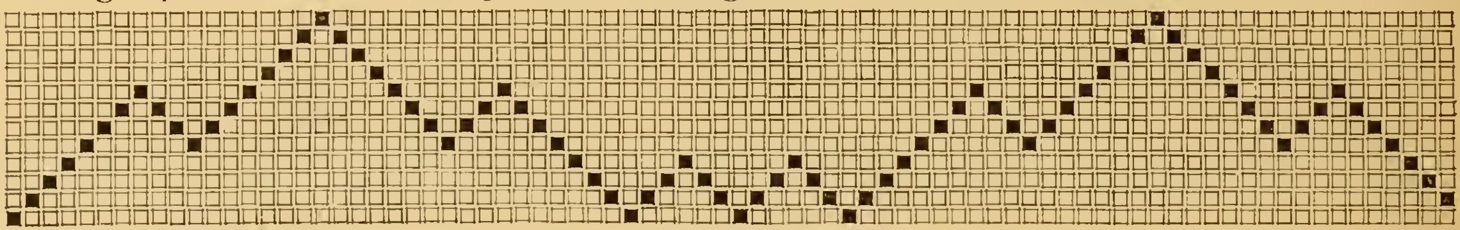


Fig. 148.

C.—Drawing-in Drafts having a Section Arrangement.

1st.—Plain Draw.

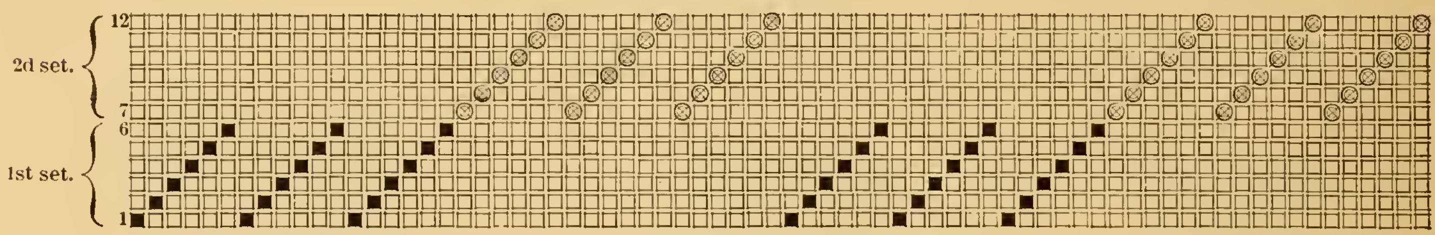


Fig. 149.

These drawing-in drafts are used to a great extent in the manufacture of damask table cloth, towels, fancy cassimeres, worsteds, etc. For these styles of draws two weaves are compounded into one, each one being operated on its own part of the harness set. The manner of using two sections we find frequently extended to three or more sections, requiring a corresponding number of weaves to be compounded into one.

In Fig. 149, we illustrate a specimen of such a kind of drawing-in draft. Harness 1 up to 6, inclusive, forms the first set; harness 7 up to 12, inclusive, forms the second set.

2nd.—Double Draws.

These drawing-in drafts are generally used in weaves for double cloth fabrics. Each system of warp-threads (face and back) getting its own harness set.

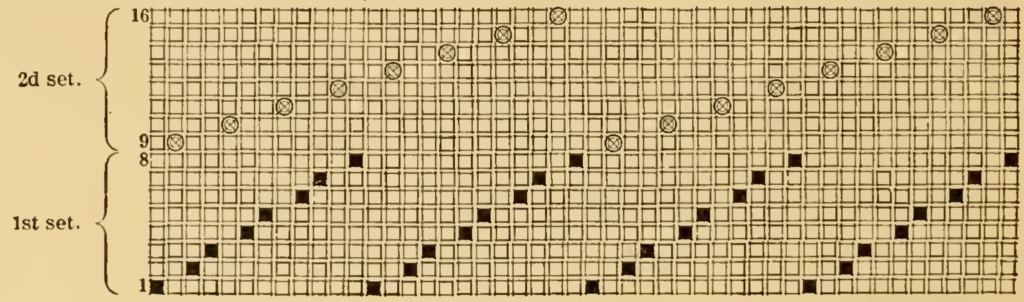


Fig. 150.

Fig. 150 illustrates a drawing-in draft to be classified in this system. 1st set of harness, 1, 2, 3, 4, 5, 6, 7 and 8; 2nd set of harness, 9, 10, 11, 12, 13, 14, 15, and 16.

Fig. 151 illustrates another specimen of drawing-in draft for 12-harness repeat.

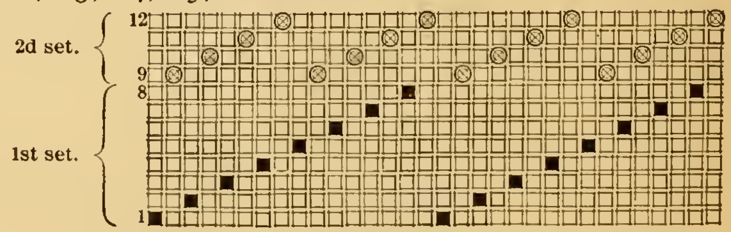


Fig. 151.

D.—Skip Draws.

These draws are in their origin short straight draws in a larger number of harness. After drawing a certain number of warp-threads plain straight, commence anew again, but one, two or more threads higher or lower than the commencement of the preceding draft.

Fig. 152 illustrates such a drawing-in draft for 8-harness, 4 threads for the short straight draw; skipping one thread.

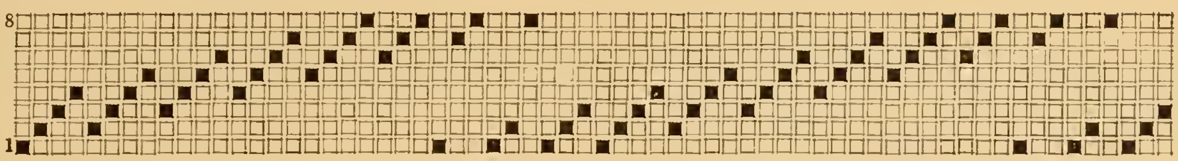


Fig. 152.

E.—Mixed or Cross Draws.

As the variety of different weaves is unbounded, so are also the drawing-in drafts, and under the above heading it is proper to classify the kind of drafts obtained in one way or another, by combining two or more drafts of the previously explained systems.

Other Points a Drawing-in Draft may require in addition to the indications for Drafting a Certain Harness.

If a warp contains threads of different thickness, color, or quality of stock, the drawing-in draft must have a copy of the repeat of pattern, clearly indicating for each warp-thread such particulars (see Fig. 153 for illustration.)

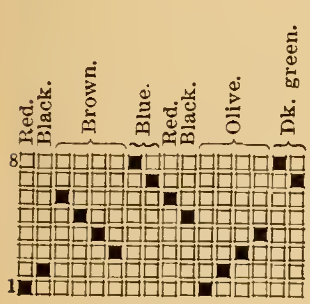


Fig. 153.

The drawing-in draft should further show the number of warp, the number of dresser, the number of ends in warp, the number and width of reed to use, the number of warp-threads to be put in one dent, instructions if any threads in particular have to be separated by the dents (see Fig. 154), and the number of heddles to be put on each harness.

Every one of these points clearly indicated on the draft will greatly assist in the production of correct work, prevent mistakes and save much time. We append a specimen sheet of a complete order for the drawing-in department, such as ought to be used in every mill.

Specimen of a Complete Drawing-in Sheet.

Fancy Cassimere, style 42.

Warp No. 393. 3600 ends in warp. Reed 13 × 4 = 69¼ inches width of warp, in reed.

D. N. 4.

Dressing:			
6	threads	black	4 run.
1	"	white	"
7	"	black	"
1	"	lavender	"
7	"	brown	"
2	"	blue	"

—

24 threads in pattern.

Selvage: 40 threads 1 inch wide in reed for each side.

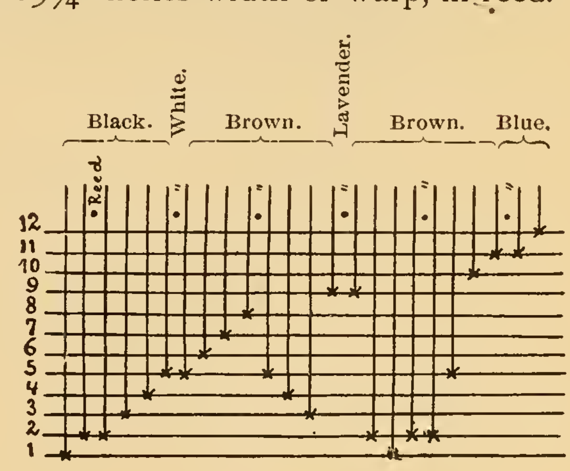


Fig. 154.

Heddles required for the different harness :

Numbers 1, 3, 4, 9, 11, each	300	heddles	=	1500
Number 2, requires	750	"	=	750
" 5, "	600	"	=	600
Numbers 6, 7, 8, 10, 12, each	150	"	=	750
				3600

Having explained the general principles of drawing-in drafts for theoretical and practical work, also their classification, the next subject for the student to learn will be " the drafting of drawing-in drafts " from the different weaves.

Drafting of Drawing-in Drafts from Weaves.

RULE: Ascertain the " repeat " of the weave in the direction of both systems of threads. Next, examine each warp-thread separately (on the design) as to its rotation of interlacing in the filling. If each warp-thread shows different places (different picks) for interlacing, each thread requires a different harness. If there are warp-threads in the repeat of the weave which have throughout the entire number of picks the same intersecting places, they can be drawn on one harness. For example, examine the two warp-threads illustrated in Fig. 155; both are working the same way $(\frac{1}{1}\frac{2}{2}\frac{1}{1})$ in its repeat of 8-picks, consequently these two threads can be drawn on one harness, giving the same result.

FIG. 155.

In Fig 156 we illustrate 3 warp-threads over 16-picks. An examination of the same will show warp-threads marked 1 and 3 interlacing correspondingly with the filling, and hence can be drawn on the same harness ; whereas thread marked 2 works differently, therefore requiring a different harness.

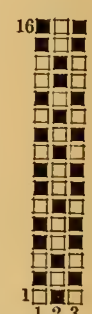


FIG. 156.

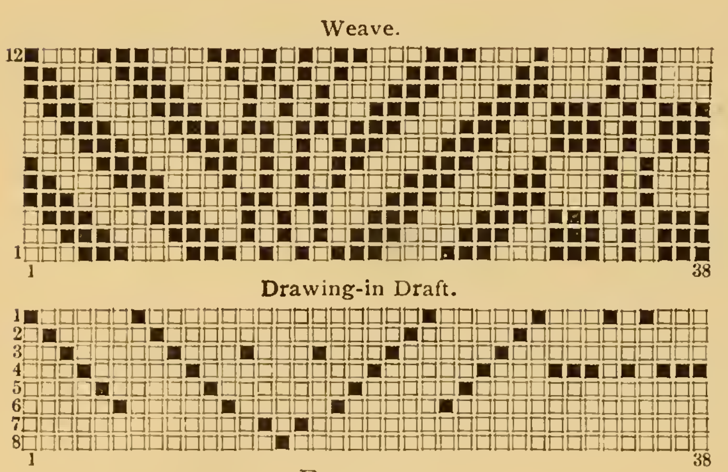


FIG. 157.

With Fig. 157 we illustrate a complete weave (one repeat) with its corresponding drawing-in draft :

38 warp-threads } in repeat.
12 picks }

An examination of each warp-thread in particular will result as follows :

Warp-threads	1, 7, 23, 29, 33, 35	correspond, thus harness	1.
"	2, 8, 22, 28	" " "	2.
"	3, 9, 13, 17, 21, 27	" " "	3.
"	4, 10, 20, 26, 30, 31, 32, 34, 36, 37, 38	" " "	4.
"	5, 11, 19, 25	" " "	5.
"	6, 12, 18, 24	" " "	6.
"	14, 16	" " "	7.

Warp-thread 15 working independent, requires a separate harness; = " 8.

Hence, we find drawing-in draft illustrated below weaves reading as follows:

The 1st	warp-thread	for harness	1.	The 20th	warp-thread	for harness	4.
The 2d	"	"	2.	The 21st	"	"	3.
The 3d	"	"	3.	The 22d	"	"	2.
The 4th	"	"	4.	The 23d	"	"	1.
The 5th	"	"	5.	The 24th	"	"	6.
The 6th	"	"	6.	The 25th	"	"	5.
The 7th	"	"	1.	The 26th	"	"	4.
The 8th	"	"	2.	The 27th	"	"	3.
The 9th	"	"	3.	The 28th	"	"	2.
The 10th	"	"	4.	The 29th	"	"	1.
The 11th	"	"	5.	The 30th	"	"	4.
The 12th	"	"	6.	The 31st	"	"	4.
The 13th	"	"	3.	The 32d	"	"	4.
The 14th	"	"	7.	The 33d	"	"	1.
The 15th	"	"	8.	The 34th	"	"	4.
The 16th	"	"	7.	The 35th	"	"	1.
The 17th	"	"	3.	The 36th	"	"	4.
The 18th	"	"	6.	The 37th	"	"	4.
The 19th	"	"	5.	The 38th	"	"	4.

Some weaves will be found inexpedient to reduce to the lowest number of harnesses, as a drawing-in draft too irregularly distributed will be difficult to comprehend by the operative who uses the same for practical work.

After making out a fancy drawing-in draft for a weave, the design for the "harness-chain" must be prepared.

Rule for Designing the Same:—Reproduce each warp-thread only the first time called for by its drawing-in draft on a different harness. For example: Produce harness-chain for weave and drawing-in draft Fig. 157.

Answer:

The 1st harness must raise and lower as follows (reading downwards):	$\frac{3 \quad 3}{\quad 3 \quad 3}$
The 2d " " " " " " "	$\frac{\quad 3 \quad 3}{1 \quad 3 \quad 2}$
The 3d " " " " " " "	$2 \frac{3 \quad 3}{\quad 3 \quad 1}$
The 4th " " " " " " "	$\frac{\quad 3 \quad 3}{3 \quad 3}$
The 5th " " " " " " "	$\frac{1 \quad 3 \quad 2}{3 \quad 3}$
The 6th " " " " " " "	$\frac{2 \quad 3 \quad 1}{3 \quad 3}$
The 7th " " " " " " "	$\frac{2 \quad 5 \quad 1}{2 \quad 2}$
The 8th " " " " " " "	$\frac{2 \quad 2}{2 \quad 5 \quad 1}$

finding in this manner harness-chain illustrated by Fig. 158.

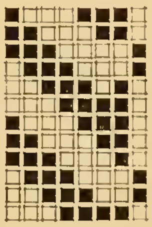


Fig. 158.

RULES FOR ESTIMATING THE NUMBER OF HEDDLES REQUIRED ON EACH HARNESS.

Straight Draws.

RULE: Divide the number of threads the warp contains by the number of harness in the set used.

EXAMPLE: 4800 ends in warp—8-harness straight draw. How many heddles are required for each harness?

Answer: 4800 ÷ 8 = 600; 600 heddles are required for each harness.

If ends remain over the full repeat they are to be added, beginning with harness one until all are taken up. These harnesses will consequently require one more heddle.

EXAMPLE: 4800 ends in warp—9-harness straight draw. How many heddles are required for each harness?

Answer: 4800 ÷ 9 = 533 full straight draws plus 3 threads.

Thus, harness	1, 2, and 3	must contain	534 heddles	(1602)
"	4, 5, 6, 7, 8 and 9	" "	533 "	(3198)
				4800

Fancy Drawing-in Drafts.

RULE: Multiply the number of threads for each harness by the number of pattern repeats in the entire warp.

EXAMPLE:—3200 ends in warp on the following drawing-in draft:

32 threads in one pattern.

3200 ÷ 32 = 100 repeats of pattern in warp.

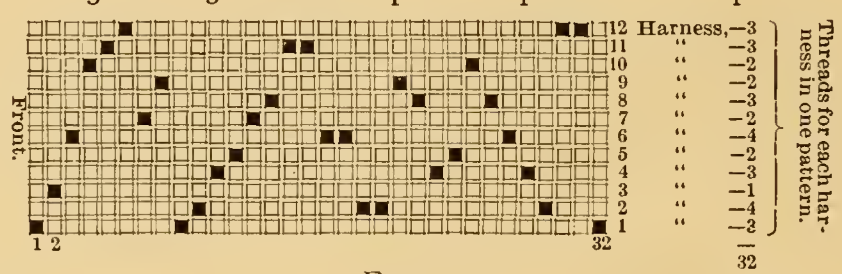


FIG. 159.

No. of Harness.	Threads per Pattern.	× 100 Repeats.	= Heddles.
1	3	"	300
2	4	"	400
3	1	"	100
4	3	"	300
5	2	"	200
6	4	"	400
7	2	"	200
8	3	"	300
9	2	"	200
10	2	"	200
11	3	"	300
12	3	"	300
	32		3200

The repeat of the pattern will not always divide into the number of the ends in the warp. Sometimes it will leave a fraction over, which we have to add separately. For example, taking the drawing-in draft as before, and supposing the number of ends for the warp to be 3206. This will give us the 100 repeats of pattern as before, plus 6 ends. Numbers 1, 3, 6, 10, 11 and 12-harness call for the first 6 warp-ends in the pattern, hence:

Number 1	harness	will	call for	301	heddles.
" 3	"	"	"	101	"
" 6	"	"	"	401	"
" 10	"	"	"	201	"
" 11	"	"	"	301	"
" 12	"	"	"	301	"

Harness 2, 4, 5, 7, 8 and 9 will remain the same as before.

THE REED.

The reed consists of two horizontal strips of wood, between which a series of narrow strips of metal (flat steel wire) are bound in.

After a warp is "drawn in its harness," it has to be "reeded;" one, two, three or more ends together are drawn in one dent or split of the reed. The purpose of the reed is, First: To guide the warp-threads after leaving the harness, holding the same during the entire width and length of the fabric evenly divided. Second: To strike the filling in evenly divided places all over the width of the fabric in beating up.

The height of a reed (distance between both horizontal strips) varies according to the fabric it is used for.

Silk fabrics	requiring	2½	to 3	inches height.
Cotton fabrics	"	2½	to 3¼	" "
Woolen fabrics	"	4	to 4½	" "
Carpets	"	4½	to 5	" "

It is advisable to have the height of a reed ¼ to ⅜ inch higher than the highest lift of any thread in the fabric. It will never do to have this height lower than any thread of the upper shed lifts, as this would chafe the warp. The reed has to be movable the least bit in the width of the lay, but is required to be steady towards front and back in almost every kind of fabric; except in the manufacture of turkish towelings, or similar textile fabrics, in which the reed is required to give way in a backward direction regulated by springs.

To get perfect work the reeds must be evenly set, the wires must stand parallel with the warp and the wire must be neither too thick, nor too thin, too wide or too narrow for the work. The "riding" of threads can often be helped by different number of threads per dent, or by taking different parts of the pattern in the same dent.

REED CALCULATIONS.

The reed is named by numbers, the number in each case indicating how many splits are in each inch. Thus a number 8 reed means a reed with 8 splits in every inch over the required width. If we call for number 16½ reed, we want a reed having 16½ splits in one inch, equal to 33 dents in every 2 inches over the entire width of the fabric. Whole numbers or half numbers alone are used for grading of reeds.

Example: Suppose we have a number 9 reed, 4 threads in one split or dent, how many ends are in one inch? How many are in a full warp if 70 inches wide in reed?

Answer: $9 \times 4 = 36$ ends of warp in one inch.
$\times$ 70 width of warp in reed
2520 ends in warp.

Hence, we find as a rule for ascertaining the number of ends in the warp, if the reed number, the threads per dent and the width of the warp in reed are known, the following:

Multiply the reed number by the threads per dent, and multiply the result by the width of the warp in reed.

Example: How many ends are in the warp if using 13½ reed, 6 threads per dent, 80 inches wide in reed?

Answer: $13\frac{1}{2} \times 6 = 81 \times 80 = 6480$ ends in warp.

The next process will be to ascertain the reed number, if the number of ends in the warp and the width in the reed are known, the threads per dent either given or to be selected according to the fabric.

RULE: Divide the number of ends in the warp by the width in the reed, which gives the number of threads per inch.

Divide this result again by the number of threads in one dent according to the weave or pattern required.

EXAMPLE: 6480 ends in warp, 80 inches wide in reed.

1st. How many ends per inch?

2d. What reed number required if 6 ends per dent are to be used?

Answer: $6480 \div 80 = 81$ ends per inch.

$81 \div 6 = 13\frac{1}{2}$, number of reed required.

It will be easily understood, how to find the width of the warp in the reed. Supposing the reed number, the threads per dent, and the number of threads in the warp are known:

RULE: Divide the number of ends in the warp by the number of ends per inch, giving as the result the number of inches the warp will be in the reed.

EXAMPLE: Reed 12×3=3600 ends in warp. What width will this fabric have in the reed?

Answer: $12 \times 3 = 36$ ends per inch.

$3600 \div 36 = 100$ inches width of fabric in reed.

The number of ends to put in one dent has to be regulated according to the fabric and the weave. Experience is the only guide for this. The coarser the reed, to a certain extent, the easier the picks go into the fabric. The finer the reed, the smoother the goods, and with perfect reeds the less reed marks.

The same number of ends are not always used in each dent, but the preceding rules may be used for finding the average number of threads per dent.

EXAMPLE: What are the threads per inch?

Reed number 20

using 1 dent, 4 ends
1 " 5 "

Answer: $4 + 5 = 9$ $9 \div 2 = 4\frac{1}{2}$ threads, average per dent, $\times$ 20 number of reed = 90 threads per inch.

EXAMPLE: What are the threads per inch?

Reed number 18

using 1 dent, 3 ends
1 " 4 "
1 " 3 "
1 " 6 "

Answer: $3 + 4 + 3 + 6 = 16$ threads in four dents.

$16 \div 4 = 4$ threads, average per dent, $\times$ 18 number of reed=72 threads per inch.

Sometimes it happens that the average number of threads includes an inconvenient fraction. To avoid a calculation with this fraction, multiply the sum of the contents of the dents by the dents per inch, and then divide by the dents per set.

EXAMPLE: What are the threads per inch, warp reeded as follows in number 12 reed:

1 dent, 5 threads.
1 " 3 "
1 " 3 "

$3 + 3 + 5 = 11 \times 12 = 132$.

$132 \div 3 = 44$ threads per inch.

Derivative Weaves.

FROM THE PLAIN OR COTTON WEAVE.

I. Common Rib-Weaves.

This sub-division of the "plain" or "cotton" weave is classified into two distinct divisions, namely, weaves forming the face of the fabric by the warp (warp effects), and weaves forming the face of the fabric by the filling (filling effects).

Warp Effects.

The principle observed in constructing these weaves is to allow more than one pick to follow in succession into the same shed of a regular plain weave. This will require a high texture for the warp in fabrics which are interlaced with them. The first common rib-weave to be formed is the change in 2, as represented in Fig. 160, requiring for its repeat 2 warp-threads and 4 picks.

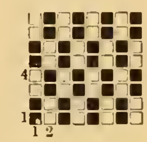


Fig. 160.

Picks 1 and 2 are interwoven in the first shed of the plain weave; picks 3 and 4 are interwoven in the other. Fig. 161 shows a clearly drawn out diagram of this weave and the corresponding interlacing of warp and filling in a fabric.

Fig. 162 illustrates the section cut of the woven fabric.

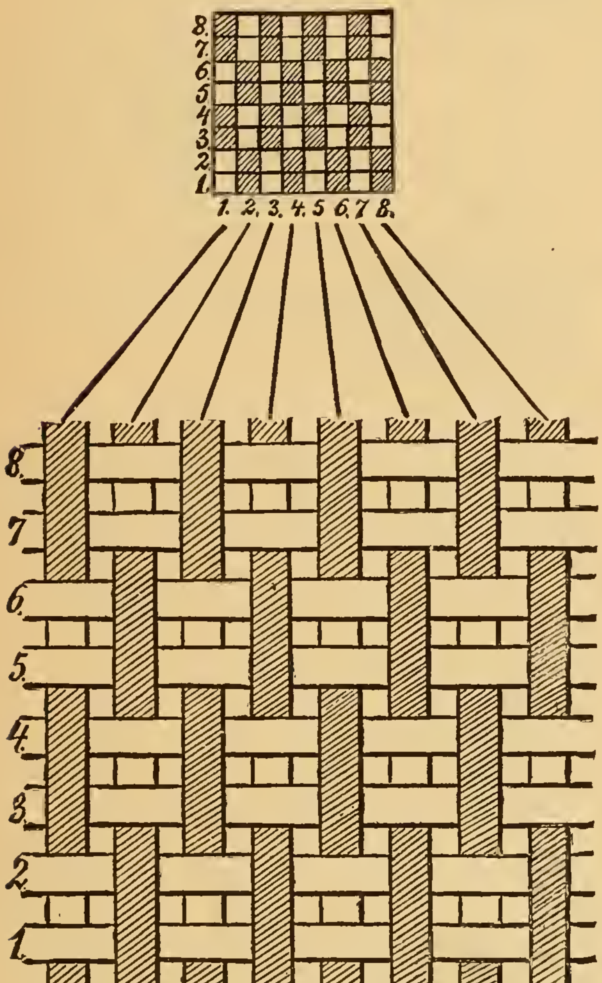


Fig. 161.

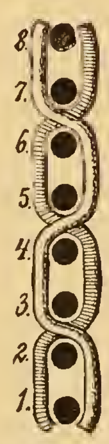


Fig. 162.

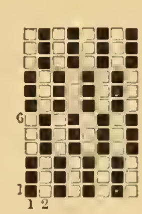


Fig. 163.

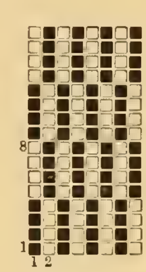


Fig. 164.

Fig. 163 illustrates the common rib-weave as obtained by a change of 3 in the filling, thus requiring for its repeat 2 warp-threads and 6 picks.

Fig. 164 illustrates the change of 4 picks in a shed for constructing the next common rib-weave, requiring for its repeat 2 warp-threads and 8 picks.

Weaves Figs. 160, 163 and 164 require for their repeat warpways, 2 threads, and therefore 2 harness, which number, in practical work on the loom, will by reason of the high texture of warp generally used be increased to 4, 6, 8 or 12 harness, with a corresponding repetition 2, 3, 4 or 6 times of the design, for the warp-threads.

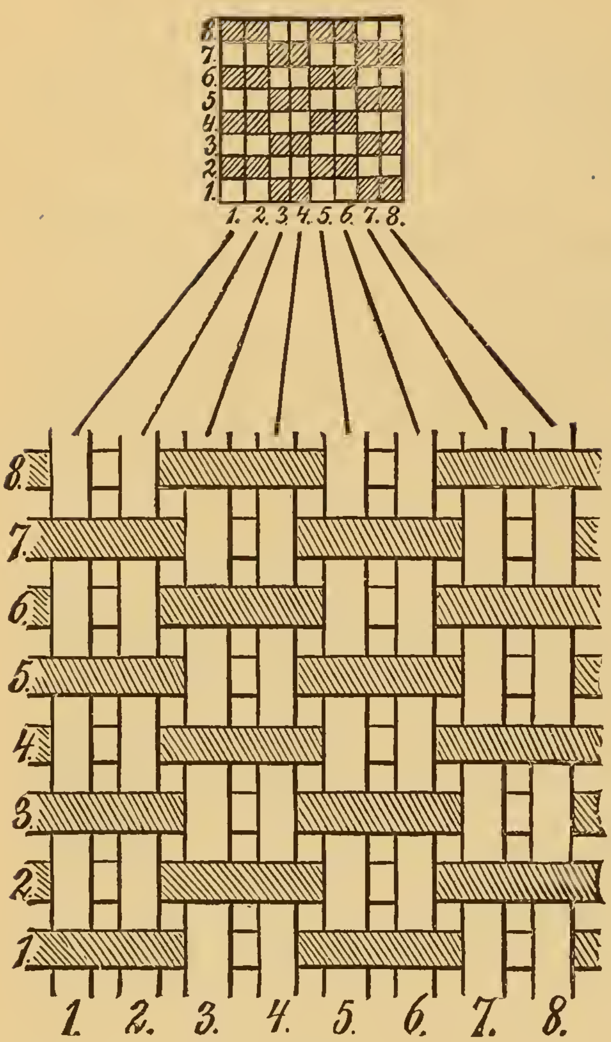


FIG. 166.

Filling Effects.

In these weaves every pick intersects alternately over and below two or three or more warp-threads; therefore being in its principle nothing more than the common "plain" weave, with two, three or more threads used instead of one in the plain weave. In their general appearance these weaves are the same as the warp effects of the same class of weaves previously explained except that the warp exchanges with the filling. As fabrics constructed with these weaves have the filling for face, a correspondingly high texture of the latter is required. The "ribs," as produced by these weaves, are formed in vertical direction, or in the direction of the warp-threads in the fabric, while in the former division, classified as warp effects, this direction is opposite—that is, in the direction of the filling.

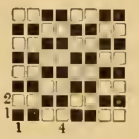


FIG. 165.

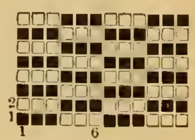


FIG. 167.

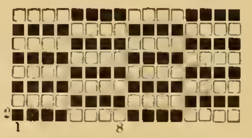


FIG. 168.

Fig. 165 illustrates the change for two warp-threads in succession, interlacing with one pick.

Fig. 166 shows a diagram illustrating the 4-harness rib-weave and the corresponding interlacing of warp and filling in a fabric.

Fig. 167 illustrates the change for three warp-threads.

Fig. 168 illustrates the change for four warp-threads.

Weave Fig. 165 has for its repeat 4 warp-threads and 2 picks.

Weave Fig. 167 has for its repeat 6 warp-threads and 2 picks.

Weave Fig. 168 has for its repeat 8 warp-threads and 2 picks.

But each weave can be made, if required, on 2-harness by drawing warp-threads interlacing the same in the filling on 1-harness.

II. Common Basket-Weaves.

These are a combination of the common rib-weaves, warp and filling effect, having the same changes. Therefore, the principle of their construction will readily be found in the enlargement, warp and filling-ways, of the common plain weave. The first or most simple basket-weave to be found is produced by the exchanging of two successive warp-threads with two successive filling-threads, alternately up and down; or an equal combination of rib-weaves, Figs. 160 and 165.

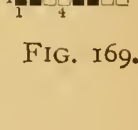


FIG. 169.

Fig. 169 illustrates this basket-weave, requiring for the repeat four warp-threads and four picks.

Warp-threads 1 and 2 are the first mate-threads.

Warp-threads 3 and 4, the second.

Picks 1 and 2 are the first mate-picks.

Picks 3 and 4, the others.

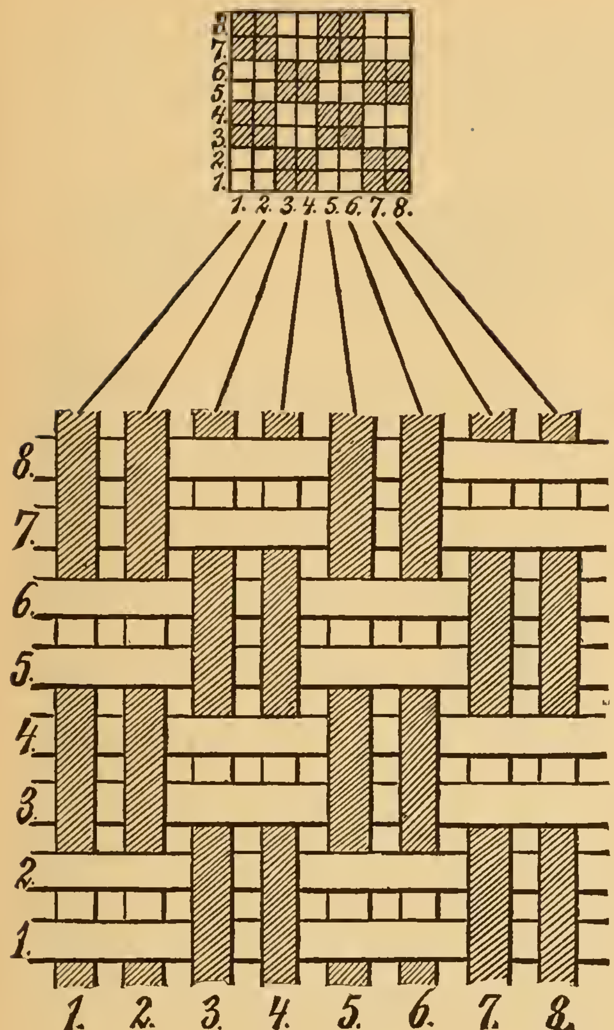


FIG. 170.

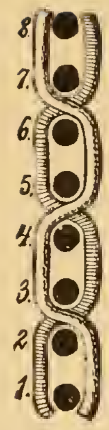


FIG. 171.

Fig. 170 shows a diagram illustrating the 4-harness basket-weave, and the corresponding interlacing of warp and filling in a fabric. Fig. 171 illustrates the section cut of the woven fabric.

Fig. 172 illustrates the common 6-harness basket-weave, having three successive warp and filling-threads working the same, and forming also a combination of weaves, Figs. 163 and 167.

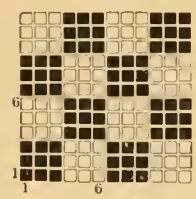


FIG. 172.

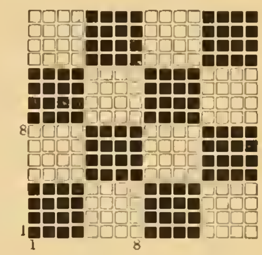


FIG. 173.

Fig 173 represents the common 8-harness basket-weave, with four successive warp-threads working the same, and also illustrates a combination of weaves, Figs. 164 and 168.

III.—Fancy Rib-Weaves.

Warp Effects.

The first step towards designing fancy rib-weaves is the combination of the regular "plain" weave with its subdivision the common rib-weave.

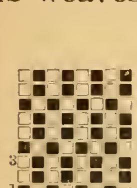


FIG. 174.

Fig. 174 is designed to illustrate the combination of one pick "plain" to alternate with two picks of the common rib-weave; or in other words, to put one pick in one shed, and two picks in the other shed of a regular plain weave.

Fig 175 illustrates the diagram of this weave with a corresponding illustration of the interlacing of warp and filling in a fabric.

Fig. 176 illustrates the section cut of the woven fabric. In its appearance in the

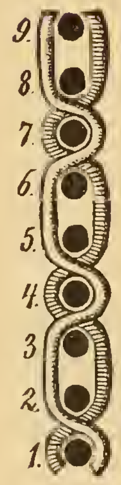


FIG. 176.

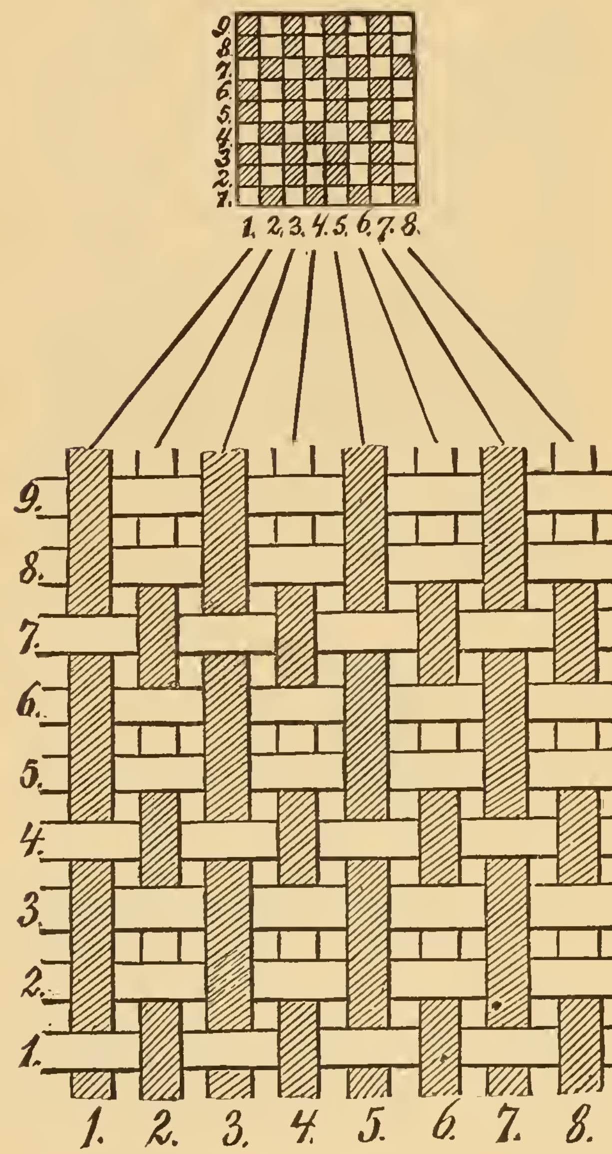


FIG. 175.

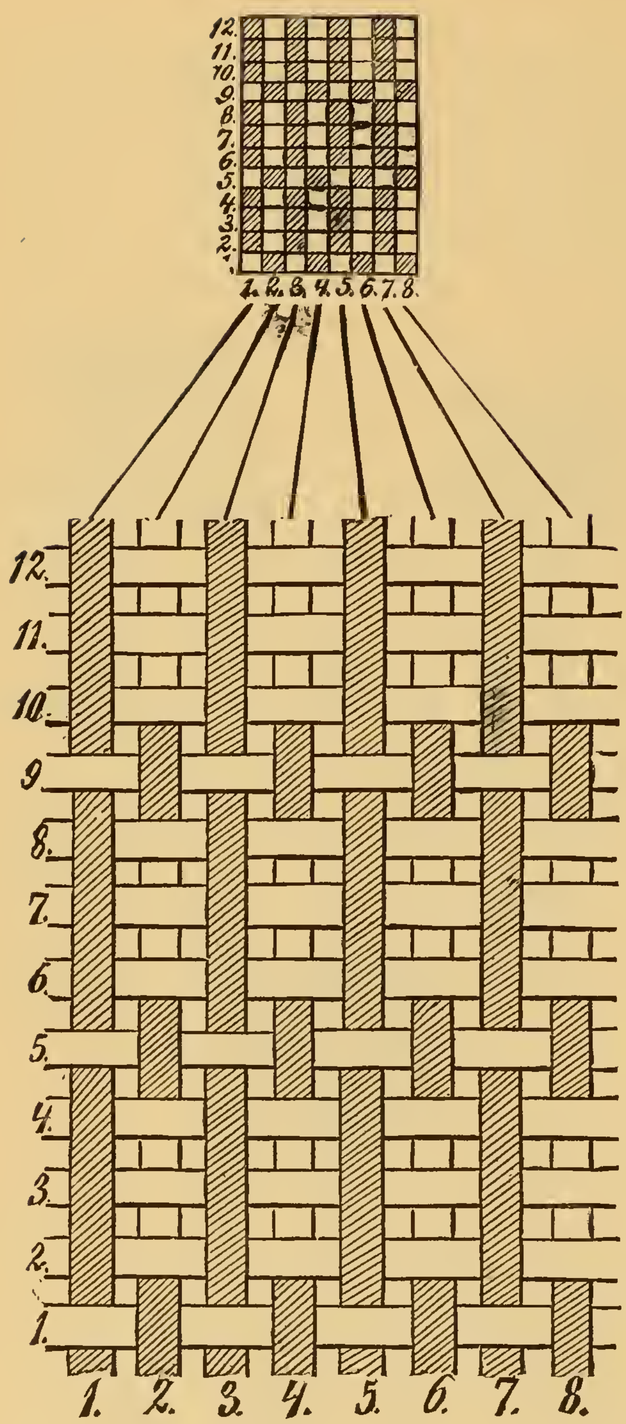


Fig. 178.

woven fabric this weave, as well as the following similarly constructed weaves, will produce the fancy effect by alternately exchanging heavy and fine rib lines.

Fig. 177 illustrates the change as to the size of the rib produced by one pick in one rib to alternate with three picks in the other rib. Repeat of weave: 2 warp-threads, and 4 picks.

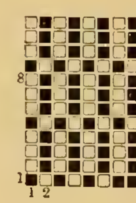


Fig. 177.

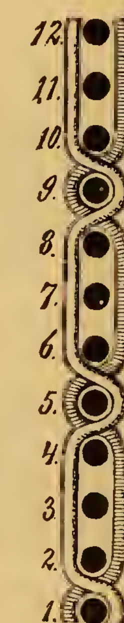


Fig. 179.

Fig. 178 illustrates the diagram of the weave, with a corresponding illustration of the interlacing of warp and filling in a fabric.

Fig. 179 illustrates the section cut of the woven fabric.

Fig. 180 illustrates a fancy rib-weave having two picks in one shed, to alternate with three picks in the other shed. Repeat of weave: 2 warp-threads and 5 picks.

Fig. 181 illustrates a fancy rib-weave as produced by a change of the shed of 1, 1 and 3 picks or two changes of the plain weave and one change of three picks in the same shed.

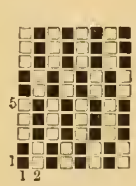


Fig. 180.

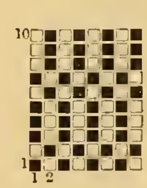


Fig. 181.

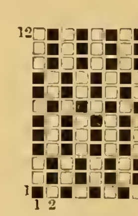


Fig. 182.

Fig. 182 illustrates the combination of three different ribs, (as to its size) or the changes for picks in one shed, as 1, 2, 3. Repeat of weave: 2 warp-threads and 12 picks.

Filling Effects.

In fabrics produced with these weaves, the rib-lines run in the direction of the warp-threads in the fabric. The face and back of the fabric will be produced with the filling, the warp forming the centre.

Fig. 183 illustrates the combination of one warp-thread in one filling change, to alternate with one filling change containing two warp-threads.

Fig. 184 illustrates the warp change of 1 and 3 in a fancy rib-weave. Repeat of weave: 4 warp-threads and 2 picks.

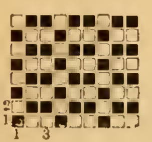


FIG. 183.

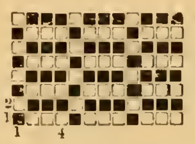


FIG. 184.

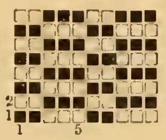


FIG. 185.

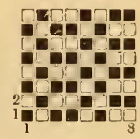


FIG. 186.

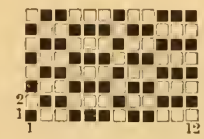


FIG. 187.

Fig. 185, with a change of 2 and 3 in its construction, requires for its repeat 5 warp-threads and 2 picks.

Fig. 186, with a change of 1, 1, 2, requires for the repeat of the weave 8 warp-threads and 2 picks.

Fig. 187, constructed by means of change 1, 2, 3, requires for the repeat of the weave 12 warp-threads and 2 picks.

IV. Fancy Basket-Weaves.

These weaves are obtained by combining common basket-effects of different sizes in one design. They also have their principle of construction in the combination of corresponding warp and filling effects of the fancy rib-weaves.

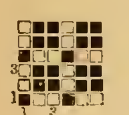


FIG. 188.

Fig. 188 illustrates the fancy basket-weave produced with an alternate change of one and two threads, warp and filling ways. Repeat: 3 warp-threads, 3 picks.

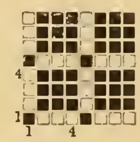


FIG. 189.

Fig. 189 is produced by the alternate changes of one and three threads, warp and filling ways. Repeat: 4 warp-threads, 4 picks.

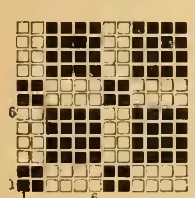


FIG. 190.

Fig. 190 illustrates a fancy basket-weave of a construction twice as heavy as the weave illustrated in Fig. 188, or the alternate changes of two and four, warp and filling ways. Repeat: 6 warp-threads, 6 picks.

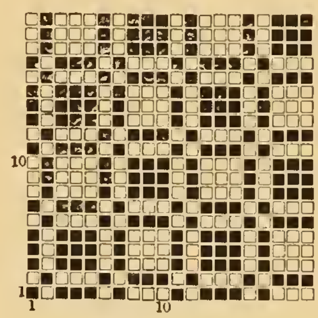


FIG. 191.

Fig. 191 illustrates a fancy basket-weave produced with a change of 3, 1, 1, for warp and filling. Repeat: 10 warp-threads, 10 picks.

This weave will also indicate an important point in the construction of fancy basket-weaves with regard to their repeat. If changes are required, and warp and filling ways are of an uneven number, the repeat for warp and filling threads will be double the number of threads called for in those changes. For example take the present weave. Changes for warp and filling are 3, 1, 1. Thus, as three is an uneven number, we find $3 + 1 + 1 = 5 \times 2 = 10$ threads of warp and 10 picks necessary for one complete repeat.

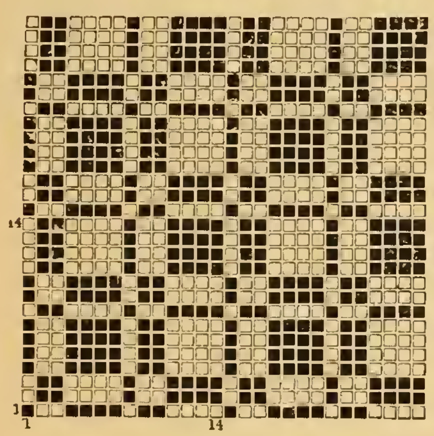
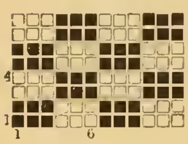


FIG. 192.

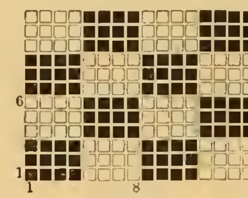
Fig. 192 illustrates a fancy basket-weave having for its foundation the change of 1, 2, 4 for warp and filling. Repeat: 14 warp-threads, 14 picks.

In addition to basket-weaves made with even changes for warp and filling, it may often be necessary to construct this division of weaves in one system heavier than in the other. The reason for constructing basket-weaves in this manner is found either in the difference of textures of warp and filling, or because of the different counts of yarn for the warp and filling. Figs. 193 and 194 illustrate two weaves constructed in this manner.



Repeat { 6 warp-threads. 4 picks.

Fig. 193.



Repeat { 8 warp-threads. 6 picks.

Fig. 194.

V. Figured Rib-Weaves.

These are the combination of common and fancy rib-weaves so as to produce a new weave. The following few examples, with the corresponding explanations, will illustrate methods by which each rib-weave (as numerous as they can possibly be constructed in plain and fancy) can be varied in an endless manner. The first step towards figuring will be to change the rib-line in a common rib-weave after a certain number of warp-threads. Figs, 195, 196 and 197 are designed for the purpose of illustrating this method.

Fig. 195 contains for its principle the common rib-weave, Fig. 160, ^{2}——$_{2}$. The rib is arranged for one pick higher for every six successive warp-threads. Repeat: 24 warp-threads and 4 picks. Thus, as 4 picks form the repeat for the common rib, find the number of warp-threads required for the full design as follows: Successive warp-threads, × number of changes, = warp-threads required for full design. $6 \times 4 = 24$.

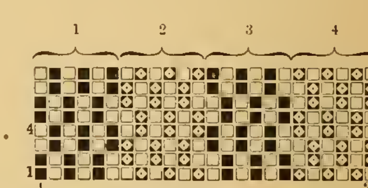


Fig. 195.

Fig. 196 contains for its principle of construction the common rib-weave, Fig. 163, ^{3}——$_{3}$. The rib is again arranged for two picks higher for every six successive warp-threads. Repeat: 18 warp-threads and 5 picks.

Fig. 197 contains for its construction the common rib-weave, Fig. 164, ^{4}——$_{4}$. The rib is arranged two picks higher for every eight successive warp-threads. Repeat: 32 warp-threads and 8 picks.

Figs. 198, 199, 200 and 201 illustrate a second division of figured rib-weaves, having for their foundation fancy rib-weave warp effects.

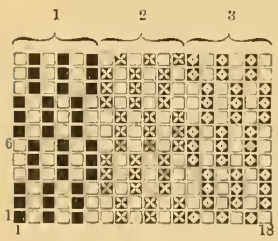


Fig. 196.

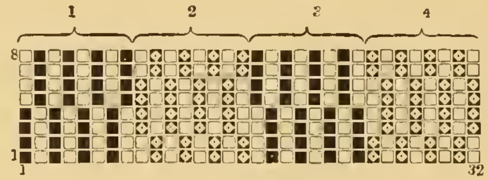


Fig. 197.

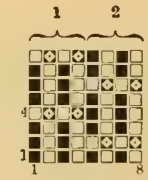


Fig. 198.

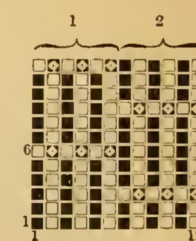


Fig. 199.

Fig. 198 is constructed out of the regular fancy rib-weave, ^{3}——$_{1}$ (see Fig. 177). Repeat: 8 warp-threads and 4 picks.

Fig. 199 is constructed out of the regular fancy rib-weave, ^{5}——$_{1}$. Repeat: 12 warp-threads and 6 picks.

Fig. 200 is constructed out of the regular fancy rib-weave, ^{4}——$_{2}$. Repeat: 24 warp-threads and 6 picks.

Fig. 201 is constructed out of the regular fancy rib-weave, ^{6}——$_{2}$, with four changes in the repeat, each change 8 warp-threads, thus: repeat 32 warp-threads and 8 picks.

Figs. 202 and 203 illustrate a third sub-division of the figured rib-weaves, having for their foundation the fancy rib-weave filling effect.

Fig. 202 is constructed out of the regular fancy rib-weave, $_{3}\text{——}^{1}$. Repeat: 4 warp-threads and 8 picks.

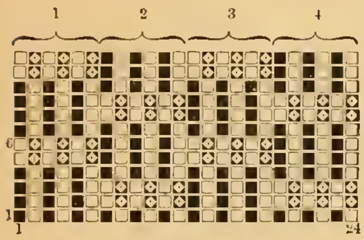


FIG. 200.

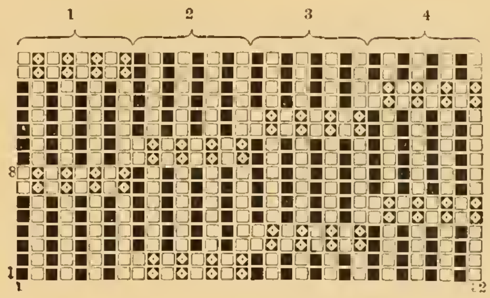


FIG. 201.

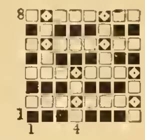


FIG. 202.

Fig. 203 is constructed out of the regular fancy rib-weave, $_{4}\text{——}^{2}$. Repeat: 6 warp-threads and 12 picks.

The next method for the designing of figured rib-weaves is the combination of the warp and the filling effects of the common rib-weaves. We may select both effects correspondingly, or combine two different effects.

Fig. 204 illustrates the combination of the common rib-weave, $^{4}\text{——}_{4}$, warp effect, with the common rib-weave, $_{4}\text{——}^{4}$, filling effect. Each effect is arranged for a repeat of 8 warp-threads and 8 picks. Repeat of complete weave: 16 warp-threads and 16 picks.

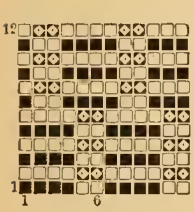


FIG. 203.

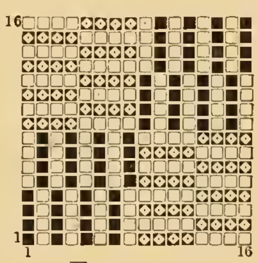


FIG. 204.

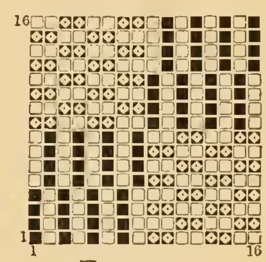
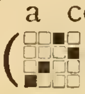


FIG. 205.

Fig. 205 illustrates the combination of the common rib-weave $^{4}\text{——}_{4}$, warp effect with the common rib-weave $_{2}\text{——}^{2}$, filling effect. Each effect is arranged for a repeat of 8 warp-threads and 8 picks. Repeat of combination design: 16 warp-threads and 16 picks. These changes of warp and filling effects may also be arranged after the shape of a certain weave. For example, Fig. 206, which is arranged after the 4-harness broken twill ().

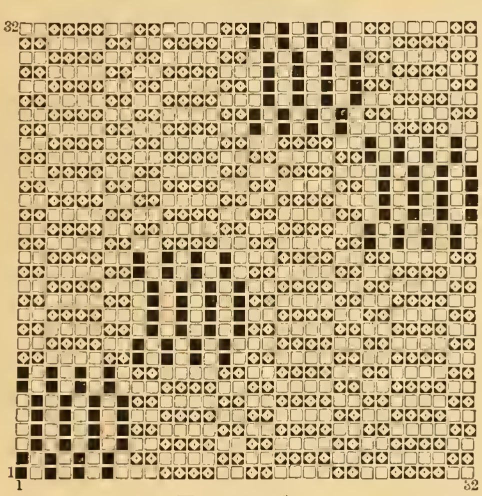


FIG. 206.

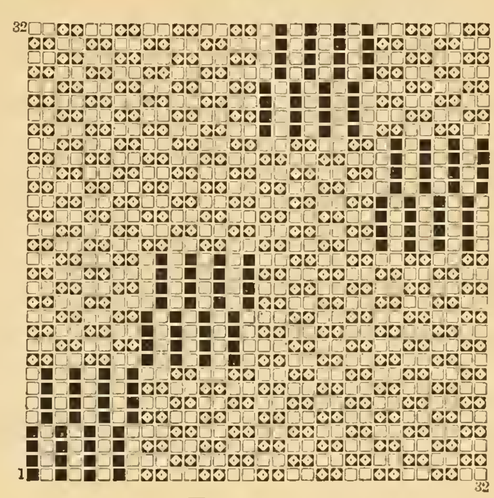


FIG. 207.

For warp and filling face the same fancy rib-weave ($^{2}\text{—}_{4}\text{—}^{2}$) is used. Each change in effect (after the 4-harness twill, as mentioned before) is arranged for 8 warp-threads and 8 picks repeat. Repeat of weave: 32 warp-threads and 32 picks.

Fig. 207 also has for its principle the four-harness broken twill. Two different common rib-weaves are used in its construction, as follows: For the warp effect $^{4}\text{———}_{4}$; for the filling effect $_{2}\text{———}^{2}$. Each change in effect is arranged for 8 warp-threads and 8 picks repeat. Repeat of weave: 32 warp-threads and 32 picks repeat.

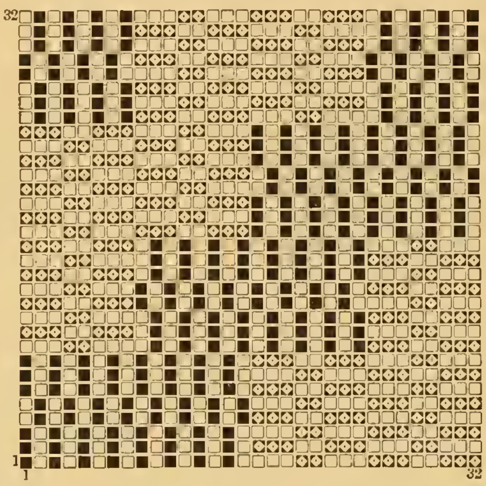


Fig. 208.

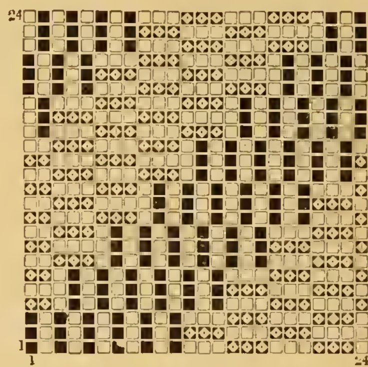


Fig. 209.

Fig. 208 illustrates a figured rib-weave having warp and filling changes equal ($^{3}\text{—}_{2}\text{—}^{3}$), and with systems of effects arranged to exchange in the shape of the 4-harness even-sided twill. (). Repeat: 32 warp-threads and 32 picks.

Fig. 209 illustrates warp and filling changes equal ($^{3}\text{———}_{3}$), both arranged to exchange in the shape of an even-sided twill. Examples 204 to 209 will indicate the great variety for figured rib-weaves. An endless number of them could easily be constructed.

In the beginning of our explanation of the common rib-weaves, we mentioned that in "warp effects" the warp forms the face and back of the fabric and the filling rests in its centre, while in "filling effects," the filling produces the face and back and the warp rests in its centre. To improve or increase the strength of the fabric we may interlace the warp or filling threads floating on the back of the fabric on an extra weave. Figs. 210, 211 and 212 are designed to give a clear illustration.

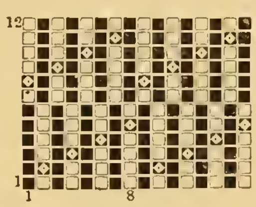


Fig. 210.

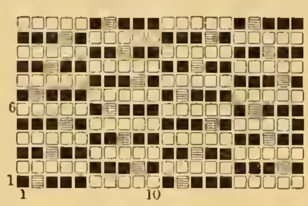


Fig 211.

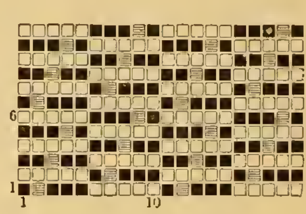


Fig. 212.

Fig. 210 illustrates the common $^{6}\text{———}_{6}$ rib-weave (warp effect), having its warp-threads, as they float on the back, interlace in rotation once more with the filling, and thus giving additional strength to the fabric.

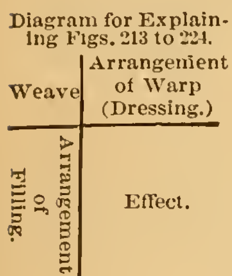
Fig. 211 illustrates the common $_{5}\text{———}^{5}$ rib-weave (filling effect). The filling, when floating on the back of the fabric, is arranged to interlace additional, after the manner of a broken twill.

Fig. 212 illustrates this additional interlacing arranged with the same twill for each rib.

Effects Produced by Using two or more Colors in Warp and Filling of Fabrics interlaced upon Rib and Basket-Weaves.

Rib and Basket-weaves are frequently used for producing various effects by different combinations of colors in warp and filling. We will describe a few of the effects most frequently used, thus giving the student the necessary points for the construction of any effect he may have occasion to produce.

Fig. 213 illustrates an effect derived by a color arrangement of the warp (dressing), 1 end light, 1 end dark, and a color arrangement of the filling, 2 picks light 2 picks dark, upon a fabric interlaced with the common rib-weave (warp effect) ^{2}——$_{2}$.



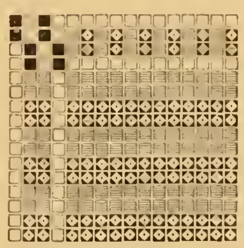


FIG. 213.

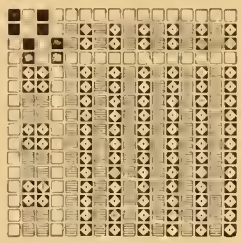


FIG. 214.

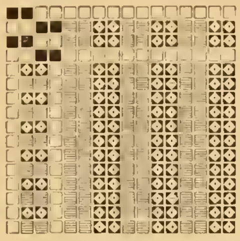


FIG. 215.

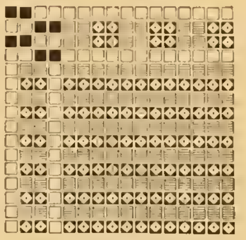


FIG. 216.

Fig. 214 illustrates the same weave and the same arrangement of the warp as Fig. 213. The arrangement of the filling is also, 2 picks dark, 2 picks light, as used in Fig. 213, but is started on the opposite shed. In Fig. 213 the light filling covers the dark warp and the dark filling covers the light warp, and the effect produced are lines across the width of the fabric, (in the direction of the filling), each line having the size of two successive picks; in Fig. 214 the light filling covers the light warp and the dark filling covers the dark warp, forming for effect a hair-line.

Fig. 215 illustrates a heavier hair-line obtained with the common rib-weave filling effect $_{2}$——^{2}. Arrangement for the warp: 2 ends light, 2 ends dark. Arrangement for the filling: 1 pick dark, 1 pick light, each style of warp covered by its own colored filling.

Fig. 216 illustrates the tricot effect produced on the same rib-weave as Fig. 215; also the same color arrangement for warp and filling, except that the light filling covers the dark warp, and the dark filling covers the light warp.

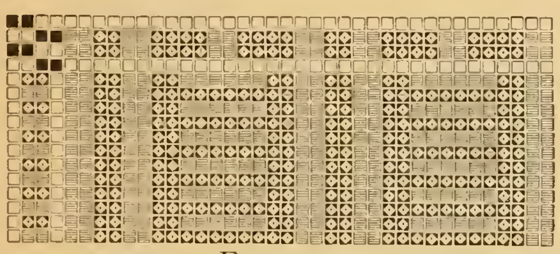


FIG. 217.

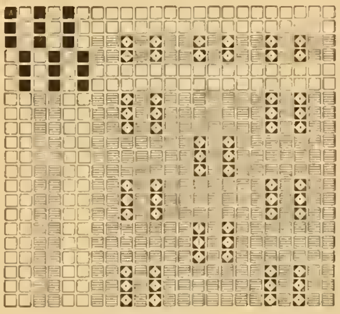


FIG. 218.

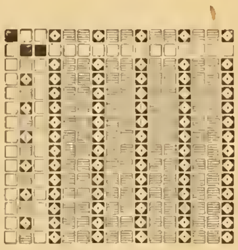


FIG. 219.

Fig. 217 illustrates an effect obtained by combining effects Figs. 215 and 216. Arrangement of the warp:

2 ends light,
2 " dark,
2 " light,
4 " dark,
2 " light,
4 " dark,
———
16 ends in repeat.

Arrangement of the filling: one pick dark to alternate with one pick light.

Fig. 218 illustrates an effect produced upon a fabric interlaced on the common rib-weave (warp effect) ^{3}——$_{3}$, with the following arrangement for the warp:

2 ends light,
1 end dark,
1 " light,
1 " dark,
———
5 ends in repeat Filling: all light.

Fig. 219 illustrates a hair-line, upon a fabric interlaced on the fancy rib-weave $\frac{2}{1}$ (filling effect). Dressing: 1 end dark, 2 ends light, = 3 ends in repeat. Filling: one pick light to alternate with one pick dark. Each color in warp is covered by its own color in filling.

Fig. 220 represents another hair line, having more ground space between each line. Weave: fancy rib $\frac{3}{1}$. Dressing: 1 end dark, 3 ends light, = 4 ends in repeat. Filling: 1 pick light, 1 pick dark. Each color in warp is covered by its own color in filling.

Fig. 221 illustrates a heavy hair-line effect similar to the one shown in Fig. 215 and is produced upon a fabric interlaced with the common 4-harness basket-weave. Dressing and arrangement of filling: 2 ends light to alternate with 2 ends dark. Each color in warp to be covered by its own filling.

Fig. 222 shows an effect produced with the same weave and dressing as Fig. 221. Filling: all light.

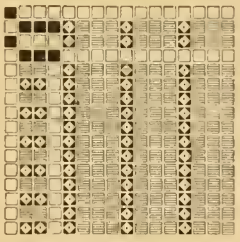


Fig. 220.

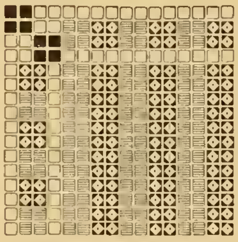


Fig. 221.

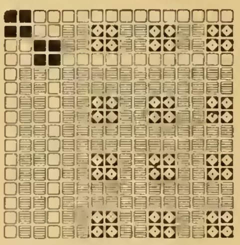


Fig. 222.

Fig. 223 illustrates a "star-effect" obtained upon a fabric interlaced with the 4-harness common basket-weave. Arrangement for warp and filling:

1 end light,
2 ends dark,
1 end light,
–
4 ends in repeat.

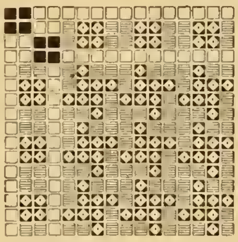


Fig. 223.

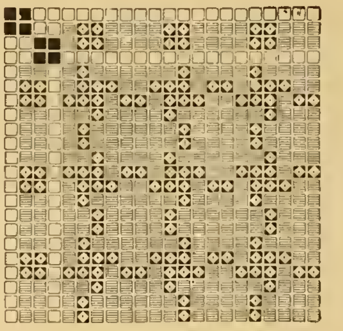


Fig. 224.

Fig. 224 illustrates another small effect upon a fabric interlaced with the 4-harness basket-weave. Arrangement for warp and filling:

2 ends dark, } or color No. 1.
4 ends light, } or color No. 2.
—
6 ends in repeat of color arrangement, and 12 ends the repeat of the entire effect.

It will be easily seen that an endless variety of effects can be produced, but those previously given illustrate the most frequently used, and will be a guide for the student in constructing other effects on 2, 3, or more, color arrangements.

VI. Oblique Rib-Weaves.

This sub-division of the rib-weaves is used in the manufacture of a line of fabrics technically known as "basket-cloth"; and they are also used to a great extent in the manufacture of worsted suitings, cloakings, etc. For their construction we use the following rule:

Divide the repeat, which must be equal warp and filling-ways, in four equal squares. (For example, take diagram, Fig. 225. Suppose □ *a*, *b*, *c*, *d* to form the repeat for the weave, warp and filling-ways. Small squares numbered 1, 2, 3 and 4 are the four equal squares required.) Next, divide the main square (*a*, *b*, *c*, *d*) into eight parts by running two *oblique lines* from each corner through the centre (*e*) to the opposite corner. For illustration, see diagram, Fig. 226: lines *b* to *d* and *a* to *c*, in addition to lines *f* to *h* and *i* to *g* will divide the main square *a*, *b*, *c*, *d* into eight even parts, each of a triangular shape, as indicated by numbers 1, 2, 3, 4, 5, 6, 7 and 8. Two methods of construction can next be observed: either we fill out every triangle containing uneven numbers with filling-weave effect, and every even-numbered triangle with a warp-rib effect, or we select two connecting triangles such as 1 and 2 = *a*, *e*, *b*, for warp effect rib-weave, and the next two triangles 3 and 4 = *b*, *e*, *c*, for filling effect, to be followed by triangle *c*, *e*, *d* with warp effect, and triangle *d*, *e*, *a* with filling effect. Weaves Figs. 227, 228, 229 and 230 are constructed according to the first-mentioned rule. Figs. 231, 232, 233 and 234 are produced according to the second method of construction.

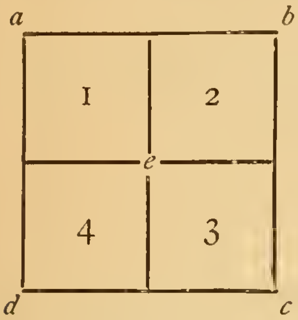


FIG. 225.

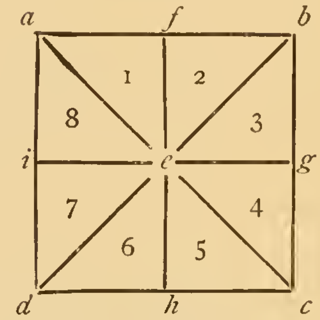


FIG. 226.

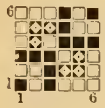


FIG. 227.

Repeat { 6 warp-threads. 6 picks.

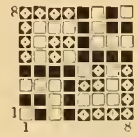


FIG. 228.

Repeat { 8 warp-threads. 8 picks.

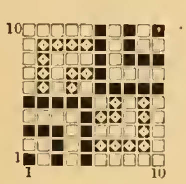


FIG. 229.

Repeat { 10 warp-threads. 10 picks.

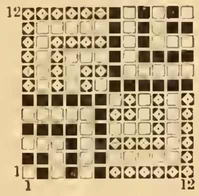


FIG. 230.

Repeat { 12 warp-threads. 12 picks.

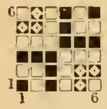


FIG. 231.

Repeat { 6 warp-threads. 6 picks.

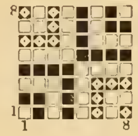


FIG. 232.

Repeat { 8 warp-threads. 8 picks.

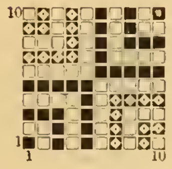


FIG. 233.

Repeat { 10 warp-threads. 10 picks.

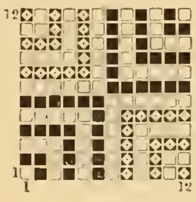


FIG. 234.

Repeat { 12 warp-threads. 12 picks.

Combining Common Rib and Oblique Rib-Weaves.

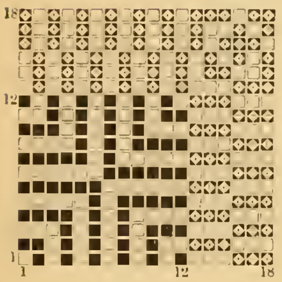


FIG. 235.

Design Fig. 235 illustrates the repetition of weave Fig. 234 with an additional common rib effect, warp and filling ways, which will form horizontal and vertical lines in the fabric for outlining the effect produced by the oblique rib-weave. Repeat: 18 warp-threads and 18 picks.

Derivative Weaves.

FROM THE REGULAR TWILLS.

I. Broken Twills.

"Broken twills" are derived from the regular twills by running the direction of the twill one-half of the repeat from the left to the right; and the other half from the right to the left. These changes of the direction of twill must be arranged so as to produce a well broken up effect. By means of this break, or change of twill, we produce a like change of the twill line, visible upon the face of the fabric; hence this classification as broken-twill weaves.

The first number of harness for producing a broken twill is four-harness, and the regular twill to be used for it is the $\frac{1}{3}$ twill.

After interlacing the first warp-thread in the first pick, and the second warp-thread in the second pick, change the direction of the twill by interlacing the third warp-thread with the fourth pick, and the fourth warp-thread with the third pick.

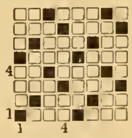


FIG. 236.

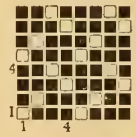


FIG. 237.

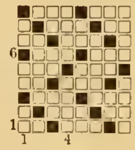


FIG. 238.

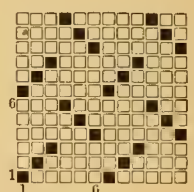


FIG. 239.

Fig. 236 illustrates this $\frac{1}{3}$ 4-harness broken twill (filling for face in fabric).

Fig. 237 represents the opposite effect, or the $\frac{3}{1}$ 4-harness broken twill (warp for face in fabric).

Fig. 238 illustrates the 4-harness $\frac{1}{3}$ twill, broken only filling ways.

After running 3 picks on regular twill from right to left, its direction is changed from left to right for the next 3 picks. Repeat: 4-harness, 6 picks.

Fig. 239 represents the broken twill derived from the six-harness $\frac{1}{5}$ twill. Three successive warp-threads are interlaced with three successive picks in regular twill from left to right, and the remaining three warp-threads and three picks are interlaced in the opposite direction of twill, *i. e.*, right to left.

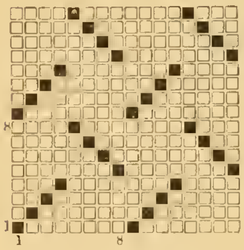


FIG. 240.

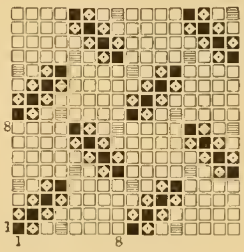


FIG. 241.

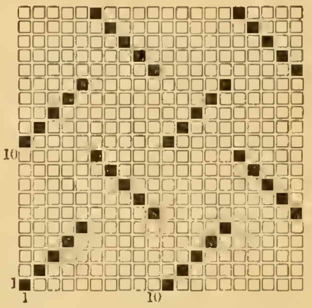


FIG. 242.

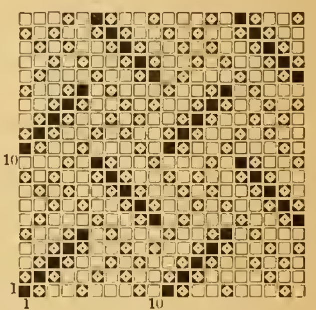


FIG. 243.

Fig. 240 illustrates the $\frac{1}{7}$ 8-harness broken twill.

Warp-threads 1, 2, 3, 4 interlacing in rotation in picks 1, 2, 3, 4.
" 5, 6, 7, 8 " " " 8, 7, 6, 5.

Fig. 241 represents twill, fig. 240, arranged for a fancy combination by adding spots, regularly distributed over the entire repeat.

Fig. 242 shows the $\frac{1}{9}$ 10-harness broken twill.

Fig. 243 represents a fancy combination weave produced out of weave fig. 242. The original 10-harness broken twill is shown in Fig. 243 in the same kind of type as in Fig. 242.

Fig. 244 illustrates the regular ^{2}——$_{2}$ twill, arranged for a broken-twill weave (broken in the direction of the warp). After running six warp-threads in the direction from left to right (regular), we form a break and run warp-threads 7 and 8 with the twill in the opposite direction.

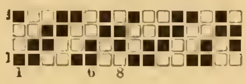


FIG. 244.

Repeat { 8 warp-threads. 4 picks.

By means of a fancy drawing-in draft (1, 2, 3, 4, 1, 2, 4, 3) we can arrange this weave for four-harness, having the foundation weave (^{2}——$_{2}$ regular twill) for the harness-chain.

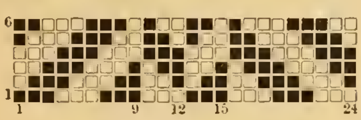


FIG. 245.

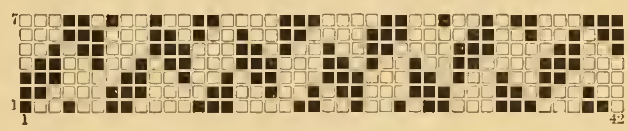


FIG. 246.

Fig. 245 shows the 6-harness ^{3}——$_{3}$ twill, arranged as follows:

9 warp-threads twill from left to right, break, and the next
3 " " " right to left, " " "
3 " " " left to right, " " "
9 " " " right to left.
—
24 " in full repeat.

Drawing-in draft will call for 6-harness; and for harness-chain the foundation twill ^{3}——$_{3}$ must be used.

Examples Figs. 244 and 245 will also illustrate and explain any different changes in using a different number of warp-threads in rotation before breaking off. In this selection we have an unlimited variety at our disposal.

Fig. 246 illustrates the breaking off of every three warp-threads in rotation upon the 7-harness ^{3}——$_{4}$ twill.

Fig. 247 represents 5 warp-threads of the $^{3}{}_{1}{}^{3}{}_{3}{}^{1}{}_{3}$ twill, used successively from the left to right; next a break and five additional warp-threads, used with a twill arranged from right to left. These breaks may also be applied to different graded twills as 27°—63°—70°, etc., and which will be treated under the sub-division of the regular twills in the next chapter.

For illustrating this point Fig. 248 is designed, representing 12 threads of the 63° steep-twill $^{5}{}_{2}{}^{1}{}_{2}$ in a direction from left to right, and 12 additional threads of the same weave having its direction of twill from right to left.

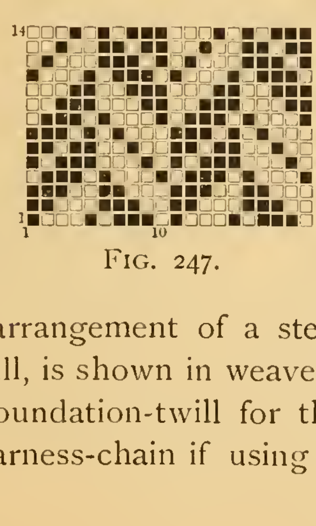


FIG. 247.

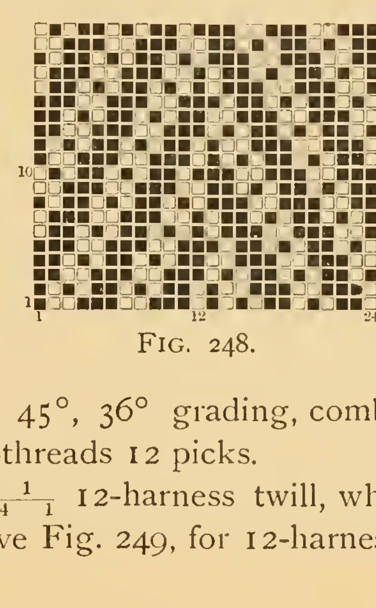


FIG. 248.

The arrangement of a steep-twill containing 70°, 63°, 45°, 36° grading, combined for a broken-twill, is shown in weave Fig. 249. Repeat: 48 warp-threads 12 picks.

The foundation-twill for this weave is the regular $^{4}{}_{1}{}^{1}{}_{4}{}^{1}{}_{1}$ 12-harness twill, which is also used for harness-chain if using a cross-draw for drafting weave Fig. 249, for 12-harness.

The next sub-division of "broken-twills" out of "regular-twills" is found in arranging the *breaking off filling ways.* For example: Fig. 250 illustrates the $_{4}$——^{4} twill broken filling ways after every four successive picks. Repeat: 8 warp-threads and 8 picks.

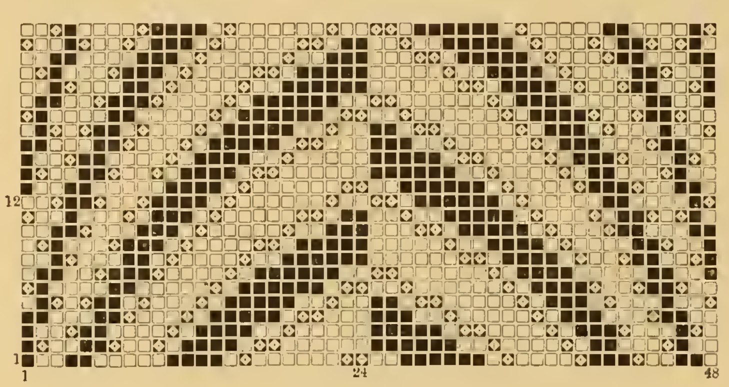


FIG. 249.

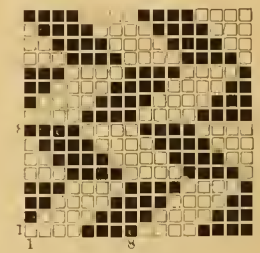


FIG. 250.

Fig. 251 shows the ^{2}——$_{1}$ twill broken filling ways after every four picks. Warp ways 2 threads are missed after every 6 warp-threads, to produce an additional fancy effect. *Breaking off regular* (or steep) *twills in the direction of the warp and the filling* will form the next movement in the construction of broken-twills out of the regular twills. In this manner Figs. 252 to 255 are constructed.

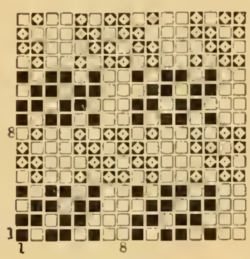


FIG. 251.

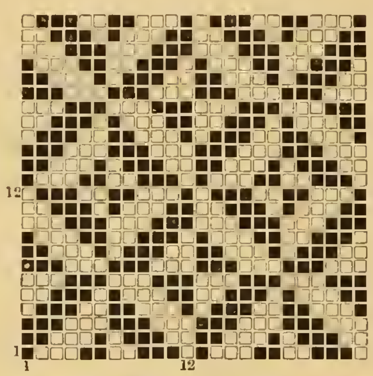


FIG. 252.

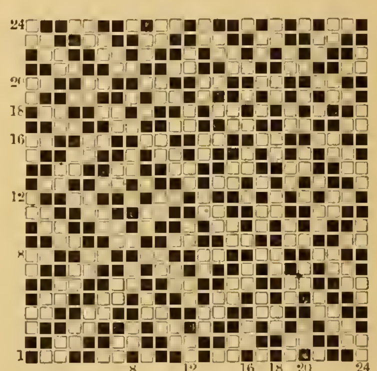


FIG. 253.

Fig. 252 is obtained from the ^{3}——$_{3}$ twill, by arranging the breaking off in the direction of the warp and filling, after every 6 successive threads. Repeat: 12 warp-threads, 12 picks.

Fig. 253 has for its foundation the regular ^{2}——$_{2}$ 4-harness twill. Arrangement for breaking the weave after warp-threads 8, 12, 16, 18, 20, and 24, thus forming twill effects of three different sizes as follows: 2, 4 and 8 threads.

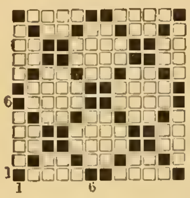


FIG. 254.

Another step towards figuring for broken-twill designs is that of using a motive (effect) for figuring by means of the two directions of the twill. To illustrate this method Figs. 254 and 255 have been designed.

Fig. 254 illustrates two repeats of the motive, warp and filling ways. Fig. 255 shows this motive applied to a broken-twill weave produced by the ^{3}——$_{3}$ twill. 12 warp-threads and 12 picks are used for each part of the effect in the motive; therefore, as 6 parts compose the motive, we have $6 \times 12 = 72$ warp-threads and 72 picks the repeat for the complete design. ■ in motive, is illustrated ■ in the design; □ in motive is shown ◻ in the design.

Warp-threads 1 to 12 in the weave equal the longitudinal row 1 of squares in the motive.

Warp-threads 13 to 24 in the weave equal the longitudinal row 2 of squares in the motive.

Warp-threads 25 to 48 in the weave equal the longitudinal rows 3 and 4 of squares in the motive.

Warp-threads 49 to 60 in the weave equal the longitudinal row 5 of squares in the motive.

Warp-threads 61 to 72 in the weave equal the longitudinal row 6 of squares in the motive.

Picks 1 to 12 in the weave equal the horizontal row 1 of squares in the motive.
Picks 13 to 24 in the weave equal the horizontal row 2 of squares in the motive.
Picks 25 to 48 in the weave equal the horizontal rows 3 and 4 of squares in the motive.

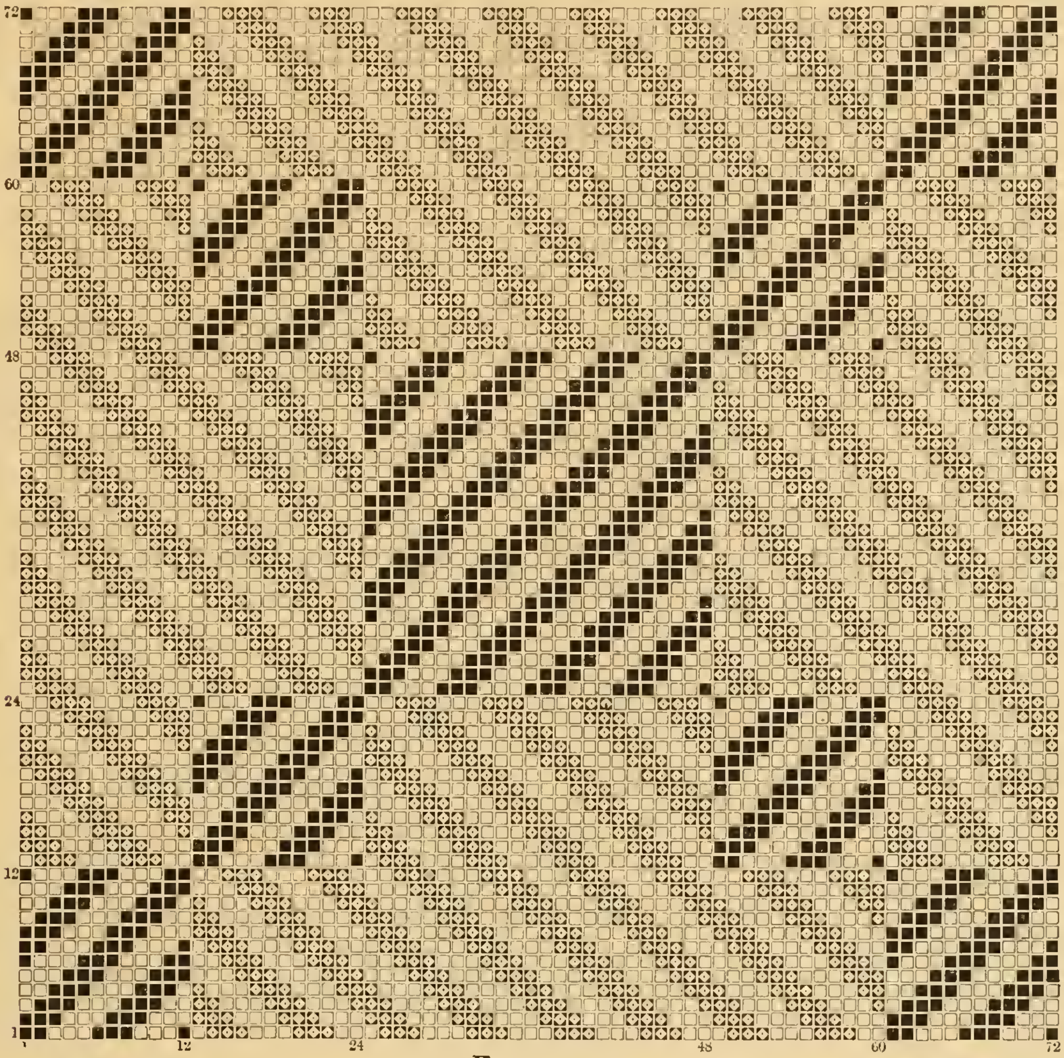


Fig. 255.

Picks 49 to 60 in the weave equal the horizontal row 5 of squares in the motive.
Picks 61 to 72 in the weave equal the horizontal row 6 of squares in the motive.

Using two or more colors in Warp and Filling for Producing effects in Fabrics interlaced with Broken Twills.

In Figs. 256, 257 and 258 we illustrate three examples of effects produced upon broken twills by various arrangements of colors in warp and filling. In Fig. 256 the common $\frac{3}{1}$ 4-har-

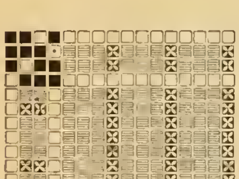


Fig. 256.

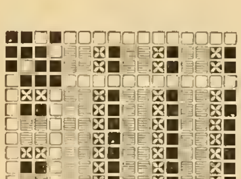


Fig. 257.

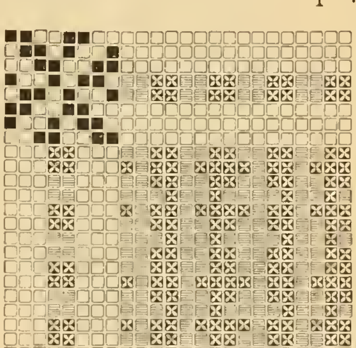


Fig. 258.

ness broken twill is shown arranged for 3 ends light, 1 end dark, or color No. 1 and color No. 2, in warp and filling. The effect obtained is a "hair-line," very extensively used in the manufacture of worsted and woolen trouserings by reason of the clear and distinct line-effect this weave produces.

Fig. 257 illustrates the same weave (4-harness broken twill) arranged for three different colors. Arrangement for warp and filling: 2 ends light or color No. 1; 1 end medium or color No. 2; 1 end dark or color No. 3.

Fig. 258 illustrates the 8-harness broken twill (broken, warp and filling ways, every four threads), arranged for 2 ends light to alternate with
2 ends dark,
—
4 ends in repeat of color arrangement and 8 ends repeat for weave and effect.

II. Steep-Twills or Diagonals.

The next sub-division of the common or regular twills are the steep-twills, which are derived from the latter by using either every other or every third, fourth, etc., warp-thread in rotation for forming the weave.

1st. Steep-Twills having 63° grading

are obtained by using every alternate warp-thread of a common twill. To illustrate their method of construction Figs. 259, 260 and 261 are designed.

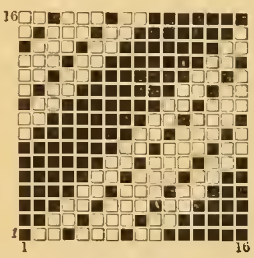


Fig. 259.

Fig. 259 illustrates the regular 16-harness twill, $\frac{7}{2}\frac{1}{3}\frac{1}{2}$.

Fig. 260 represents the same weave, every other warp-thread indicated by a different kind of type.

Fig. 261 illustrates the steep twill or diagonal weave as obtained by using only warp-threads shown in Fig. 260 with ■.

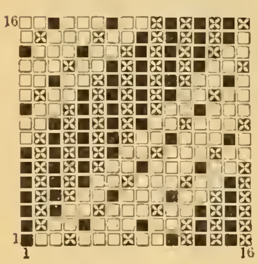


Fig. 260.

This example of constructing a steep twill out of a regular twill, which has an even number of warp-threads for its repeat, will also explain that the former requires only one-half the number of harness that are used in the foundation weave.

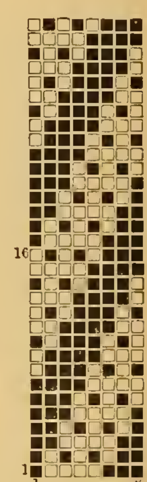


Fig 261.

Thus the present example—
16-harness for regular twill only requires
8-harness for its corresponding steep twill.

If we construct a steep twill out of a regular twill which has an uneven number of harness for its repeat, the same will not be reduced as in the case with an even number. Thus, 9-harness in

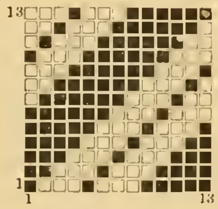


Fig. 262.

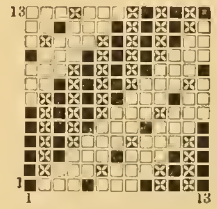


Fig. 263.

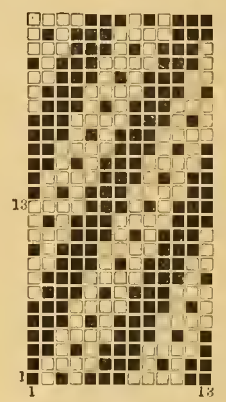


Fig. 264.

the regular twill requires 9-harness for the steep twill. Again, 11-harness regular twills require 11-harness for the repeat in their respective steep twills, etc.

For example: we give in Fig. 262 the regular twill known as $\frac{6}{3}\frac{1}{3}$. 13-harness repeat.

Fig. 263 illustrates again the analysis of the same with the view of constructing its respective "steep-twill," which is illustrated in Fig. 264. An examination of Fig. 263 shows warp-threads 1 and 13 indicated by the same kind of type; so, in constructing the steep-twill after using warp-thread 13 of the common twill for warp-thread 7 of the steep-twill, we must use warp-thread 2 of the common twill for warp-thread 8 of the steep-twill, and so on, until warp-thread 12 of the regular twill forms the last warp-thread (13) in the repeat for the steep-twill.

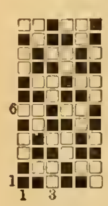


Fig. 265.

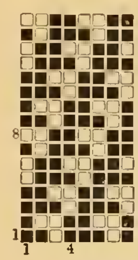


Fig. 266.

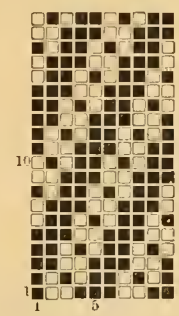


Fig. 267.

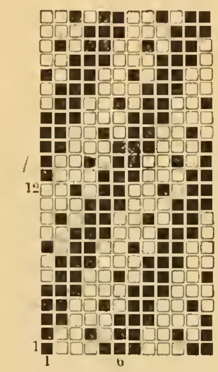


Fig. 268.

These two examples will easily demonstrate to the student the great amount and variety of steep-twills, 63° grading, which can be constructed out of the common or regular twills of 45° grading.

Weaves Fig. 265 to 276 illustrate a few of the steep-twills most frequently used.

Fig. 265 illustrates a 3-harness steep-twill (63°) derived from the regular twill, $\frac{2}{2}\frac{1}{1}$ Repeat: 3 harness and 6 picks.

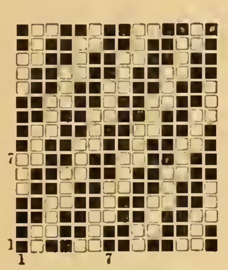


Fig. 269.

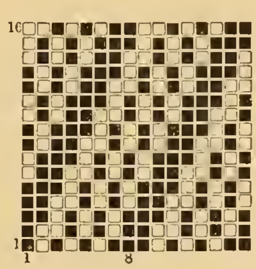


Fig. 270.

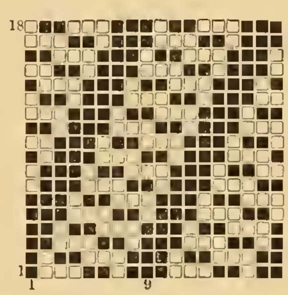


Fig. 271.

Fig. 266 represents the 4-harness steep-twill (63°) derived from the regular 8-harness twill $\frac{4}{2}\frac{1}{1}$. Repeat: 4 harness and 8 picks.

Fig. 267 illustrates the 5-harness steep-twill (63°) derived from the regular 10-harness twill, $\frac{5}{2}\frac{1}{2}$. Repeat: 5 harness and 10 picks.

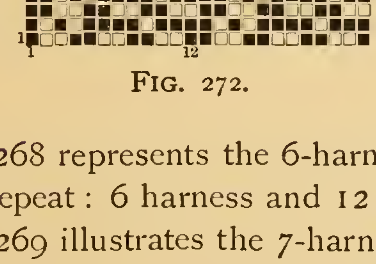


Fig. 272.

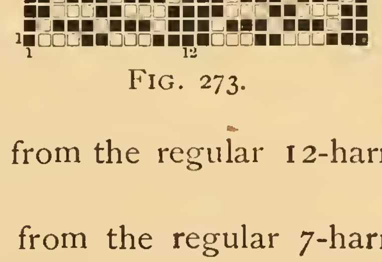


Fig. 273.

Fig. 268 represents the 6-harness steep-twill (63°) derived from the regular 12-harness twill, $\frac{5}{2}\frac{1}{4}$. Repeat: 6 harness and 12 picks.

Fig. 269 illustrates the 7-harness steep-twill (63°) derived from the regular 7-harness twill, $\frac{4}{3}$. Repeat: 7 harness and 7 picks.

Fig. 270 illustrates the 8-harness steep-twill (63°) derived from the regular 16-harness twill, $\frac{5\ \ 2\ \ 2}{2\ \ 2\ \ 3}$. Repeat: 8 harness and 16 picks.

Fig. 271 represents the 9-harness steep-twill (63°) derived from the regular 18-harness twill, $\frac{6\ \ 1\ \ 1\ \ 1\ \ 1}{2\ \ 1\ \ 2\ \ 1\ \ 2}$. Repeat: 9 harness and 18 picks.

Fig. 272 illustrates the 12-harness steep-twill (63°) derived from the regular 24-harness twill, $\frac{4\ \ 1\ \ 2\ \ 2\ \ 1\ \ 4\ \ 1}{1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 2\ \ 2}$. Repeat: 12 harness and 24 picks.

Fig. 273 represents the 12-harness steep-twill (63°) derived from the regular 24-harness twill, $\frac{7\ \ 1\ \ 1\ \ 2\ \ 2\ \ 1\ \ 1}{2\ \ 1\ \ 1\ \ 1\ \ 1\ \ 1\ \ 2}$. Repeat: 12 harness and 24 picks.

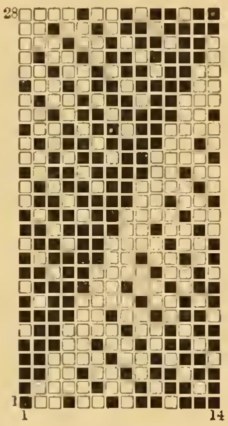


Fig. 274.

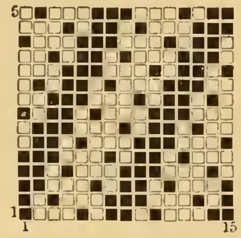


Fig. 275.

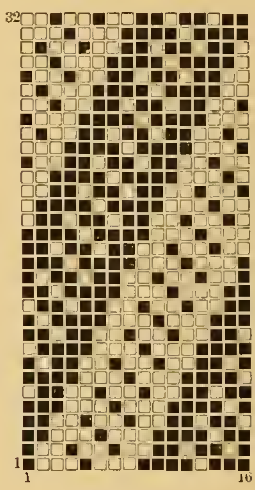


Fig. 276.

Fig. 274 illustrates the 14-harness steep-twill (63°) derived from the regular 28-harness twill, $\frac{5\ \ 2\ \ 2\ \ 2\ \ 1\ \ 1\ \ 1}{1\ \ 1\ \ 1\ \ 2\ \ 2\ \ 2\ \ 5}$. Repeat: 14 harness and 28 picks.

Fig. 275 represents the 15-harness steep-twill (63°) derived from the regular 15-harness twill, $\frac{5\ \ 1\ \ 1}{2\ \ 4\ \ 2}$. Repeat: 15 harness and 15 picks.

Fig. 276 represents the 16-harness steep-twill (63°) derived from the regular 32-harness twill, $\frac{5\ \ 2\ \ 2\ \ 5\ \ 1\ \ 1\ \ 1}{1\ \ 1\ \ 1\ \ 4\ \ 2\ \ 2\ \ 4}$. Repeat: 16 harness and 32 picks.

2d. Steep-Twills having a grading of 70°.

These twills are derived from the regular twills by using every third warp-thread in rotation for the construction of the new weave. To give a clear understanding diagram No. 277 is designed. *A* represents one repeat of the regular twill known as the $\frac{4\ \ 1}{1\ \ 2}$ 8-harness twill; *B* illustrates the drafting of the different warp-threads according to previously given explanation for forming *C*, the new design.

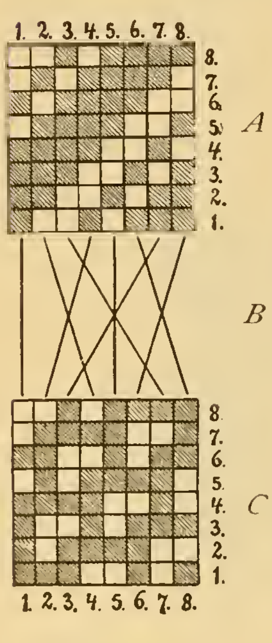


Fig. 277.

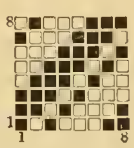


Fig. 278.

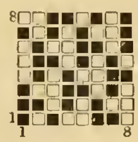


Fig. 279.

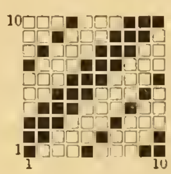


Fig. 280.

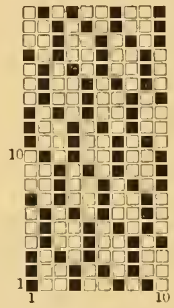


Fig. 281.

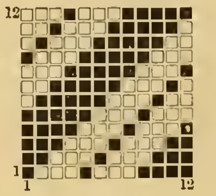


Fig. 282.

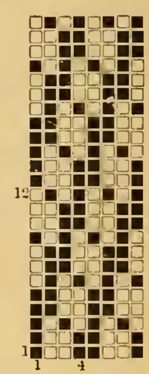


Fig. 283.

Arrangement of drafting: 1, 4, 7, 2, 5, 8, 3, 6. Repeat: 8 harness, 8 picks.

Fig. 278 represents the regular twill known as $\frac{3\ \ 1}{3\ \ 1}$, and

Fig. 279 represents the steep-twill (70°) derived out of it. Repeat: 8 harness, 8 picks.

Fig. 280 the regular twill $\frac{3\ \ 1}{3\ \ 3}$ is shown, arranged for a 70° steep-twill in Fig. 281. Repeat; 10 harness, 10 picks.

Fig. 282 the regular 12-harness twill $\frac{5}{3}\frac{1}{3}$ is shown, arranged for its 70° steep-twill in Fig. 283. Repeat: 4 harness, 12 picks.

Fig. 284 illustrates the regular 15-harness twill $\frac{5}{2}\frac{2}{2}\frac{2}{2}$, and Fig. 285 the 70° steep-twill derived out of it. Repeat: 5 harness, 15 picks.

Fig. 286 represents the 70° steep-twill designed out of the regular twill $\frac{6}{3}\frac{1}{3}$ (shown in Fig. 262, page 56). Repeat: 13 harness, 13 picks.

Fig. 287 illustrates the steep-twill having 70° grading, which is derived from the regular twill $\frac{7}{2}\frac{1}{3}\frac{1}{2}$ (see Fig. 259, page 56). Repeat: 16 harness and 16 picks.

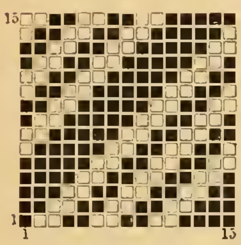


FIG. 284.

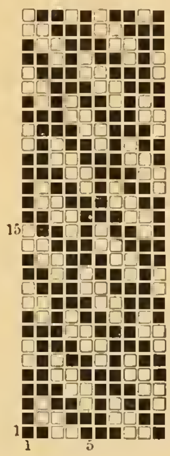


FIG. 285.

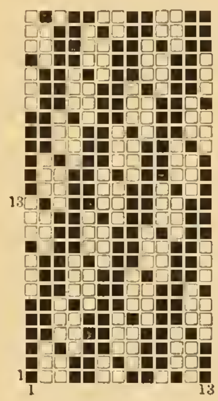


FIG. 286.

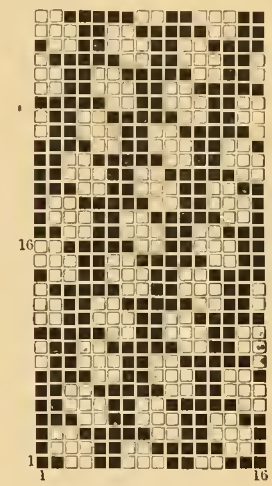


FIG. 287.

These few examples (Figs. 277 to 287) will easily explain the method of construction for these weaves; we would only add that if the number of harness in repeat for the regular twill can be divided by 3, the number of harness in repeat for the steep-twill will be reduced one-third, as follows:

12-harness regular twill to 4-harness steep (70°).
15 " " " 5 " " "
18 " " " 6 " ' " etc., etc.

Any number of harness repeat for a regular twill which cannot be equally divided by 3 requires the same number of harness for the steep-twill as is used in its foundation twill.

3d. Steep-Twills having a grading of 75°.

Weaves of this sub-division of the regular twill of 45° grading, are derived from the latter by using every fourth warp-thread in rotation. In constructing 75° steep-twills out of regular twills having a number of harness for their repeat which can be divided evenly by four, only one-fourth the number of harness are required; for example:

12 harness "regular" = 3 harness "75° steep."
16 " " = 4 " " "
20 " " = 5 " " "
24 " " = 6 " " " etc., etc.

Again, in constructing 75° steep-twills out of regular twills having for their repeat an even number of harness not called for in previous rule, the number of harness required is lowered one-half; for example:

14 harness "regular" = 7 harness "75° steep."
18 " " = 9 " " "
22 " " = 11 " " "
26 " " = 13 " " " etc., etc.

These two given rules will readily explain a third, as follows:

Every regular twill of an uneven number of harness for its repeat, if used for the construction of a steep-twill of 75° grading, requires every warp-thread of the former used; or in other words:

Steep-twills of 75° grading, constructed out of regular twills having an uneven number of harness for their repeat, require an equal number of harness for the former; for example:

9 harness	"regular"	=	9 harness	"75° steep."			
11	"	"	= 11	"	"	"	
13	"	"	= 13	"	"	"	
15	"	"	= 15	"	"	"	etc., etc.

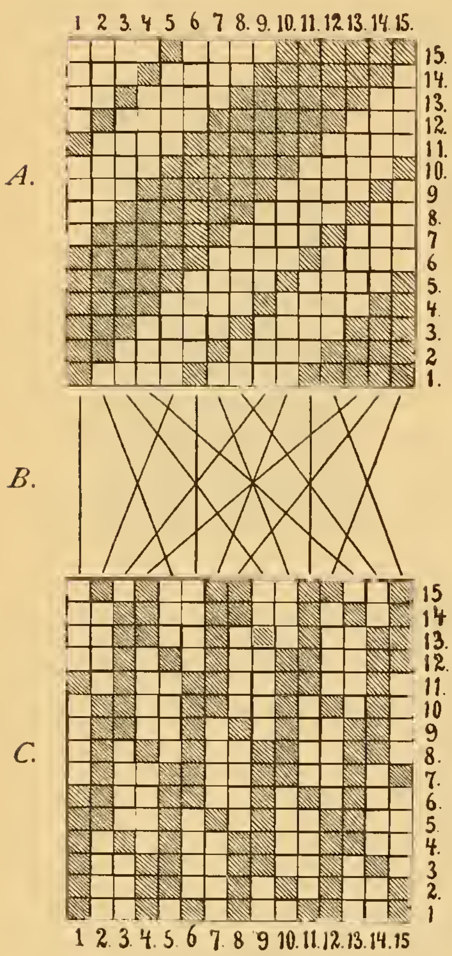


FIG. 288.

To give a clear understanding of the construction of the 75° steep-twills, diagram 288 is designed, illustrating under *A* one repeat of the regular twill, $\frac{6}{4}\frac{1}{4}$ = 15 harness.

B illustrates the drafting of the different warp-threads (after rule given at beginning) for forming *C*, the new design.

Arrangement of drafting: 1, 5, 9, 13, 2, 6, 10, 14, 3, 7, 11, 15, 4, 8, 12. Repeat: 15 harness, 15 picks.

Fig. 289 represents the regular twill, $\frac{6}{4}\frac{2}{4}$ for 16 harness repeat.

Fig. 290 shows its 75° steep-twill derived by drafting 1, 5, 9, 13. Repeat: 4 harness, 16 picks.

Fig. 291 illustrates the steep-twill of 75° grading which is derived from the regular twill of 45° grading, $\frac{6}{3}\frac{1}{3}$ = 13 harness. (See Fig. 262, page 56.) Repeat: 13 harness, 13 picks.

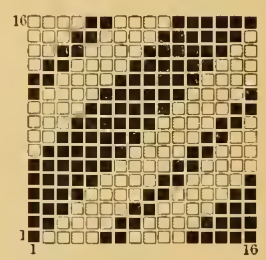


FIG. 289.

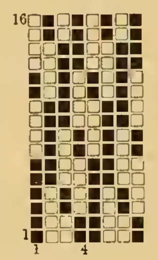


FIG. 290.

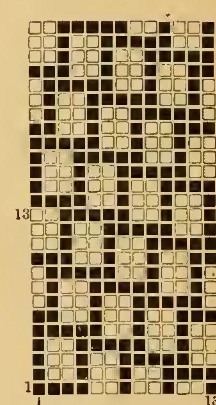


FIG. 291.

III. Reclining Twills (27° grading).

This sub-division of the regular twills has its principle of construction very nearly related to the ones given regarding the steep-twills; in fact, points given in the latter as to warp will apply in the present sub-division of twills to the filling. Therefore in constructing a twill of 27° grading out of a regular twill of 45° grading, we only use every alternate pick of the latter. For example, Figs. 292, 293, 294, 295, 296 and 297.

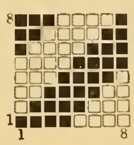


FIG. 292.

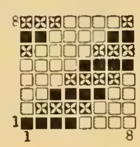


FIG. 293.

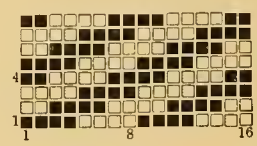


FIG. 294.

Fig. 292 represents the regular 8-harness twill $\frac{4}{\quad}\frac{\quad}{4}$. Fig. 293 illustrates the same twill analysed, every alternate pick indicated by a different style of type. Fig. 294 represents the new weave, derived from weave Fig. 293 by using only picks 1, 3, 5 and 7. Repeat: 8 harness and 4 picks.

Fig. 295 represents the regular twill $\frac{4}{\quad 2}\frac{1}{\quad 2} = 9$-harness. Fig. 296 is its analysis. Fig. 297 is the reclining twill derived from the latter. Repeat: 9-harness and 9 picks.

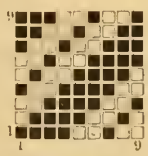


FIG. 295.

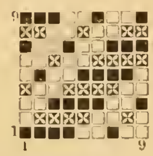


FIG. 296.

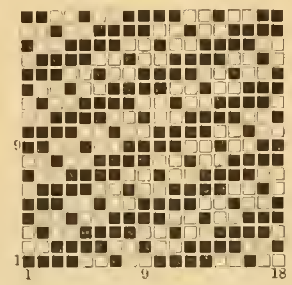


FIG. 297.

These two examples will clearly illustrate the method to be observed in designing reclining twills for any number of harness. Regular twill weaves with an even number of picks in repeat reduce to one-half the number in the reclining twill; again, regular twills with an uneven number of picks for their repeat require, if changed to reclining twills, the same number of picks.

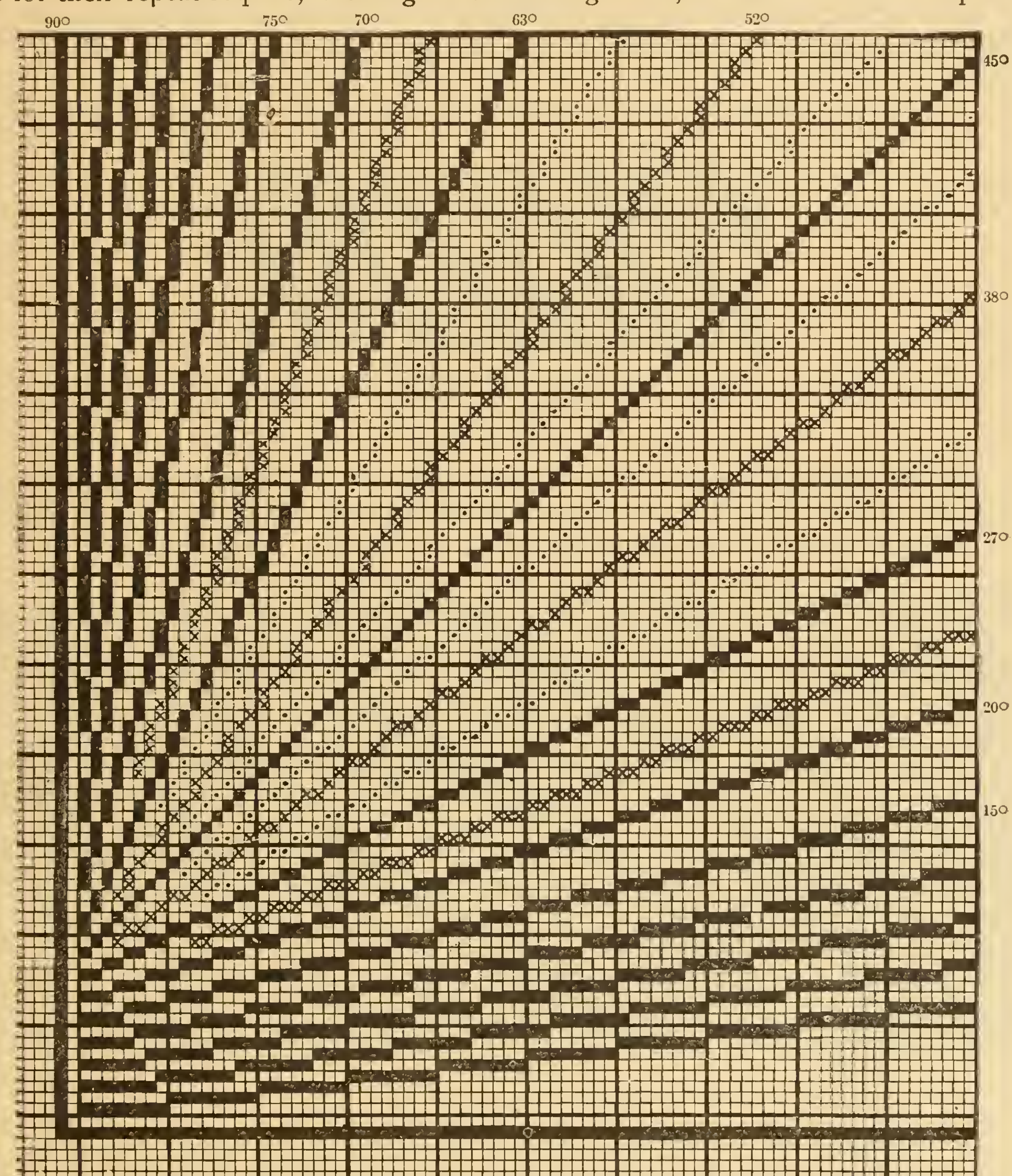


Diagram for illustrating the construction of steep twills of 52°, 63°, 70° and 75° grading, and reclining twills of 38°, 27°, 20°, and 15° grading.

IV. Curved Twills.

This sub-division of the "twills" is derived by a combination of "regular" 45° twills with 63°, 70° or 75°, or similarly graded "steep-twills." One kind of these twills is run for a certain number of threads, after which the run, without forming an interruption, is changed to the other

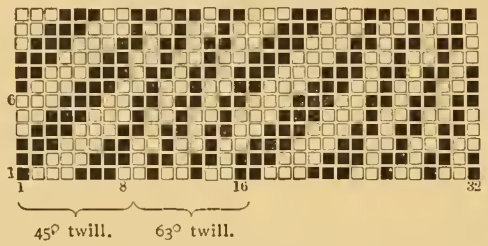


Fig. 298.

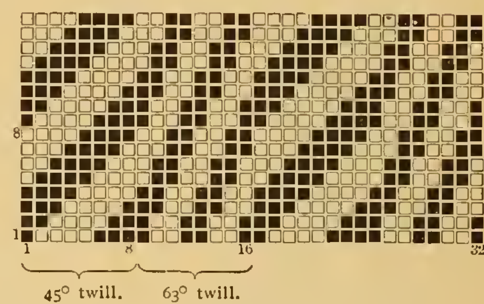


Fig. 299.

system. The same twill which is used in 45° must also be used in the construction of the steeper twills.

The following few designs will clearly explain the method of constructing curved twills.

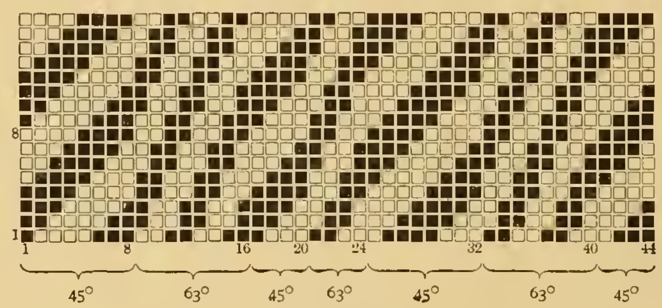


Fig. 300.

Fig. 298 illustrates the curved twill obtained from the $\frac{3}{\quad 3}$ twill. 8 warp-threads are designed in the regular 45° twill and 8 warp-threads in its 63° steep-twill = 16 warp-threads repeat. Drawing-in draft: 16-harness straight draw or 6-harness section draw.

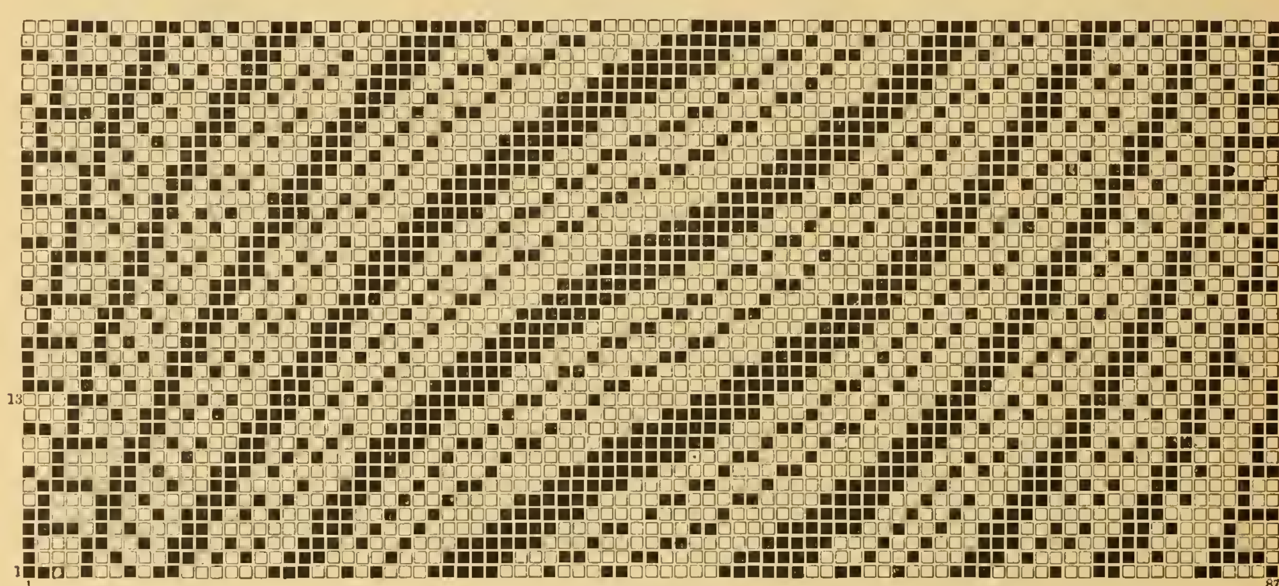


Fig. 301.

Fig. 299 illustrates the curved twill obtained from the $\frac{4}{\quad 4}$ twill. 8 warp-threads are designed in the regular 45° twill and 8 warp-threads in its 63° steep-twill = 16 warp-threads repeat. Drawing-in draft: 16-harness straight draw or 8-harness section draw.

Fig. 300 illustrates another curved twill obtained from the $\frac{4}{4}$ twill.

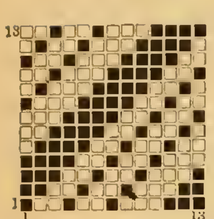


FIG. 302.

Warp-threads	1 to 8	call for the	45°	regular twill.
"	9 to 16	" "	63°	steep "
"	17 to 20	" "	45°	regular "
"	21 to 24	" "	63°	steep "
"	25 to 32	" "	45°	regular "
"	33 to 40	" "	63°	steep "
"	41 to 44	" "	45°	regular "

Repeat of design: 45 warp-threads, 8 picks.

Drawing-in draft: 8 or 16-harness section draw.

Drawing-in Draft for 13-Harness.

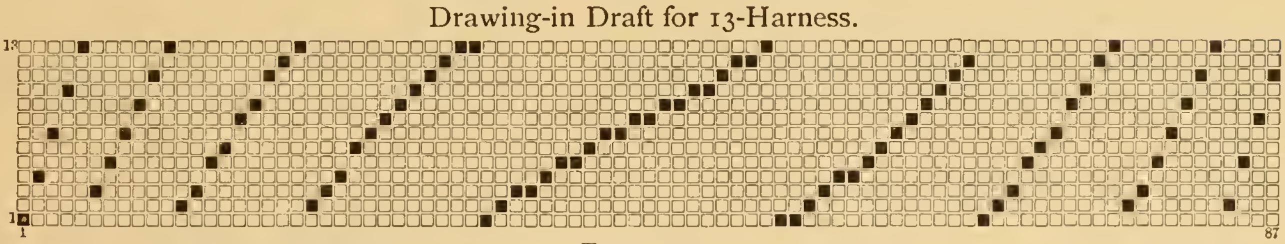


FIG. 303.

Fig. 301 represents a curved twill with 87 warp-threads for repeat, which is obtained from the regular $\frac{4}{3}\frac{1}{2}\frac{1}{2}$ 13-harness twill (shown in Fig. 302) according to draft represented in Fig. 303, and thus will readily explain itself, as the drawing-in draft also clearly indicates the different grading of the twill.

V. Skip-Twills.

This sub-division of our regular or foundation twills embraces the weaves in which the twill line does not run continuously through the entire design. In their general appearance these represent a combination of parts taken from a regular twill.

They are designed as follows: After drafting successively 2, 3, 4 or more threads from a regular twill for the new weave, skip (or omit) 1, 2, 3 or more threads; draft again 2, 3, 4 or more successive threads, then skip again, and continue in this manner to draft and skip until you get the repeat for the new weave.

We can arrange this skipping in the direction of the warp, in the direction of the filling, or in both systems.

1st. Skip-Twills in which the Skipping is arranged for the Warp.

Fig. 304 represents the regular 4-harness twill $\frac{2}{2}$.

Fig. 305 illustrates the skip-draft reading as follows: Take two, miss one, four times over; or 1, 2, 4, 1, 3, 4, 2, 3.

FIG. 304.

FIG. 305.

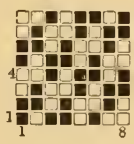


FIG. 306.

FIG. 307.

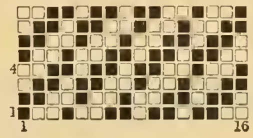


FIG. 308.

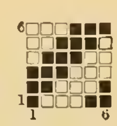


FIG. 309.

Fig. 306 represents the skip-twill derived by means of draft Fig. 305 from the $\frac{2}{2}$ 4-harness twill shown in Fig. 304. Repeat: 8 warp-threads, 4 picks.

Fig. 307 illustrates a second kind of skip-draft for 4-harness, reading as follows: Take four, miss one, four times over; or 1, 2, 3, 4, 2, 3, 4, 1, 3, 4, 1, 2, 4, 1, 2, 3, which, if applied to the 4-harness twill $\frac{2}{2}$ shown in Fig. 304, will produce the design as represented in Fig. 308.

Repeat: 16 warp-threads, 4 picks.

Drawing-in draft: Either 16-harness straight draw, or for 4 or 8-harness with a section arrangement.

Fig. 309 is the 6-harness $\frac{3}{\quad 3}$ twill.

Fig. 310 represents a skip-draft reading as follows: Take six, skip two, three times over. This skip-draft, if applied to the $\frac{3}{\quad 3}$ twill (Fig. 309) will produce the weave of a skip-twill, as shown in Fig. 311.

Fig. 310.

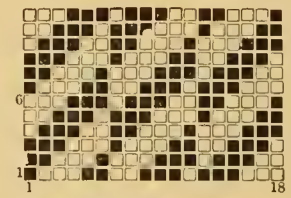


Fig. 311.

Fig. 313 shows another variation of the skip-twill, derived from the common twill $\frac{3}{\quad 3}$ (Fig. 309) by means of skip-draft illustrated in Fig. 312. The latter reads as follows: Take three, skip two, six times over, twill from left to right; take three, skip two, six times over, twill from right to left.

Repeat: 36 warp-threads, 6 picks.

Fig. 312.

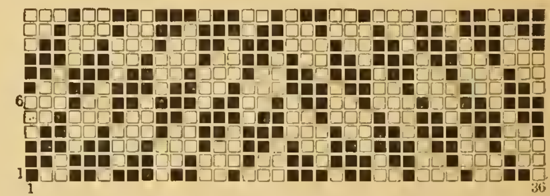


Fig. 313.

For drawing-in draft use skip-draw shown in Fig. 312. For harness-chain use the regular twill shown in Fig. 309.

In Fig. 314 we illustrate a skip-twill derived from the regular twill $\frac{3}{\quad 4}$ (7-harness) by means of skip-draft shown in Fig. 315. Take two, miss two, seven times over, forms the repeat of this skip-draft.

Repeat of weave: 14 warp-threads, 7 picks.

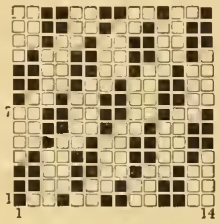


Fig. 314.

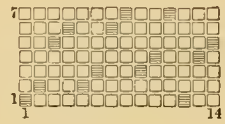


Fig. 315.

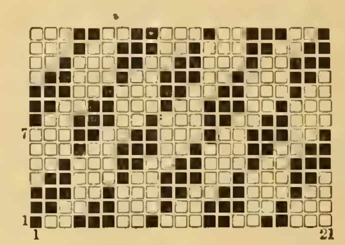


Fig. 316.

Weave Fig. 316 is derived from the same regular twill as Fig. 314, but has a different drafting, as follows: Take three, miss two, seven times over.

Repeat of weave: 21 warp-threads, 7 picks.

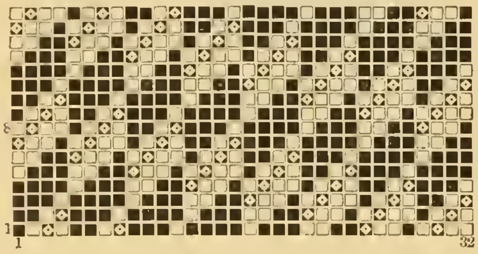


Fig. 317.

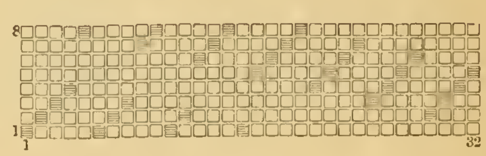


Fig. 318.

Fig. 317 represents a skip-twill derived from the 8-harness $\frac{4}{\quad 2}\frac{1}{\quad 1}$ by means of skip-draw shown in Fig. 318.

Repeat of weave: 32 warp-threads, 8 picks.

Fig. 319 illustrates the skip-twill derived from the 14-harness $\frac{3}{1}\frac{3}{3}\frac{1}{3}$ regular twill by the following drafting: Take three, miss six, fourteen times over.

Repeat of weave: 42 warp-threads, 14 picks.

Fig. 320 represents the skip-twill derived from the 18-harness $\frac{3}{3}\frac{3}{2}\frac{1}{2}\frac{1}{3}$ regular twill, derived by means of the following drafting: Take three, skip ten, eighteen times over.

Repeat of weave: 54 warp-threads, 18 picks.

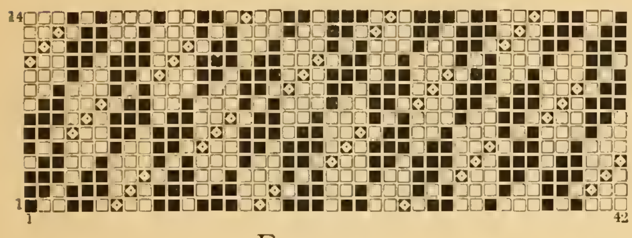


FIG. 319.

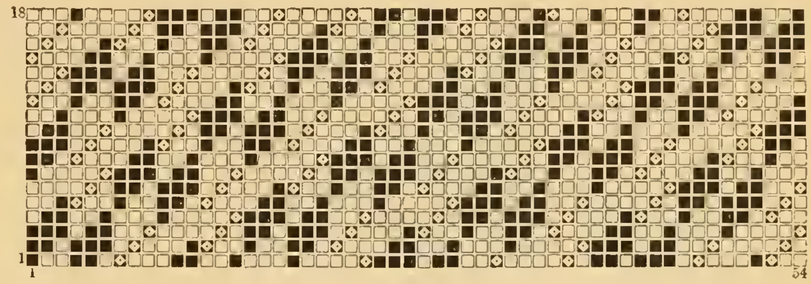


FIG. 320.

These few designs for skip-twills, with a regular exchanging of "take" and "miss," will readily establish the rule for finding the number of warp-threads required for one repeat, as follows:

Multiply the number of harness the foundation (or regular) twill contains (this is also equal to the number of picks for the repeat of the skip-twill) by the number of warp-threads taken in rotation in the skip-draft before missing a certain number of threads; for example :—

Fig. 320	number of harness in foundation twill	18 ×	number of warp-threads taken in rotation in skip-draft	3 = 54	repeat of warp-threads in s. t.
" 319	" "	14 ×	" "	3 = 42	" "
" 317	" "	8 ×	" "	4 = 32	" "
" 316	" "	7 ×	" "	3 = 21	" "
" 314	" "	7 ×	" "	2 = 14	" "

The next step for figuring skip-twills is that of arranging the skip-effects produced by the warp into two or more different sizes. In their general principle of construction these kinds of skip-twills are identical with the ones given before. Figs. 321 and 322 are designed as illustrations.

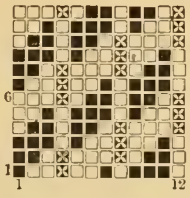


FIG. 321.

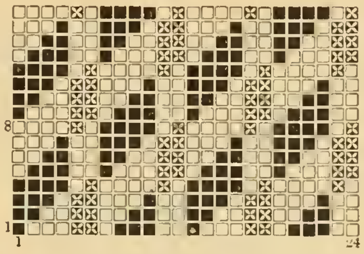


FIG. 322.

Fig. 321 is derived from the regular $\frac{3}{3}$ 6-harness twill. Arrangement of skip-draft is as follows: Take three, skip two, take one, skip two, four times over.

Repeat: 12 warp-threads, 6 picks.

Fig. 322 has for its foundation the regular 8-harness twill $\frac{4}{4}$. Arrangement of skip-draft: Take four, skip three, take two, skip three, four times over.

Repeat: 24 warp-threads, 8 picks.

A further process in figuring skip-twill is found in arranging the skipping in the direction of the filling. After taking two, three or more picks in rotation from any of the "regular" 45° twills, miss one, two, three or more picks; then continue again to take an equal number as before, again miss a certain number of picks, and proceed in this manner until the repeat is obtained.

Figs. 323 and 324 are designed for illustrating this sub-division of skip-twills.

Fig. 323—repeat: 4-harness, 16 picks—is derived from the regular 4-harness twill $\frac{2}{2}$ in the following manner: Take four, miss one, four times over.

Fig. 324—repeat: 8-harness, 24 picks—is derived from the regular 8-harness twill $\frac{3}{2}\frac{1}{2}$, as follows: Take three, miss four, eight times over.

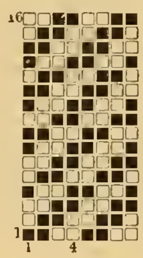


Fig. 323.

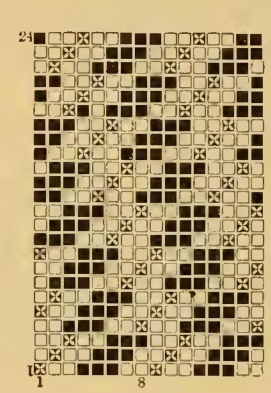


Fig. 324.

The rule for finding the number of picks necessary for one repeat of design is: Multiply the number of harness in repeat by number of picks taken in rotation before skipping. The result will be the number of picks necessary for one repeat in design; for example:—

Fig. 323—4 (number of harness) × 4 (picks in rotation) = 16 picks in one repeat.
" 324—8 " " × 3 " " = 24 " " "

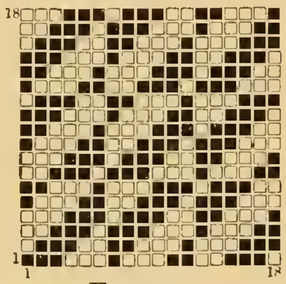


Fig. 325.

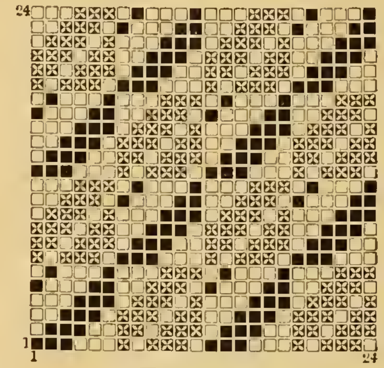


Fig. 326.

The next course in figuring skip-twills is that of combining warp and filling skip-effects in the same design.

Figs. 325, 326 and 327 illustrate this sub-division of the skip-twills.

Fig. 325—repeat: 18 warp-threads, 18 picks—has for its foundation the 6-harness $\frac{3}{3}$ regular twill. Take six, miss two, three times over in one repeat for warp and filling directions.

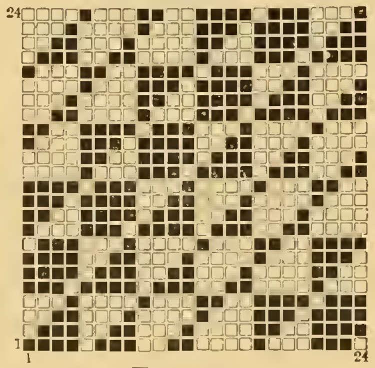


Fig. 327.

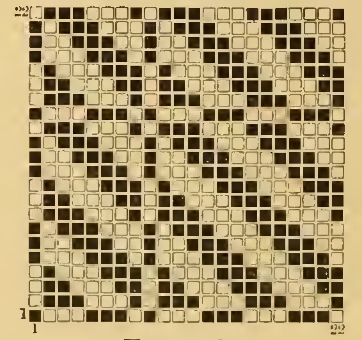


Fig. 328.

Fig. 326—repeat: 24 warp-threads, 24 picks, and Fig. 327—repeat: 24 warp-threads, 24 picks—are figured skip-twills of a more elaborate design.

In Fig. 326 6 threads in rotation, warp and filling ways, are used before skipping. In Fig. 327 4 threads in rotation, warp and filling ways, are used before skipping 3 threads.

Fig. 328—repeat: 22 warp-threads, 22 picks—is designed to illustrate skip-effects irregularly arranged, and is derived from the common $\frac{3}{3}$ 6-harness twill. Arrangement of drafting for this weave is: Take one, miss two, take seven, miss two, take one, miss two, take thirteen, miss two.

VI. Combination Steep-Twills (of 63° grading).

This sub-division of the twill weaves is produced by combining two regular twills (45°) which either have the same number of warp-threads for their repeat, or two regular twills where one weave contains one-half, one-third or one-fourth the number of warp-threads in its repeat compared to the number of warp-threads found in the repeat of the other weave. In designing these combination twills the two weaves are combined, one pick of one twill to alternate with one pick of the second twill. Diagram Fig. 329 is designed to give a clear illustration of their method of construction. In the same

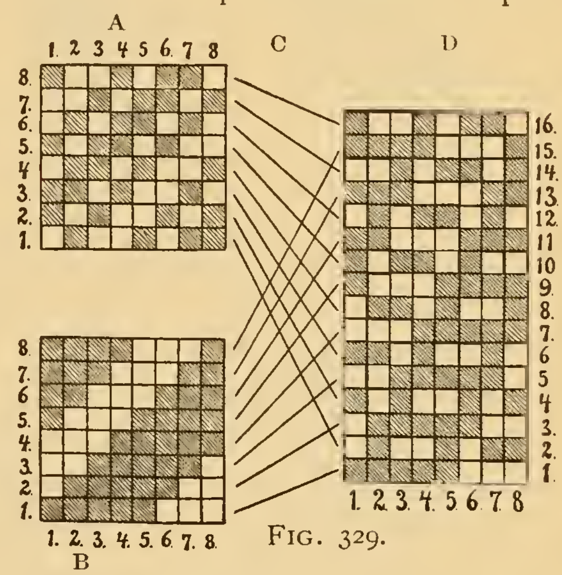


Fig. 329.

A represents the regular 8-harness twill $\frac{1\ \ 1\ \ 2}{1\ \ 2\ \ 1}$.
B " " " " $\frac{5}{3}$.
C " the drafting so as to get
D = the combination 63° steep-twill.
Repeat: 8 harness and 16 picks.
Arrangement of drafting:

1st	pick of	combination	twill is	1st	pick of	regular	twill	B.
2nd	"	"	"	1st	"	"		A.
3rd	"	"	"	2nd	"	"		B.
4th	"	"	"	2nd	"	"		A.
5th	"	"	"	3rd	"	"		B.
6th	"	"	"	3rd	"	"		A.
7th	"	"	"	4th	"	"		B.
8th	"	"	"	4th	"	"		A.
9th	"	"	"	5th	"	"		B.
10th	"	"	"	5th	"	"		A.
11th	"	"	"	6th	"	"		B.
12th	"	"	"	6th	"	"		A.
13th	"	"	"	7th	"	"		B.
14th	"	"	"	7th	"	"		A.
15th	"	"	"	8th	"	"		B.
16th	"	"	"	8th	"	"		A.

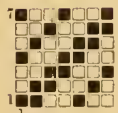


Fig. 330.

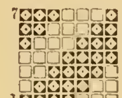


Fig. 331.

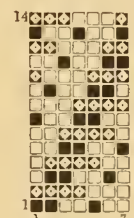


Fig. 332.

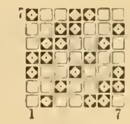


Fig. 333.

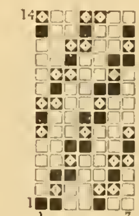


Fig. 334.

Fig. 330 illustrates the regular (45°) 7-harness twill $\frac{2\ \ 1}{2\ \ 2}$.
Fig. 331 represents the regular 7-harness twill known as $\frac{4}{3}$.
Fig. 332 clearly illustrates the combination of these two weaves (Figs. 330 and 331), or its "*Combination Steep-Twill*" of 63° grading.

To simplify the combination each regular twill is shown by a different type and this style of type is retained in the combination twill. Repeat of combination twill, Fig. 332, is 7-harness and 14 picks.

Fig. 333 illustrates the regular 45° twill, known as $\frac{2}{2}\frac{1}{2}$, which, with weave Fig. 330 (from the previous example), is used in constructing weave Fig. 334. Repeat of the latter: 7-harness and 14 picks.

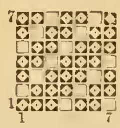


FIG. 335.

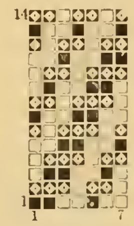


FIG. 336.

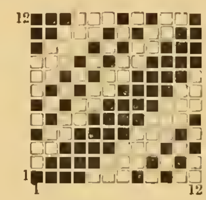


FIG. 337.

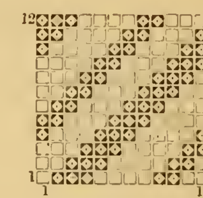


FIG. 338.

Fig. 330 is shown combined again with a different weave, Fig. 335, in the 7-harness and 14-picks combination twill-weave, Fig. 336.

12-harness weave, Fig. 337, and 12-harness weave, Fig. 338, are illustrated as combined in its 63° combination steep-twill by weave shown in Fig. 339. Repeat of the latter: 12-harness, 24 picks.

Fig. 341 illustrates another 12-harness combination twill, 63° grading, obtained by combining weave, Fig. 337 = 12-harness regular twill $\frac{4}{3}\frac{1}{1}\frac{1}{2}$, and weave Fig. 340 = 12-harness regular twill $\frac{1}{3}\frac{1}{2}\frac{1}{2}\frac{1}{1}$. Repeat for the combination twill-weave: 12-harness, 24 picks.

Fig. 342 represents the combination steep-twill for 12 harness 24 picks repeat, as produced by combining the regular 12-harness twill shown in Fig. 337 ($\frac{4}{3}\frac{1}{1}\frac{1}{2}$) with itself, starting from two different points.

The foregoing examples illustrating the construction of the sub-division of twills classified in general as "combination twills" indicate that an immense variety of different new weaves can be produced.

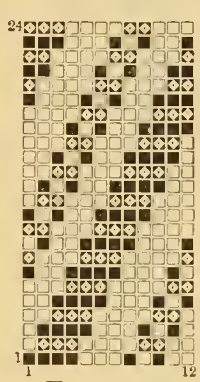


FIG. 339.

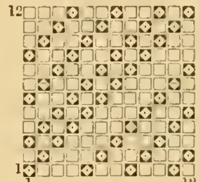


FIG. 340.

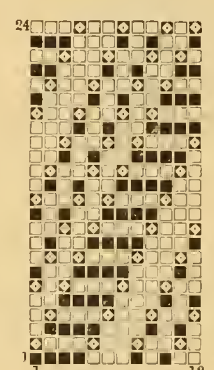


FIG. 341.

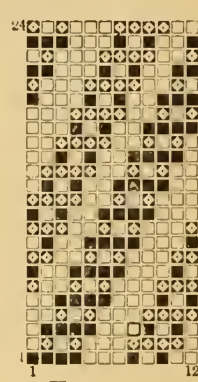


FIG. 342.

The principle of combining weaves in this manner, or the construction of new designs out of one weave, as shown by rules and examples, is of great value to every designer, as it enables him to produce a large variety of weaves.

In addition to the combination steep-twills, constructed out of two twills and in regular order, we can vary the order systematically as much as we choose; again, we may combine three four or five regular twills for one combination twill; in fact, the great variety of new weaves we can construct is unlimited.

VII. Corkscrew Twills.

This sub-division of the "regular" (45°) twills is derived from the latter by means of a "double draw." This procedure will, to a certain extent, reduce the texture of the warp for the face in the fabric, hence a greater number of those threads per inch, compared with the regular twill, are required.

A. Corkscrew Twills having for their Foundation One of the Regular Twills.

This sub-division of the corkscrew twills commences with 5-harness, after which they can be made on any number of harness desired.

Figs. 343, 344, 345, 346 are designed to illustrate the method of operation for drafting the 5-harness corkscrew twill from its foundation weave, the regular 5-harness twill known as $\frac{3}{2}$, and which is represented in Fig. 343.

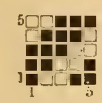


FIG. 343.

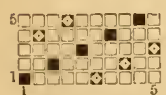


FIG. 344.

Fig. 344 shows the double draw as required for drafting from Fig. 343.

Weave Fig. 345 shows 5-harness corkscrew (with 5 picks in its repeat).

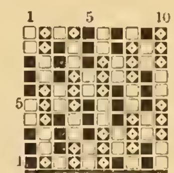


FIG. 345.

FIG. 346.

Drawing-in draft for practical work, will call for a 5-harness "straight draw," as illustrated in Fig. 346. The present system of treating corkscrew twills will always be more advantageous on an uneven number of harnesses, as only such a number will allow an equal breaking off for the two twill-effects as visible on the face of the fabric.

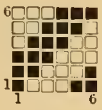


FIG. 347.

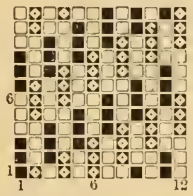


FIG. 348.

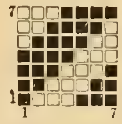


FIG. 349.

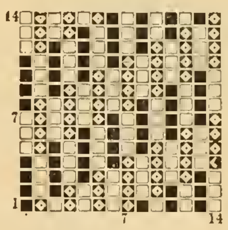


FIG. 350.

Fig. 347 shows the regular 6-harness $\frac{3}{3}$ twill. By means of double drafting, 1–4, 2–5, 3–6, 4–1, 5–2, 6–3, we derive Fig. 348, the 12-harness corkscrew. Drawing-in: "Straight draw," 12-harness.

Fig. 349 illustrates the 7-harness $\frac{4}{3}$ twill. By double drafting (1–5, 2–6, 3–7, 4–1, 5–2, 6–3, 7–4) we derive weave Fig. 350, the 7-harness corkscrew. Drawing-in: "Straight draw," for 7-harness.

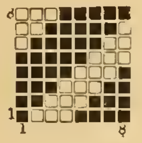


FIG. 351.

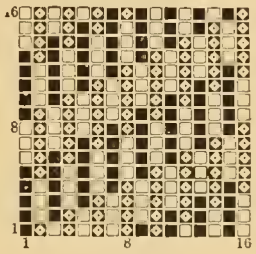


FIG. 352.

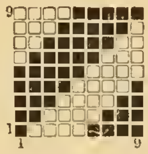


FIG. 353.

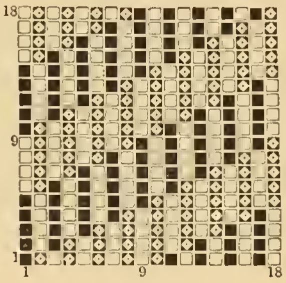


FIG. 354.

Fig. 351 represents the 8-harness $\frac{5}{3}$ twill, and Fig. 352 illustrates the latter arranged for the corkscrew weave, which is derived by means of double drafting the regular twill. (1, 6, 2, 7, 3, 8, 4, 1, 5, 2, 6, 3, 7, 4, 8, 5.) Drawing-in: Straight draw 16-harness or double draw on 8-harness only.

Fig. 353 illustrates the 9-harness twill known as $\frac{5}{4}$.

Fig. 354 represents the corresponding corkscrew, derived from the former by means of double draw (1, 6, 2, 7, etc.). In corkscrew weaves for a high number of harness in their repeat, as 11, 13, 15, etc., the interlacing of the warp and filling is very loose; so the fabric may get too spongy in handling. To remedy this, without changing the face of the fabric, the floating of the warp upon the back of the fabric must be reduced, which is accomplished by adding one or more places of interlacing for the float. For example, Fig. 355, represents the 11-harness corkscrew weave, which

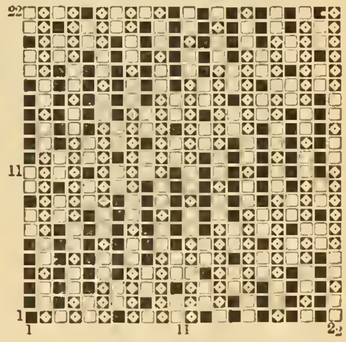


FIG. 355.

should require the 11-harness $^{6}\text{——}_{5}$ twill, but where is found in the present example a change of the 5 down in rotation, to 2 down, 1 up, 2 down.

Thus the actual foundation for the present weave is the regular 11-harness $^{6}\text{—}_{2}\text{—}^{1}\text{—}_{2}$ twill.

B. Corkscrew Weaves Derived by Combining Two Regular Twills.

This sub-division of corkscrews has for its object the forming of different sized twill lines upon the face of the fabric, which is obtained by combining two different twills of an equal repeat. In constructing the corkscrew use alternately one warp-thread from one twill, one warp-thread from the other twill, until all the harnesses are taken up. For example, Fig. 356, a 12-harness corkscrew-weave, which is designed from the 6-harness twill $^{4}\text{——}_{2}$ (see Fig. 357) and the 6-harness twill $^{3}\text{——}_{3}$ (see Fig. 358).

Drawing-in draft: 12-harness "straight draw."

Repeat: 12 harness and 6 picks.

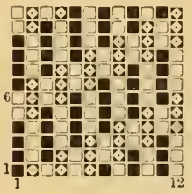


Fig. 356.

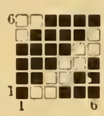


Fig. 357.

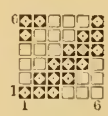


Fig. 358.

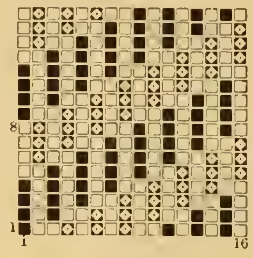


Fig. 359.

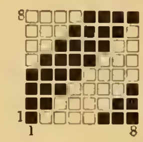


Fig. 360.

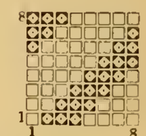


Fig. 361.

In examining the corkscrew weave we find its

1st	warp-thread	the same	as the	1st	warp-thread	in Fig.	357.
2nd	"	"	"	1st	"	"	358.
3rd	"	"	"	2nd	"	"	357.
4th	"	"	"	2nd	"	"	358.
5th	"	"	"	3rd	"	"	357.
6th	"	"	"	3rd	"	"	358.
7th	"	"	"	4th	"	"	357.
8th	"	"	"	4th	"	"	358.
9th	"	"	"	5th	"	"	357.
10th	"	"	"	5th	"	"	358.
11th	"	"	"	6th	"	"	357.
12th	"	"	"	6th	"	"	358.

The number of harness required for the corkscrew weave will always equal the combined number of harness required for the regular twills.

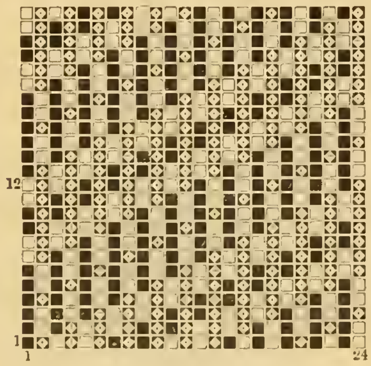


Fig. 362.

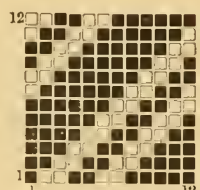


Fig. 363.

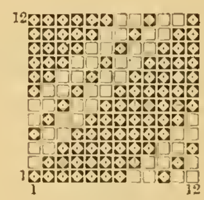


Fig. 364.

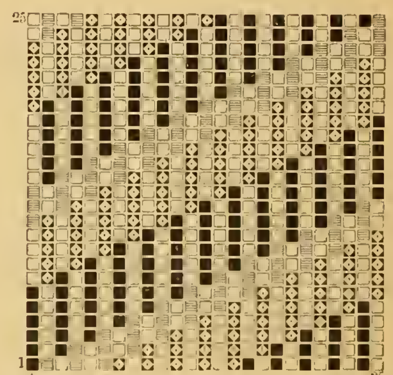


Fig. 365.

In Fig. 359 we illustrate a 16-harness corkscrew, composed out of the regular twill $^{4}\text{——}_{4}$ (Fig. 360) and $^{3}\text{——}_{5}$ (Fig. 361).

Drawing-in draft: 16 harness "straight draw." Repeat: 16 harness and 8 picks.

In Fig. 362, we illustrate a 24-harness corkscrew obtained from the regular twill $^{6}{}_{2}{}^{2}{}_{2}$, shown in Fig. 363, and $^{7}{}_{2}{}^{1}{}_{2}$, shown in Fig. 364.

Drawing-in draft: 24 harness "straight draw." Repeat: 24 harness and 12 picks.

This corkscrew weave will also illustrate the arranging of a loose to a closer interlacing. For example: Suppose we constructed a corkscrew of the two regular twills $^{6}{}_{5}$ and $^{7}{}_{5}$, and found the fabric to be perfect as to size of twill lines upon its face, yet too spongy in structure. In this instance, the weave Fig. 362 would readily dispense with the obstacle without changing the appearance of its face.

The next step for figuring in corkscrews is the production of three different-sized twill lines, as in weave Fig. 365, which shows one twill of 6 picks, a second twill of 5 picks and a third twill of 3 picks connected uninterruptedly with each other.

C. *Figuring with the Filling upon the Face of Corkscrew Weaves.*

Any of the different corkscrew weaves illustrated and explained in their construction under sub-divisions *A* and *B* (also any other corkscrew derived from the principles given) can be arranged for the third sub-division of corkscrews. As mentioned, the object is to form figures of different size, design and combination upon the face of a corkscrew weave by floating the filling, which otherwise rests imbedded between the warp-threads that form either face or back of the fabric, at certain spaces, and this in regular distances after a given arrangement. These spots, obtained upon the face of any corkscrew, will appear distinctly in piece-dyed fabrics if a single yarn for filling is used and a double or twist for warp; again, by using lustre yarn for warp and common for filling.

In fancy corkscrews, where we use a different colored yarn for warp and filling, these spots (floating the filling upon the face of the fabric) will readily be visible. Silk filling may also be introduced, at certain of these floating picks, which will greatly assist in producing fancy effects.

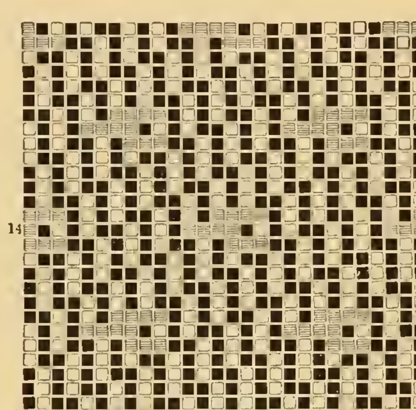


Fig. 366.

To give a clearer understanding of the nature of this floating Figs. 366 and 367 are arranged.

Fig. 366 has for its foundation the 7-harness corkscrew shown before in Fig. 350. We illustrate the new weave by three different characters of types:

■ for raisers }
□ for sinkers } from common corkscrew.
▤ for sinker for floating the filling upon the face of the fabric.

Repeat: 14 warp-threads, 14 picks.

Motive for arranging spots: 

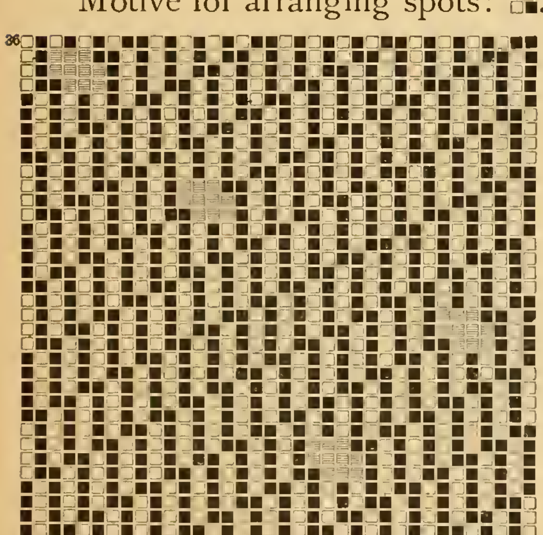
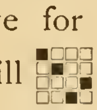


Fig. 367.

Fig. 367 illustrates the forming of filling spots upon the regular 9-harness corkscrew (see fig 354).

Motive for arranging these spots is the 4-harness broken-twill 

■ for raisers }
□ for sinkers } from common corkscrew.
▤ for sinkers for floating the filling upon the face of the fabric.

Repeat: 36 warp-threads, 36 picks.

Drawing-in draft will reduce the 36 warp-threads upon 15-harness as follows: 1, 2, 3, **4**, **5**, 6, 7, 8, 9, 1, 2, 3, **10**, **11**, 6, 7, 8, 9, 1, 2, 3, **12**, **13**, 6, 7, 8, 9, 1, 2, 3, **14**, **15**, 6, 7, 8, 9.

D. Curved Corkscrew Twills.

This sub-division of the corkscrew weaves is derived from the regular twills by drafting in both directions, according to the same rules given in constructing the corkscrew under sub-divisions *A* and *B*. After starting to draft from left to right for a certain number of threads, reverse the direction of drafting until the starting point is reached.

Front.

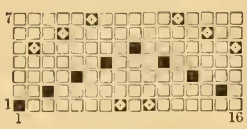


FIG. 368.

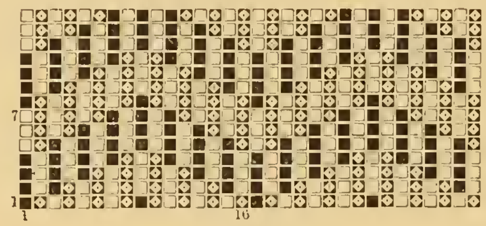


FIG. 369.

Front.

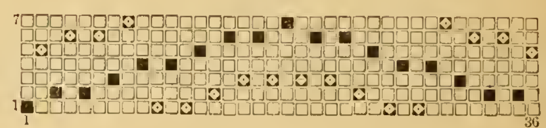


FIG. 370.

For example: Take the 7-harness regular twill ${}^{4}\text{———}_{3}$, from which commence to draft as follows: 1, 5, 2, 6, 3, 7, 4, 1, 5, 1, 4, 7, 3, 6, 2, 5, as represented in double draw Fig. 368.

Fig. 369 illustrates the "curved" (wavy) corkscrew derived by means of this double draft from the 7-harness (${}^{4}\text{———}_{3}$) twill. Repeat: 16 warp-threads, 7 picks. Drawing-in draft: 16-harness "straight" draw and one repeat of corkscrew weave from Fig. 369 for harness chain; or 7-harness double draw, Fig. 368, and "regular" twill ${}^{4}\text{———}_{3}$ for harness chain.

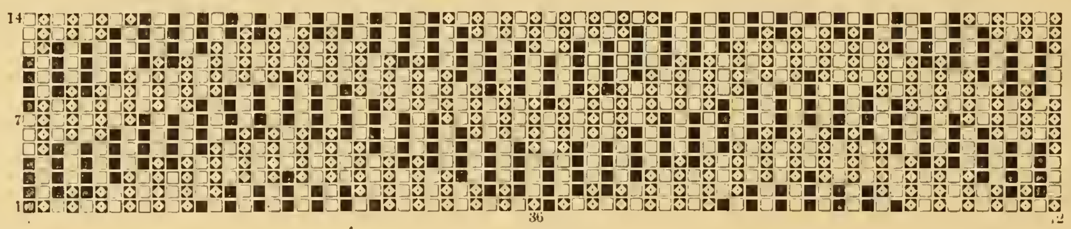


FIG. 371.

If the twill lines upon the face of the fabric are not required so steep, draft every one or every second, third, or fourth, etc., warp-thread for each twill twice or three times, or oftener, upon the same harness. Figs. 370, 371, 372, 373 are illustrations of this kind.

Fig. 370 illustrates a double-draw, which has for its principle of construction, 2 warp-threads upon 1 harness, and 1 warp-thread upon the next.

On points where the twill changes its direction, judgment must be used so as to prevent the last pick floating too far.

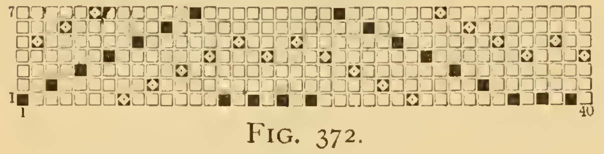


FIG. 372.

Fig. 371 illustrates the curved corkscrew as derived from the "regular" ${}^{4}\text{———}_{3}$ 7-harness twill by means of drawing-in draft, Fig. 370. Repeat: 36 warp-threads, 7 picks. For drawing-in draft use Fig. 370; for harness chain the regular ${}^{4}\text{———}_{3}$ twill.

A double-draw in which the point of reversing the twill is more balanced, to give a more wavy appearance when applied to a fabric, is shown in Fig. 372. The point harness of the one twill shown in ■ type is drawn in four times in rotation, whereas its corresponding point

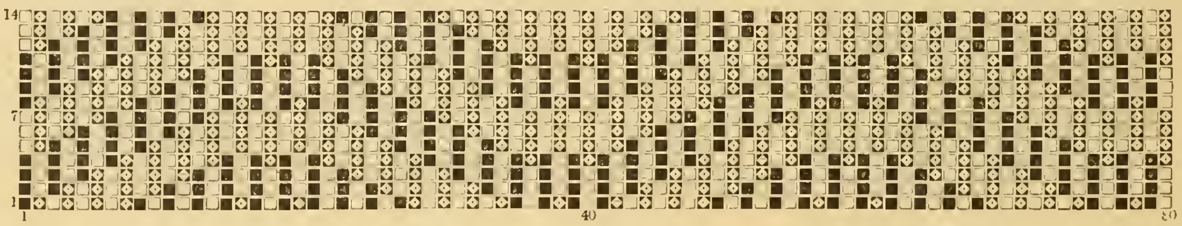


FIG. 373.

for the other twill is arranged to correspond as nearly as possible, without producing any place for filling-floats on rear of fabric.

Fig. 373 illustrates the corkscrew weave as derived from the 7-harness twill $\frac{4}{3}$ when using double draw given under Fig. 372. Repeat: 40 warp-threads 7 picks.

Double draw: requiring 7-harness for the 40 warp-threads in repeat of weave.

The next step in figuring in this division of corkscrew weaves is the use of filling-float effects as explained under sub-division C.

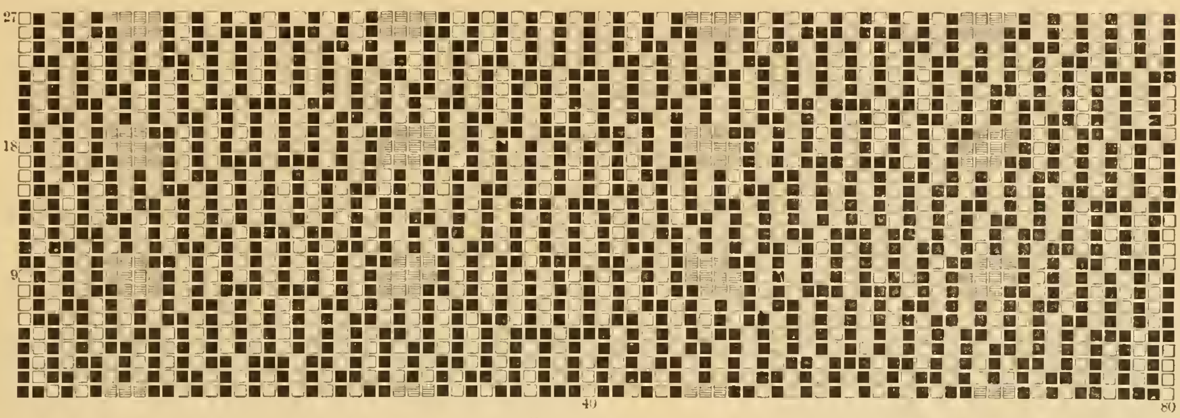


Fig. 374.

Corkscrew weave Fig. 374, is designed to clearly illustrate this point. Repeat: 40 warp-threads and 9 picks.

The regular twill, which is used for the construction of the curved corkscrew, is the $\frac{5}{4}$ 9-harness twill. ▪ for raisers, ▫ for sinkers, from curved corkscrew; ▤ for sinkers for floating the filling upon the face of the fabric.

E. Corkscrew Weaves Composed of Warp and Filling Twills.

If all the different divisions of corkscrew weaves, thus far explained, are used in practical work, the warp will form the face and back of the fabric, whereas the filling will rest imbedded

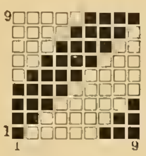


Fig. 375.

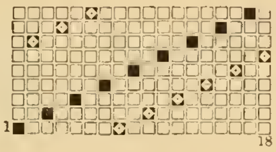


Fig. 376.

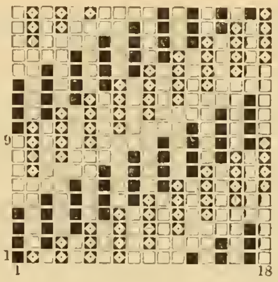


Fig. 377.

between the warp (except in the few floating spots used in Figs. 374, 367, 366). In the present division of corkscrews the filling is used to show a third line besides the two lines produced by the warp.

To give a thorough understanding Figs. 375, 376, 377, 378, 379 and 380 have been designed.

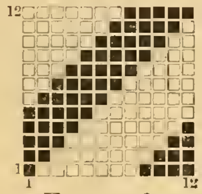


Fig. 378.

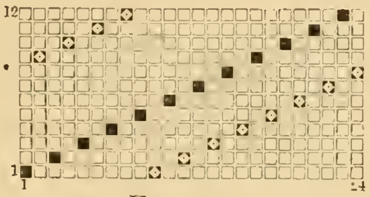


Fig. 379.

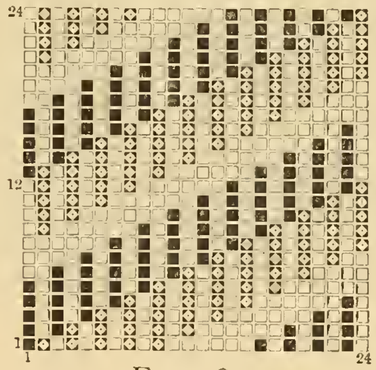


Fig. 380.

Fig. 375 represents the 9-harness twill known as $\frac{4}{5}$. Fig. 376 the drafting by which weave Fig. 377 is produced. Repeat for the latter: 18 warp-threads and 9 picks. For drawing-in use either 18-harness straight draw, and for harness chain one repeat of corkscrew; or, 9-harness double draw (Fig. 376), and for harness chain the $\frac{4}{5}$ twill (Fig. 375).

Fig. 378 represents the 12-harness $\frac{5}{7}$ twill. Fig. 379 the drafting by which corkscrew weave Fig. 380 is derived. Repeat for the latter: 24 warp-threads and 12 picks. For drawing-in use either 12-harness double draw (Fig. 379), and for harness chain the $\frac{5}{7}$ twill (Fig. 378); or, 24-harness straight draw, and for harness chain one repeat of corkscrew weave, 24-harness and 12 picks (Fig. 380).

F. Corkscrew Weaves Figured by the Warp.

In this division of corkscrew weaves, figures of any size or form are produced by arranging a corresponding floating of alternate warp-threads. Every uneven numbered warp-thread (1, 3,

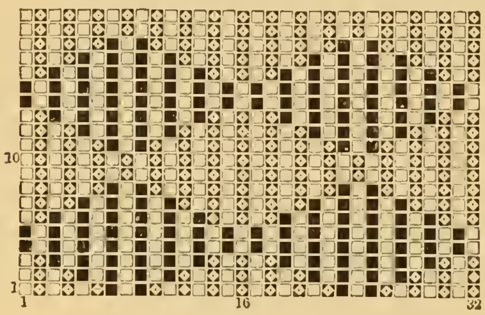


Fig. 381.

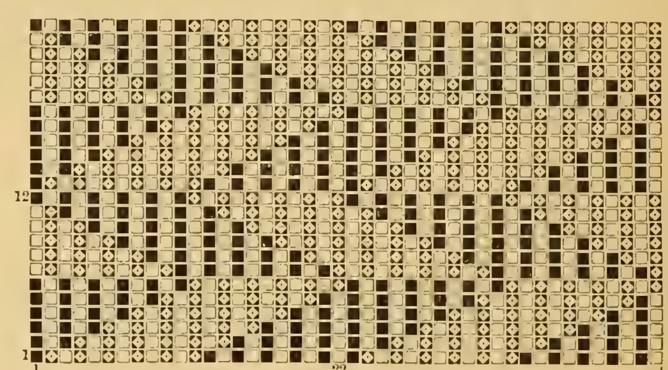


Fig. 382.

5, 7, etc.,) is used for producing the figure, while the ground is produced by the even numbered warp-threads. Figs. 381 to 383 are designs illustrating this method of figuring.

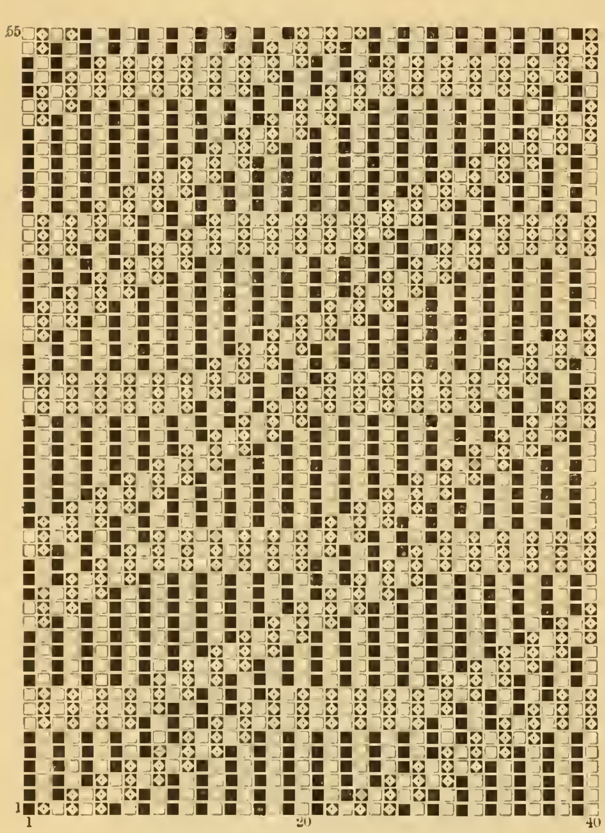


Fig. 383.

Fig. 381. Repeat: 16 warp-threads and 10 picks.

Fig. 382 Repeat: 22 warp-threads and 12 picks.

Fig. 383. Repeat: 20 warp-threads and 55 picks.

Before closing the lecture on the corkscrew weaves we shall briefly refer to division G of the latter, or *corkscrew weaves in which the face and back of the fabric is produced by the filing;* the warp resting between the filling.

This arrangement for corkscrews is very little used, on account of the high number of picks required to produce a close face in the fabric.

In Fig. 384 we give an illustration of the 7-harness filling corkscrew. This weave readily explains itself as the mate to the warp corkscrew illustrated in Fig. 350, page 69, the raisers being exchanged for sinkers and *vice versa.* Repeat: 7 harness and 7 picks.

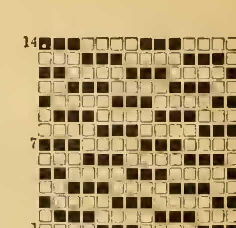


Fig. 384.

In the same manner any design given under headings *A* and *B* of the sub-divisions of corkscrews can be used for filling face by proceeding with it the same as with Fig. 384 in Fig. 350.

VIII. Entwining Twills.

This class of the twill weaves (which might also be considered another kind of "broken twills") is derived from the regular twill weaves by running one, two, three or more pieces of twills parallel to each other in one direction (45° grading), and towards these twill lines, at right angles, a second system of one, two, three or more pieces of twill lines (generally of equal size and construction as the first). This arrangement of twills meeting each other at right angles, the one twill continuing where the other stops, and alternately changing between both systems, will give the fabric the appearance of entwining twill lines or set of twill lines; hence the name.

The following designs, Figs. 385 to 396 readily explain themselves as such twill weaves, and also illustrate the manner of constructing similar original weaves.

Fig. 385 repeat: 8 warp-threads and 8 picks. This design is constructed from the 4-harness $^{2}—_{2}$ twill, and has two parallel lines of twills.

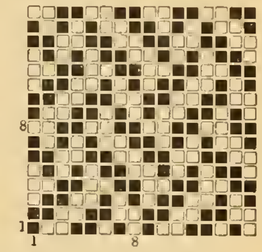


Fig. 385.

Rule for Finding the Number of Harness Required for Entwining Twills:—The number of harness required (or warp-threads in one repeat) is ascertained by multiplying the repeat of the foundation twill by the number of pieces of twills used.

In the present design this will result in the following multiplication:

$$4 \times 2 = 8$$

Repeat of foundation twill × pieces of twills used = number of harness required.

It will be advantageous for the student to construct additional designs of entwining twills out of the 4-harness $^{2}—_{2}$ twill, using 3 pieces of twills = 12-harness;
4 " " = 16-harness;
5 " " = 20-harness, etc., etc.

The rule given for ascertaining the repeat of the warp-threads in the design will also apply to the repeat of the picks.

Fig. 386 represents the entwining twill formed with the 6-harness $^{3}—_{3}$ twill and four pieces of twills. Thus 6 × 4 = 24 warp-threads and picks for repeat.

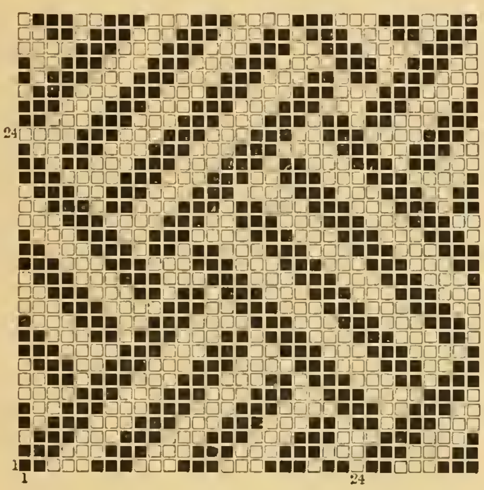


Fig. 386.

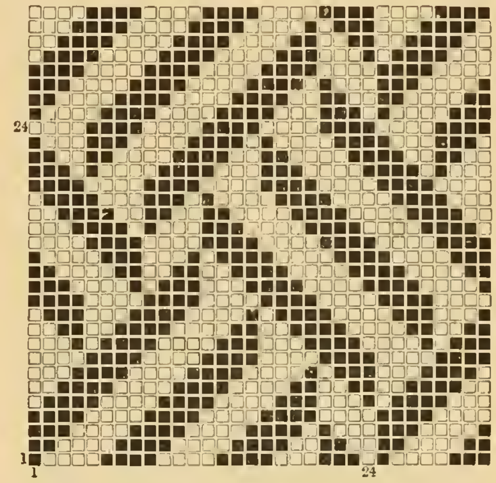


Fig. 387.

Fig. 387 illustrates the entwining twill produced with the 8-harness $^{4}—_{4}$ twill, having three pieces of twills for the construction. 8 × 3 = 24 warp-threads and picks in one repeat.

In accordance with designs Figs. 386 and 387, and their methods of construction, the following designs may readily be produced:

$^{3}—_{3}$-6-harness twill for foundation weave	× 2 pieces of twills	= 12	repeat of warp-threads and picks.
	× 3 " "	= 18	
$^{4}—_{4}$-8-harness twill for foundation weave	× 2 " "	= 16	repeat of warp-threads and picks.
	× 4 " "	= 32	

A sub-division of these entwining twills is produced by forming squares surrounded by parallel twill lines. The squares thus produced may be filled up by other twills, basket-weaves, rib-weaves, etc., or they may be left empty. In this manner designs Figs. 388 to 395 are formed.

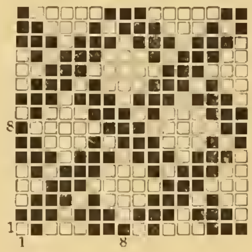


FIG. 388.

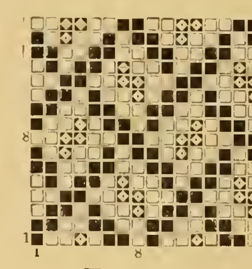


FIG. 389

Fig. 388. Repeat: 8 warp-threads, 8 picks. In this design, which is constructed from the $\frac{3}{5}$ 8-harness twill, the squares produced by the twill lines is left empty.

Fig. 389—repeat: 8 warp-threads, 8 picks—is produced from the $\frac{2}{6}$ 8-harness twill; the squares produced by the twill lines entwining each other at right angles, is filled out by the two centre warp-threads interlacing with the filling in the shape of a 4-harness twill.

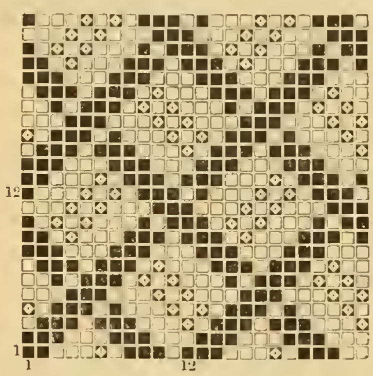


FIG. 390.

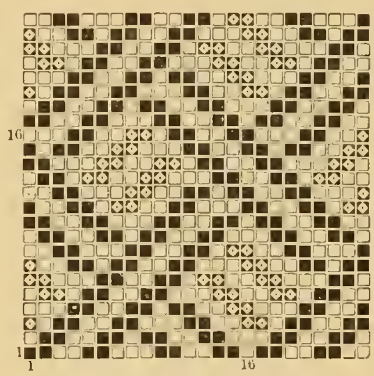


FIG. 391.

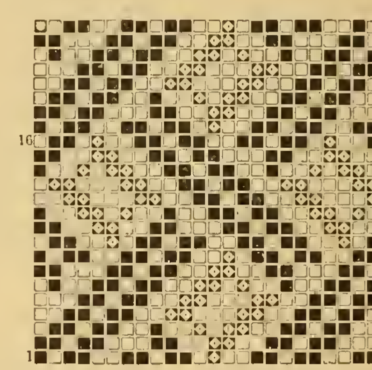


FIG. 392.

Fig. 390—repeat: 12 warp-threads, 12 picks—is produced from the $\frac{3}{9}$ 12-harness twill; the squares in this weave being filled out by the motive $_{3}{}^{1}{}_{1}{}^{1}{}_{3}$ twill.

Fig. 391—repeat: 16 warp-threads, 16 picks—is produced from the $\frac{2}{2}\frac{2}{10}$ 16-harness twill.

Fig. 392—repeat: 16 warp-threads, 16 picks—is produced from the $\frac{2}{1}\frac{2}{11}$ 16-harness twill.

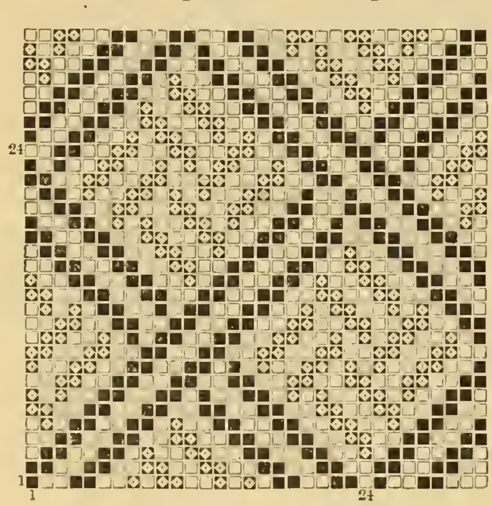


FIG. 393.

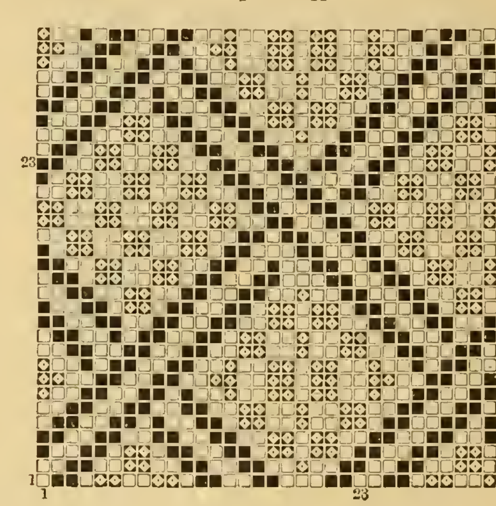


FIG. 394.

Figs. 389, 390, 391, 392, as well as the following three weaves, Figs. 393, 394 and 395, show the twills interlacing each other thus ■, while the weave used for filling out the squares, produced by means of the latter, is shown thus ⊡.

Fig. 393, repeat: 24 warp-threads, 24 picks. In this design an additional entwining arrangement of twills is used for filling out the squares produced by the main entwining twill lines.

Fig. 394, repeat: 23 warp-threads, 23 picks. In this design two kinds of basket-weaves are used (alternately) for interlacing warp and filling in the places of squares produced by the main entwining twill lines.

Fig. 395, repeat: 24 warp-threads, 24 picks. In this design a pointed twill is used for filling out the squares produced by the entwining twill lines.

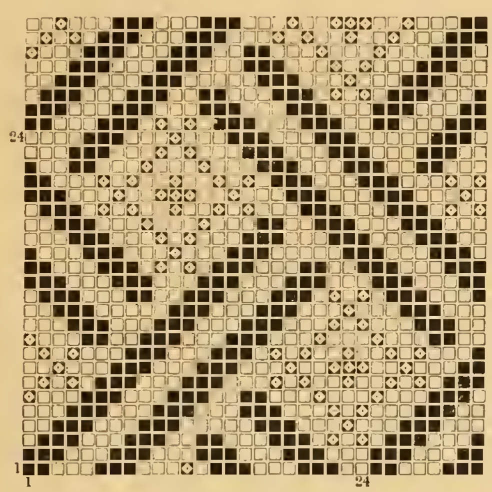


Fig. 395.

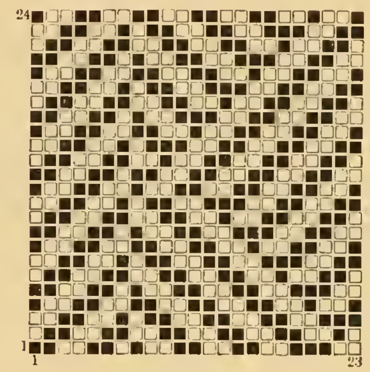


Fig. 396.

Fig. 396—repeat: 23 warp-threads, 24 picks—illustrates the novel combination of an entwining twill and suggests the great variety of weaves which can be designed for this sub-division of the regular twills.

IX. Twills Having Double Twill Effects.

These twill weaves are obtained by connecting two, three, four or more parallel twill lines, in one repeat, with another twill line (main line) which runs in an opposite direction.

Rule for Constructing these Weaves.

Run your main twill at a grading of 45° in a direction from left to right over the entire repeat of the weave (see ■ in weaves Figs. 397, 398, 399 and 400); next run the other twills at right angles to the first mentioned twill (see ▫ in weaves 397 to 400) and stop so as to form a clear connecting spot (and without running both twills into each other).

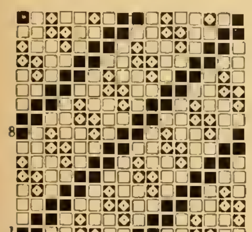


Fig. 397.

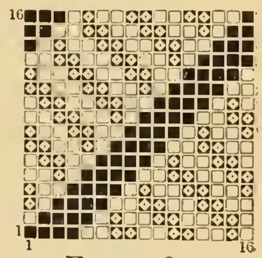


Fig. 398.

Figs. 397 to 400 are weaves designed in this manner, and clearly illustrate this sub-division of twill weaves.

Fig. 397. Repeat: 8 warp-threads, 8 picks. "Main twill" is $\frac{2}{6}$ = 8-harness, "cross-bar twill or double will effect" $\frac{2}{2}$ for 2 warp-threads.

Fig. 398. Repeat: 16 warp-threads, 16 picks. "Main twill" $\frac{4}{12}$ = 16-harness. "Cross-bar twill or double twill effect" $\frac{2}{2}$ for 5 successive warp-threads.

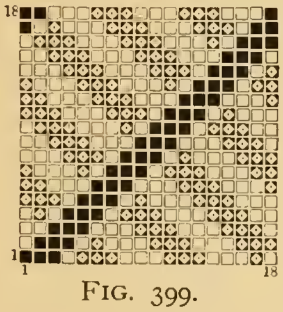


Fig. 399.

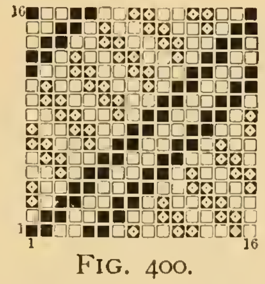


Fig. 400.

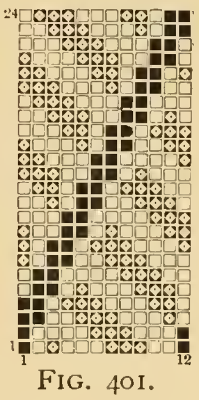


Fig. 401.

Fig. 399. Repeat: 18 warp-threads, 18 picks. Main twill $\frac{3}{15}$ = 18-harness. Cross bar twill or double twill effect $\frac{3}{3}$.

Fig. 400. Repeat: 16 warp-threads and 16 picks.

The main twill in the present design is $\frac{2}{2}\frac{2}{10}$ = 16-harness. The "crossbar twill," or double twill effect, is the $\frac{2}{2}$ 4-harness twill.

Twills of a different grading than 45° for the main twill line can also be used. For example, steep-twills of 63°, 70° or 75° grading. Again, the cross-bar twill may be changed, if required, to a like different grading.

Fig. 401 illustrates a fancy twill of the present division constructed from the 63° steep-twill derived from the $\frac{4}{20}$ = 24-harness foundation-twill for the main twill, and the $\frac{3}{3}$ = 6 harness 45° twill for the double-twill effect.

X. Twill Weaves Producing Checkerboard Effects.

This sub-division of the twill weaves is obtained by combining any of our regular twills, warp for face, with the same twill weave, filling for face.

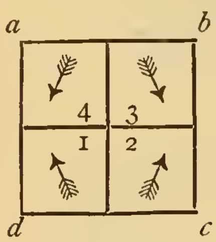


Fig. 402.
a, b, c, d, repeat of weave.

Rule.—Divide the repeat (equal distance for warp and filling) into four even squares (see diagram Fig. 402), and insert the twill weave, warp for face, into every uneven numbered (1, 3,) square, and the twill weave, filling for face, into every even numbered (2, 4,) square.

The direction of the twill in the warp effect must be opposite to the twill in the filling effect; hence if running the direction of the twill, in the present example, for the warp for face effect from the right to the left, we must run the direction of the twill in the effect having filling for face from the left to the right. This direction of running the twill is illustrated in the diagram Fig. 402 by the four arrows.

Another point to be kept in mind when designing for this kind of weave is, that in places where the warp and filling effect meets, a clear cut must be produced; *vice versa,* change from sinker to raiser or raiser to sinker.

For illustrating the foregoing rule weaves Figs. 403 to 411 have been constructed.

Design Fig. 403 illustrates the checkerboard effect obtained from combining a double repeat of the 3-harness twill $\frac{2}{1}$ with a double repeat of its corresponding filling effect $\frac{1}{2}$. Repeat: 12 warp-threads, 12 picks.

Design Fig. 404 is constructed from the 4-harness $\frac{3}{1}$ and $\frac{1}{3}$ twill. Each effect used for four successive warp-threads and picks equals one repeat of the weave in the warp and filling effect. Complete repeat of the design calls for 8 warp-threads and 8 picks.

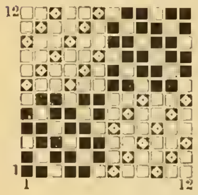


Fig. 403.

Fig. 404.

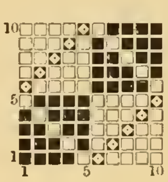


Fig. 405.

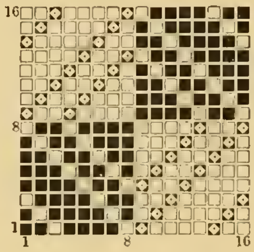


Fig. 406.

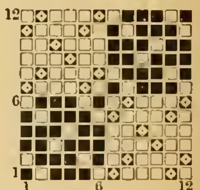


Fig. 407.

Fig. 405 illustrates a similar arrangement as explained by weave Fig. 404, applied to the 5-harness twill, $\frac{4}{1}$ and $\frac{1}{4}$. Repeat: 10 warp-threads and 10 picks.

Design Fig. 406 illustrates the checkerboard effect derived from combining the 8-harness twill $\frac{2}{1}\frac{4}{1}$ or warp face, with $\frac{1}{4}\frac{1}{2}$, being the filling for face of the same weave. Repeat: 16 warp-threads and 16 picks.

Design Fig. 407 represents the checkerboard effect derived by combining the 4-harness broken twill, warp for face, with the same weave, filling for face. 6 warp-threads and 6 picks or equal 1½ repeat are used for each effect. Repeat: 12 warp-threads and 12 picks.

Combination of Warp and Filling Effects from a 45° Twill Weave after a given Motive.

The next step towards figuring twill weaves is found in combining the warp and filling effect of a regular twill (the same as used in the preceding chapter on checkerboard effects) after a given motive (idea of a figure as desired to be made). Weaves Figs. 408*a* and 410 illustrate two examples, which readily explain their construction after the motives given in Figs. 408 and 409.

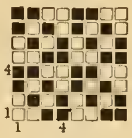


FIG. 408.

Motive for weave Fig. 408*a*
4 warp and
4 filling changes.

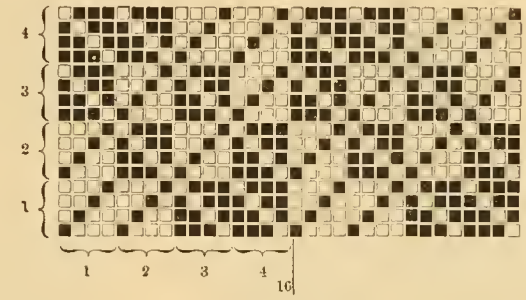


FIG. 408*a*.

Weave derived out of motive Fig. 408.
Repeat: 16 warp-threads, 16 picks.

Fig. 408 represents a motive after which weave Fig. 408*a* is constructed. The motive calls for four changes in effect in each direction, which equals (4 × 4 =) 16 possible changes over the entire surface of one repeat in the motive. In the design (weave) Fig. 408*a*, 4 warp-threads and 4 picks are used for each change in the motive, and the 4-harness twills $\frac{1}{3}$ and $\frac{3}{1}$ (warp and filling effect of the same regular twill) are used for interlacing warp and filling.

The rules given under the head of checkerboard effects also apply to this sub-division.

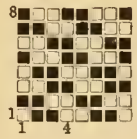


FIG. 409.

Motive for weave Fig. 410
4 warp and
8 filling changes.

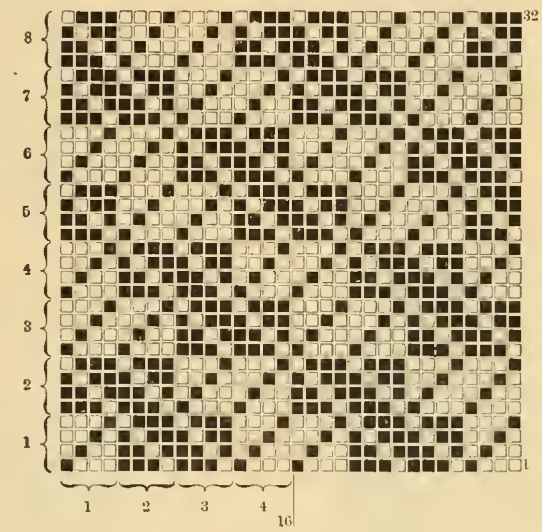


FIG. 410.

Weave derived out of motive Fig. 409.
Repeat: 16 warp-threads, 32 picks.

Fig. 409 represents a motive after which weave Fig. 410 is constructed. The motive calls for four changes warp, and eight changes filling, ways, which equals (4 × 8 =) 32 different possible changes over the entire surface of one repeat in the motive. In weave Fig. 410, 4 warp-threads and 4 picks are used for each change in the motive, with the 4-harness twills $\frac{3}{1}$ and $\frac{1}{3}$ for interlacing warp and filling.

XI. Fancy Twill Weaves.

The next plan for designing twill weaves is that of combining basket weaves, rib weaves, etc., arranged in the shape of twills, with any of the regular twills as may be desired.

Weaves Figs. 411 to 421 illustrate a few such examples:

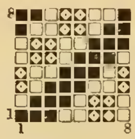


Fig. 411.

Repeat: { 8 warp-threads, 8 picks.

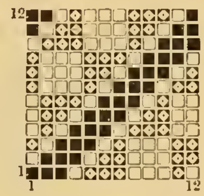


Fig. 412.

Repeat: { 12 warp-threads, 12 picks.

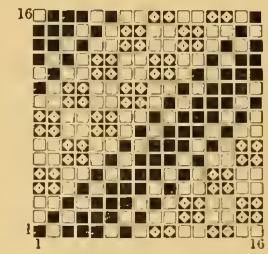


Fig. 413.

Repeat: { 16 warp-threads, 16 picks.

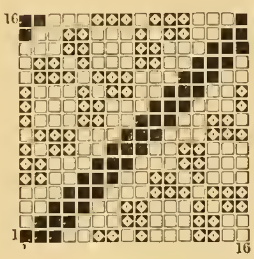


Fig. 414.

Repeat: { 16 warp-threads, 16 picks.

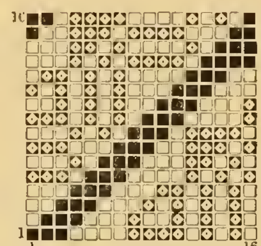


Fig. 415.

Repeat: { 16 warp-threads, 16 picks.

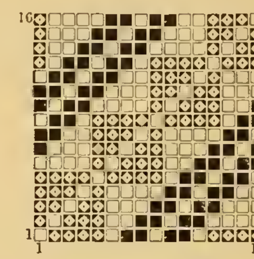


Fig. 416.

Repeat: { 16 warp-threads, 16 picks.

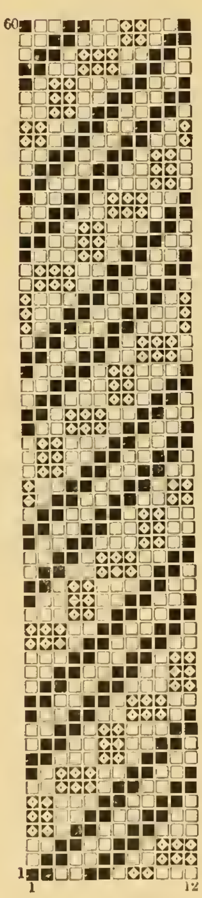


Fig. 417.

Repeat: { 12 warp-threads, 60 picks.

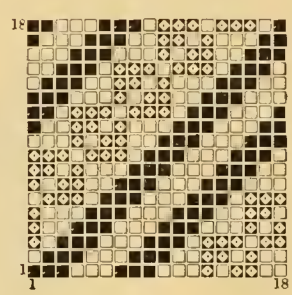


Fig. 418.

Repeat: { 18 warp-threads, 18 picks.

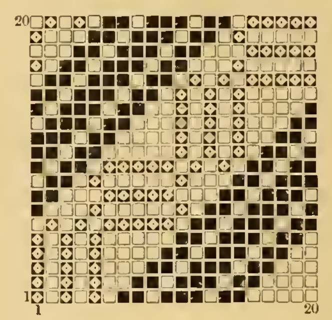


Fig. 419.

Repeat: { 20 warp-threads, 20 picks.

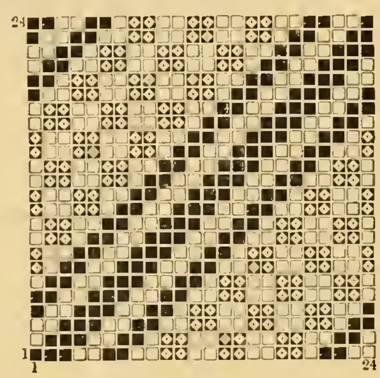


Fig. 420.

Repeat: { 24 warp-threads, 24 picks.

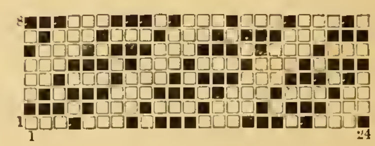


Fig. 421.

Repeat: { 24 warp-threads, 8 picks.

XII. Pointed Twills.

Pointed twills constitute the next sub-division of twills, and are derived from the latter by means of point draws (previously explained and illustrated under the head of drawing in drafts, page 33). The plainest "point draw" calls for each harness in rotation (beginning at number one, or front) until all harnesses are taken up. Next proceed to draw the rotation of harness backwards until you get on to the starting point. The first and last harness of the set (representing the front and rear harness), technically known as "point harness," are drafted only once; thus requiring only one-half the number of heddles compared to the others. If using a fancy point-draw, use the point harness in the one effect, straight in the next effect, and *vice versa.*

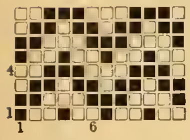


FIG. 422.

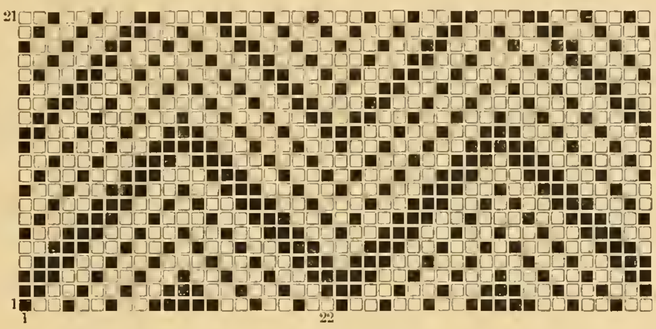


FIG. 423.

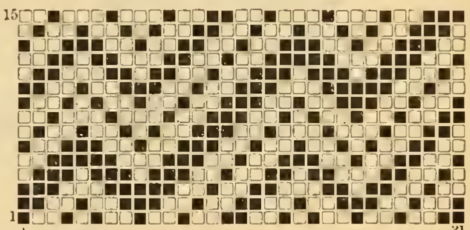


FIG. 424.

Fig. 422 illustrates a "point twill" composed of the $\frac{2}{\ }\frac{\ }{2}$ 4-harness twill executed on the regular 4-harness point draw, 1, 2, 3, 4, 3, 2. Repeat: 6-harness and 4 picks.

Fig. 423 represents a "point twill" composed of the 21-harness $\frac{3}{\ }\frac{\ }{2}\frac{1}{\ }\frac{\ }{2}\frac{1}{\ }\frac{\ }{2}\frac{2}{\ }\frac{\ }{2}\frac{1}{\ }\frac{\ }{2}\frac{1}{\ }\frac{\ }{2}$ regular twill. The point draw required is as follows: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 11 10, 9, 8, 7, 6, 5, 4, 3, 2. Repeat: 22 warp-threads and 21 picks, requiring 12-harness point draw. This will illustrate that the entire repeat of a regular twill must not be used in the construction of its "point twill," as in the present example only 12 threads of the regular twill, with 21 threads for repeat in weave are used, (9 threads being entirely omitted).

The second kind of "point twills" is designed from the regular twills by means of a "fancy point draft." For example, weave Fig. 424, which in its mode of construction is designed from the $\frac{3}{\ }\frac{\ }{2}\frac{1}{\ }\frac{\ }{2}\frac{2}{\ }\frac{\ }{2}\frac{1}{\ }\frac{\ }{2}$ 15-harness twill by means of the following fancy point-draft: 1, 2, 3, 4, 5, 4, 3, 2, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 11, 10, 9, 8, 9, 10, 11, 12, 13, 14 and 15.

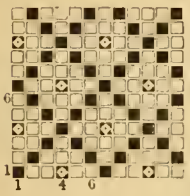


FIG. 425.

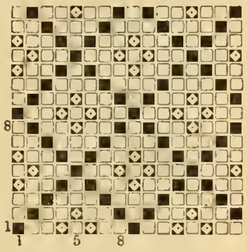


FIG. 426.

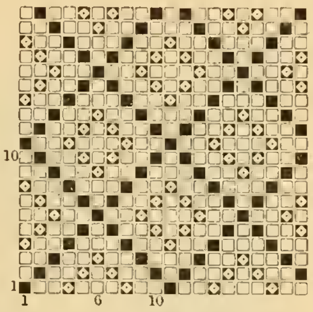


FIG. 427.

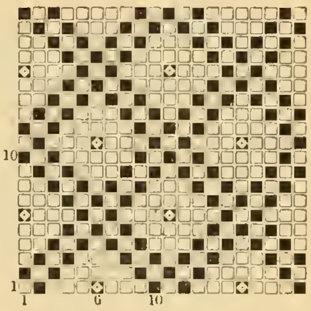


FIG. 428.

The next step for figuring in point twills is to arrange the pointed effect in the direction of the filling. Giving Figs. 422, 423 and 424 each one-quarter of a turn, or in other words turning them so as to bring the filling into the position of the warp and the warp into the position of the filling, will produce weaves for this system. A straight draw for an equal number of harness, which is necessary for the foundation twill, is required for this pointed twill (filling ways). Thus, weave Fig. 422 will require a 4-harness straight draw with 6 picks; weave Fig. 423 a 21-harness "straight draw" with 22 bars in chain; weave Fig. 424 a 15-harness "straight draw" with 31 bars in chain.

The next course for figuring in pointed twills is to arrange the pointed effect, warp and filling ways; forming in this manner squares standing on one of their corners. These designs offer very many fanciful arrangements and are extensively used in the manufacture of fancy cotton fabrics.

Fig. 425 is derived from the 3-harness $^{1}—_{2}$ regular twill by means of draft: **1**, 2, 3, **1**, 3, 2. Repeat: 6 warp-threads and 6 picks.

Fig. 426 represents enlargement of Fig. 425 to 8 warp-threads and 8 picks repeat.

Fig. 427 shows the same weave enlarged to 10 warp-threads and 10 picks.

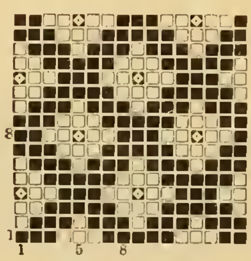


FIG. 429.

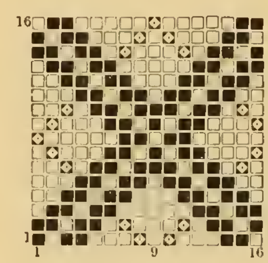


FIG. 430

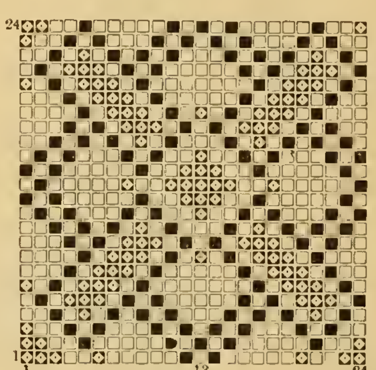


FIG. 431.

Fig. 428 illustrates a pointed twill derived from the $_{1}{}^{1}—{}_{3}{}^{1}$ twill by means of point draft, 1, 2, 3, 4, 5, 6, 5, 4, 3, 2.

Figs. 429 to 435 represent a few novel and interesting designs of "pointed twills," which by means of the different styles of type used readily indicate their method of construction.

Fig. 429. Repeat: 8 warp-threads, 8 picks. Point draw for 5-harness as follows: 1, 2, 3, 4, 5, 4, 3, 2.

Fig. 430. Repeat: 16 warp-threads, 16 picks. Point draw for 9-harness as follows: 1, 2, 3, 4, 5, 6, 7, 8, 9, 8, 7, 6, 5, 4, 3, 2.

Fig. 431. Repeat: 24 warp-threads, 24 picks. Point draw for 13-harness as follows: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2.

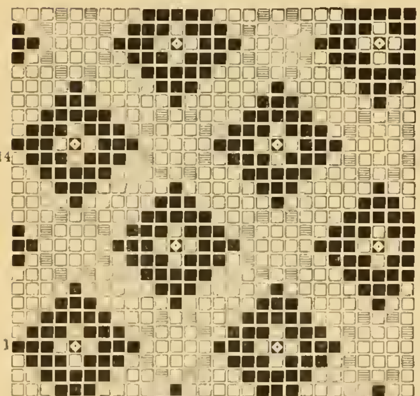


FIG. 432.

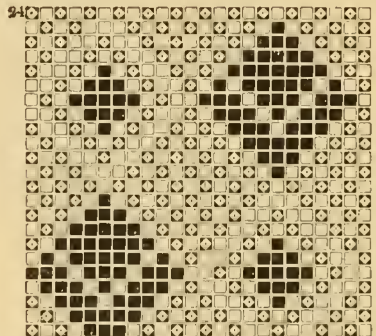


FIG. 433.

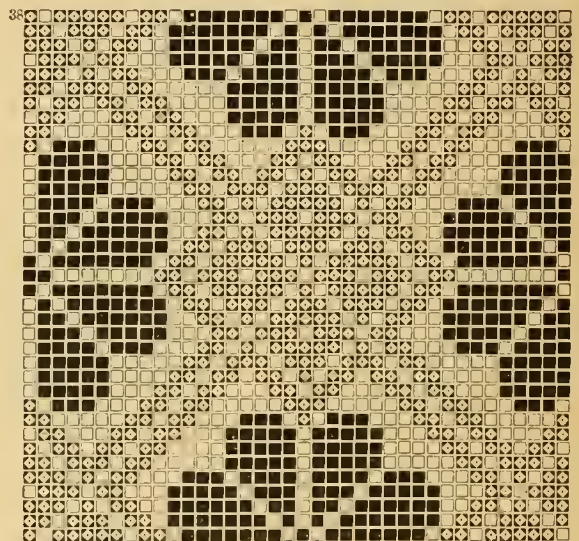


FIG. 434.

Fig. 432. Repeat: 14 warp-threads, 14 picks. Point draw for 8-harness: 1, 2, 3, 4, 5, 6, 7, 8, 7, 6, 5, 4, 3, 2.

Fig. 433. Repeat: 24 warp-threads, 24 picks. Point draw for 13 harness: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2. This design has only the point arrangement, warp ways.

Fig. 434. Repeat: 38 warp-threads and 38 picks. Point draw calls for 20-harness. Draw harness 1 up to and including 20 from front to rear, then follow by drawing harness 19 to 2 from rear to front.

FIG. 435.

□, ▤, Sinkers; ⊡, ■ Raisers.

Fig. 435. Repeat: 30 warp-threads, 30 picks. Point draw requires 16-harness. Draw harness 1 up to and including 16 from front to rear, then follow by drawing harness 15 to and including 2 from rear to front.

Derivative Weaves from Satins.

DOUBLE SATINS.

These weaves are designed for woolen goods in which we desire to increase the strength and yet retain the satin face and finish. They are derived from the regular satins by adding one more intersection of each warp and filling thread in one repeat, either to the right or left, above or below, or in a short regular distance from the original point.

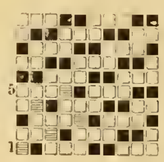


FIG. 436.
▤ and ◘ for Raisers.

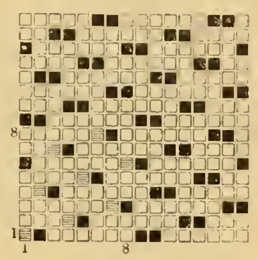


FIG. 437.
▤ and ■ for Raisers.

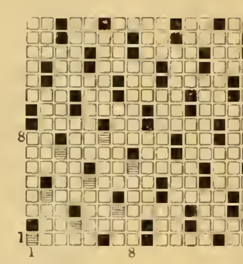


FIG. 438.
▤ and ■ for Raisers.

Fig. 436 illustrates the 5-harness (filling face) double satin. The common 5-harness satin we find clearly indicated by ▤. One point added (■) to the right has given the double satin. An examination of the same will show us a proportionally large float of the filling, thus leaving all the advantages of the satin for the face of the fabric. The warp we find changed in the new design from 1—4 to 1—1 1—2, or twice as many intersections in the short repeat of 5 threads, giving the fabric for which this weave is to be used proportionally more strength.

Fig. 437, representing the 8-harness (filling for face) double satin, is designed upon the same principle as that of Fig. 436; having a larger repeat it will better demonstrate the purpose than the former.

Fig. 438 illustrates the double satin (filling for face) produced in connection with the 8-harness satin, filling face. This time the adding point is found above the one for the regular satin, so the filling receives one more point of interlacing in each repeat; hence more strength in the fabric, filling ways.

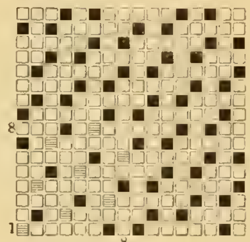


FIG. 439.
▤ and ◘ for Raisers.

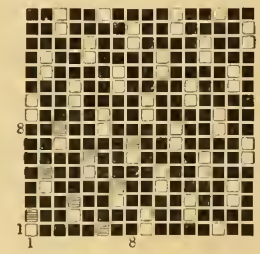


FIG. 440.
□ and ▤ for Sinkers; ■ for Raisers.

Fig. 439 shows another and a different arrangement of the 8-harness double satin (filling face), having its added point in an oblique position to the original intersection of the regular satin; consequently increasing the point of interlacing equally for warp and filling.

Fig. 440 shows the regular 8-harness satin warp for face, arranged for double satin, and in its construction will correspond to Fig. 438. Both of the last mentioned designs also demonstrate the arrangement of the 8-leaf satin warp for face, after the principle observed either in Fig. 437 or 439.

Granite-Weaves.

Under this system of weaves we classify small broken-up effects, which are derived from the foundation weaves in various ways.

Amongst the effects most frequently used, we find those that are derived from the satin-weaves. In this manner Figs. 441 to 469 are designed.

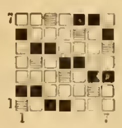


Fig. 441.

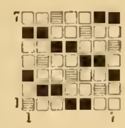


Fig. 442.

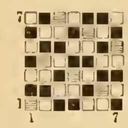


Fig. 443.

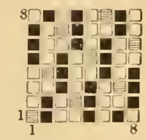


Fig. 444.

Figs. 441 to 443 are granite-weaves derived from the 7-harness satin. The latter is shown in each design by ▤.

Designs Figs. 444 to 447 are derived from the 8-harness satin. The first two weaves are obtained by adding three additional points of interlacing to each original satin spot (▤).

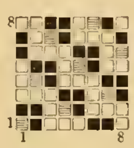


Fig. 445.

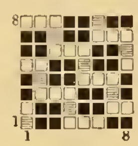


Fig. 446.

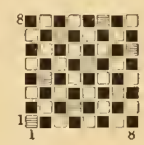


Fig. 447

The last two weaves are obtained by adding four additional points of interlacing to the original one. The original 8-harness satin is shown in each design by ▤.

Weaves Figs. 448, 449 and 450 are designs of granites having for their foundation the 12 harness satin. The latter is again indicated by a different type (▤) from that of its addition for producing the granite-weave required.

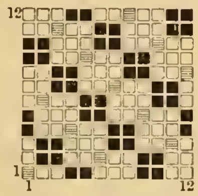


Fig. 448.

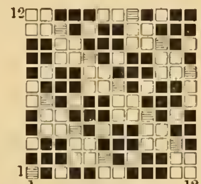


Fig. 449.

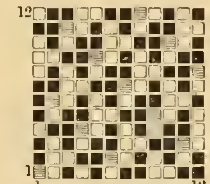


Fig. 450.

Weaves Figs. 451 and 452 are derived from the 15-harness satin, which is similar to the preceding ones indicated by ▤.

Weaves Figs. 453, 454 and 455 are granites, constructed in their foundation out of the common 18-harness satin-weave.

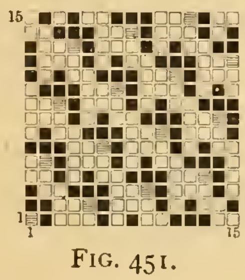


Fig. 451.

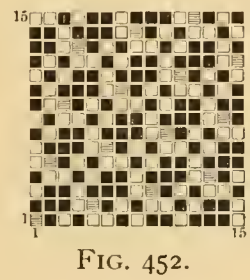


Fig. 452.

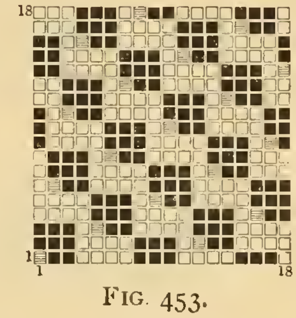


Fig. 453.

Fig. 453 is produced by adding eight additional points of interlacing to the original spot.

Figs. 454 and 455 are obtained by adding (regular) seven additional points of interlacing to the original spot (indicated by ▤).

Another method for producing granite-weaves is that of using the common satin-weaves for the foundation, but so arranging the latter in their construction as to have every even-numbered warp-thread in the main design (motive) missed, or not taken into consideration at all. Thus the 5-harness satin will call for 10 warp-threads; the 7-harness to be arranged, in the manner above

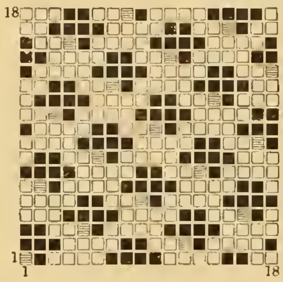


FIG. 454.

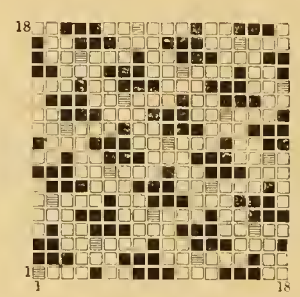


FIG. 455.

described, for 14-harness, etc., etc. To give a clearer understanding of the method of procedure, Figs. 456 to 465 have been designed.

Fig. 456 represents the common 5-harness satin designed on every uneven-numbered (1, 3, 5, 7, 9) warp-thread.

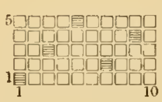


FIG. 456.

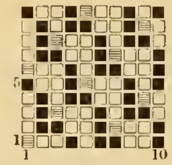


FIG. 457.

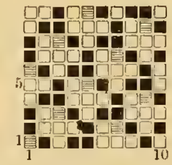


FIG. 458.

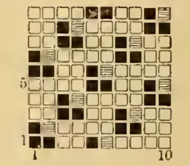


FIG. 459.

Figs. 457, 458 and 459 illustrate granite-weaves obtained from the latter foundation weave by means of adding four additional points of interlacing (selected differently in each design) to the original spot of the 5-harness satin.

Granite-weaves Figs. 460, 461 and 462 are obtained, by means similar to the preceding cases, from the 7-harness satin. Their repeat is: 14 harness and 7 picks.

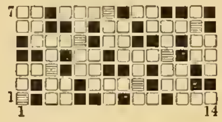


FIG. 460.

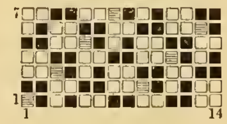


FIG. 461.

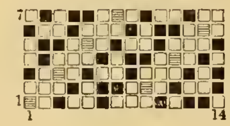


FIG. 462.

Designs Figs. 463, 464 and 465 are designed out of the 8-harness satin, and their repeat is 16 warp-threads and 8 picks. In designs Figs. 457 to 465 the original weave for the foundation (or the 5-, 7- or 8-harness satin) is shown by ⊟.

In the same manner that we construct granite-weaves out of the 5-, 7- and 8-harness satin, we can also construct granite-weaves out of satin-weaves having a higher number of harness for their repeat.

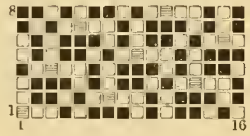


FIG. 463.

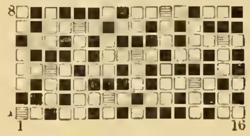


FIG. 464.

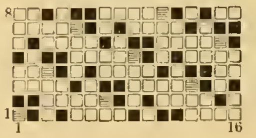


FIG. 465.

By using in this manner the 9-harness satin we will get 18-harness for the granite-weave and if we use the 10-harness satin-weave we will get 20-harness for repeat of its corresponding granite-weave, thus always requiring twice as many harnesses in repeat for the granite-weave as for the foundation satin-weave.

The next step in designing granite-weaves is the use of any satin-weave for foundation on each third successive warp-thread, which will equal: "Take one warp-thread, miss two," in the foundation satin-weave for the new design.

To give a more perfect illustration of this method of procedure Figs. 466 and 467 have been constructed.

Fig. 466 illustrates the 5-harness satin-weave to be applied for the foundation of a granite under the previously explained principle of "take one, miss two," thus calling for warp-threads 1, 4, 7, 10, 13 in constructing the satin for foundation.

FIG. 466.

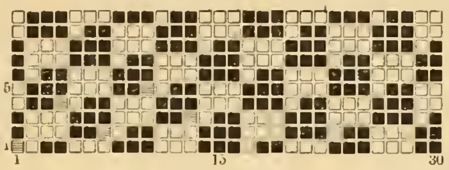


FIG. 467.

Weave Fig. 467 represents a granite-weave as derived from the foundation, Fig. 466. The original satin spots are shown in both designs by the same character of type, thus giving a clearer and more perfect illustration of the method of procedure. Any granite-weave, constructed in accordance with the present example out of a satin-weave, will always require three times the number of harness for its repeat that the satin calls for. Thus, the 5-harness satin requires 15-harness in granite-weave; the 7-harness satin requires 21-harness in granite-weave; the 8-harness satin requires 24-harness in granite-weave, etc., etc.

This will readily explain that when using a high number of repeat in satin for foundation, a corresponding increase in the granite-weave will occur. For example, take the 12-harness satin which equals 36-harness in granite, a repeat too large for the number of harness operated in the loom. To prevent difficulties arising in this manner, we can readily substitute the missings of certain warp-threads for the filling, using warp-ways each thread in rotation as in the case of the example in the filling.

The peculiar characteristics of the face of a fabric interlaced on a granite-weave, "small broken-up effects," will readily admit this change. The present rule, "take one, skip two," in producing the foundation satin can also be extended to "take one, skip three," or "take one, skip four."

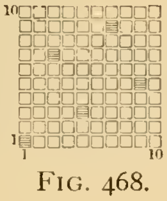


FIG. 468.

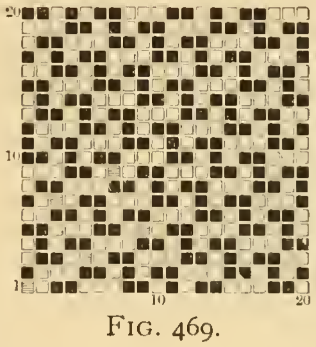


FIG. 469.

Another method of designing granite-weaves having a satin-weave for foundation, is that of using the latter in the former, as follows: "Take one thread, miss one" (or two, or three, etc.) in the direction of the warp and the filling, thus increasing correspondingly the repeat of the warp-threads and picks. To illustrate the present method Figs. 468 and 469 have been designed.

Weave Fig. 468 illustrates the 5-harness satin arranged in its repeat upon every alternate warp-thread and pick. Repeat: 10 threads each system.

Weave Fig. 469 illustrates the arrangement of above-mentioned satin-weave changed to a granite-weave.

The character of type used in weave Fig. 469, for indicating one repeat of the satin-weave, is shown to correspond with that used in Fig. 468.

It will be seen readily that it is possible to construct an endless variety of granite-weaves in this manner, therefore we only give these few examples to indicate the elementary principles of their construction.

Other Methods of Constructing Granite-Weaves.

Granite-weaves may be produced also by various other methods. Among those most advantageously used are those produced by using a suitable effect arranged in the shape of a broken twill.

For example, we have designed weave Fig. 470, which will readily explain the method of procedure, as well as indicate how to proceed in constructing similar effects. A further method of designing granite-weaves is the using of a certain number of warp-threads and picks on a warp effect and exchanging alternately for the same size and figure, filling effect.

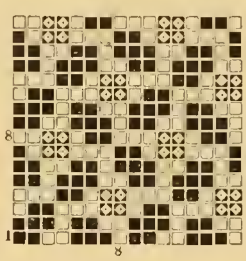


FIG. 470.

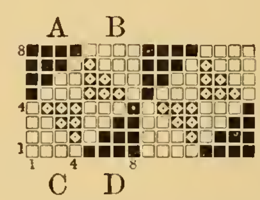


FIG. 471.

For example, in constructing by this method a granite-weave for 8 warp-threads and 8 picks, divide the 8 threads each system contains, thereby getting 4 squares of 4 by 4 threads dimension. Next put the effect desired into one of these squares. Into each square connecting with one side insert the same effect, exchanging from the breaking-off line, raisers for sinkers and *vice versa*.

The fourth square, left unoccupied thus far, will readily appear as the connecting link for producing the entire weave.

Figs. 471, 472 and 473 are constructed in this manner. Fig. 471, repeat: 8 warp-threads and 8 picks.

Effect *A* for the first square of 4 x 4 threads, is shown by ▪.

B represents the square connecting with *A* on one side, situated on the right hand side. It contains the same effect shown in *A* reversed, raisers exchanged for sinkers.

C represents the other square connecting with *A*. It also contains the effect shown in square *A* reversed, raisers exchanged for sinkers.

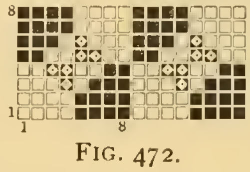


FIG. 472.

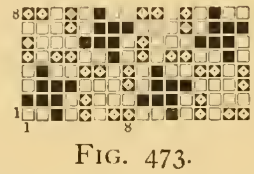


FIG. 473.

FIG. 474.

Weave in squares *B* and *C* is shown by ⊡ so as to distinguish it better from *A* and *D*; also to indicate more plainly the method of procedure to be observed in the construction of different weaves.

Square *D* forms the corresponding connection in the design. ▪ is used in this square for warp up, similar to square *A*.

Weaves Figs. 472 and 473 are constructed with different effects, but in their method of construction correspond with weave Fig. 471. Repeat in Figs. 472, 473 and 474: 8 harness and 8 picks.

Weave Fig. 474 contains the same method of construction as the foregoing three examples, the only difference being that the shape of the square is changed this time to a rectangle produced by 2 picks and 4 warp-threads. Repeat of weave: 8 warp-threads and 4 picks.

Weave Fig. 475 illustrates a granite-weave similar to those already explained. Repeat: 20 warp-threads and 20 picks. Four changes in each system; thus 4 x 4 = 16 squares (each separated by a break) in complete weave.

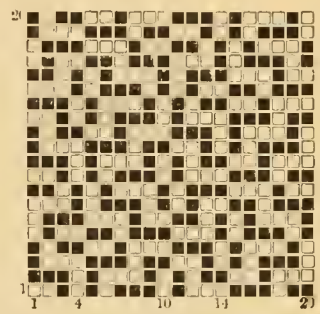


FIG. 475.

As mentioned at the beginning, by granite-weaves we mean those weaves which form, when applied for interlacing a fabric (worsted or woolen goods), small broken-up effects upon its face. As this indicates to a certain extent a regularly distributed arrangement of interlacing, warp and filling, it will be seen readily that we can also construct and classify under this system of granite-weaves, designs having no real foundation of structure, but in which the method of interlacing will produce the small broken-up effect upon the face of the fabric.

Weaves Figs. 476 to 486 illustrate a few specimen designs constructed in this manner.

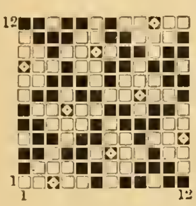


FIG. 476.

Repeat: 12 warp-threads, 12 picks.

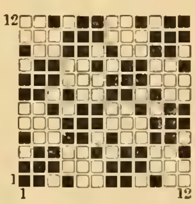


FIG. 477.

Repeat: 12 warp-threads, 12 picks.

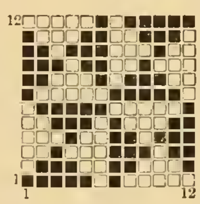


FIG. 478.

Repeat: 12 warp-threads, 12 picks.

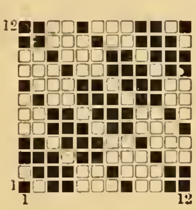


FIG. 479.

Repeat: 12 warp-threads, 12 picks.

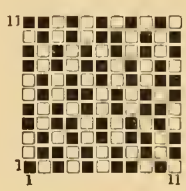


FIG. 480.

Repeat: 11 warp-threads, 11 picks.

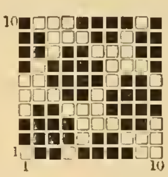


FIG. 481.

Repeat: 10 warp-threads, 10 picks.

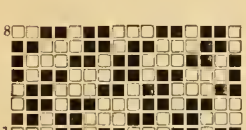


FIG. 482.

Repeat: 8 warp-threads, 8 picks.

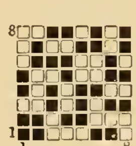


FIG. 483.

Repeat: 8 warp-threads, 8 picks.

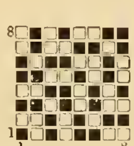


FIG. 484.

Repeat: 8 warp-threads, 8 picks.

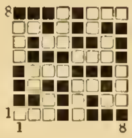


FIG. 485.

Repeat: 8 warp-threads, 8 picks.

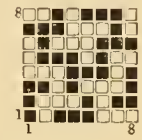


FIG. 486.

Repeat: 8 warp-threads, 8 picks.

Combination of Different Systems of Weaves for one Design.

As indicated, designs or weaves classified under this head are produced by combining two, three or more weaves from those explained in any of the preceding systems, or divisions of it; also any new weaves similarly constructed by any of the rules given or examples illustrated. Thus it may readily be seen that a great number of such combined weaves can be constructed, but practice will teach us to be careful in selecting the weaves for combination, so as to have them harmonize in their method of interlacing and to secure perfect work upon the loom, as well as the proper finish of the fabric after it has gone through the finishing process. This point must especially be taken into consideration in the manufacture of woolen fabrics, as these generally require fulling; therefore places more irregularly interlaced in one part of the design than in other parts will have a tendency to shrink irregularly in the fulling process. In the manufacture of fabrics requiring no finishing at all, or requiring but very little (such as shearing, calendering or pressing, etc.), this trouble will be of less consequence than in the case of fabrics requiring a finish.

Therefore the rule for designing weaves for worsted and woolen fabrics under the present system, is as follows: Only combinations of weaves are allowed in which the fabric shrinks regularly at the loom and during the fulling and scouring process.

We will introduce a few designs containing the principles of the various combinations and thus explain the whole system.

For example, it may be desire to produce a stripe effect upon a ground interlaced with the plain weave, and in addition the stripe be required to stand out more prominently than the ground. In this manner design Fig. 487 is constructed.

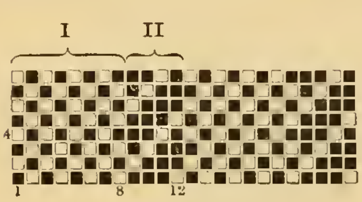


Fig. 487.

Repeat: 12 warp-threads and 4 picks.

8 warp-threads (1—8) marked I interlace in the regular plain weave.
4 warp-threads (9—12) marked II interlace in the regular 4-harness $\frac{3}{1}$ twill.

12 warp-threads repeat.

Suppose, again, we would use in our present example one kind of yarn (same size, quality, color). A careful examination of the subject by the novice will convince him that the 8 warp-threads working with the plain weave must intersect twice as often with the filling as the 4 threads working with the $\frac{3}{1}$ twill. Practice will readily demonstrate that the 8 warp-threads interlacing on plain, will become tighter (take up more) than the 4 warp-threads interlaced in twill. The entire warp being a continuous repetition of the 12 warp-threads until taken up, will thus have the arrangement of 8 warp-threads interlaced with the plain weave and 4 warp-threads interlaced with the $\frac{3}{1}$ twill taken alternately and repeated over its entire width. This in turn will produce a tighter texture in the plain woven part as compared with the twill part.

A perfect fabric requires an even texture all over its surface, which is not guaranteed in the present example because of the vast difference in the result of interlacing of the plain weave and the twill weave in the same fabric.

We will next consider methods to be employed for producing an even texture (or as nearly even as possible). Either we must use a heavier size of yarn for those warp-threads which interlace on the $\frac{3}{1}$ 4-harness twill as compared with the warp-threads woven on plain; or we must use a higher texture (more ends per inch) for the twill part than for the part interlacing with the plain weave.

If we should select the first mentioned point for evening the texture in the present example, we increase the bulk of the fabric, which may be objectionable, whereas if we employ the second point this will be to a great extent avoided. This will better explain itself by means of the following rule as to sizes of threads compared with their diameter: "the weights of threads do not change in proportion to their diameters, but vary in the same ratio as the squares of their diameters." This will readily demonstrate the second given point as the proper one to be used in the present example for producing the required even, or as nearly even as possible, texture.

In weave Fig. 488 we illustrate the combination of 9 warp-threads interlaced with the 5-harness satin, and 10 warp-threads interlaced on a fancy twill; both weaves combined forming corresponding stripes in the fabric. On examination the amount of intersections in each weave will clearly appear to the student to be even, thus no great trouble can result in combining these two weaves into one. It also explains the method of procedure in combining similar weaves for the same purpose.

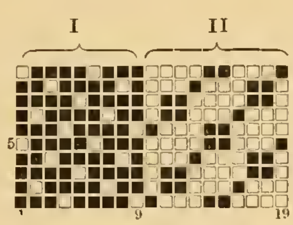


FIG. 488.

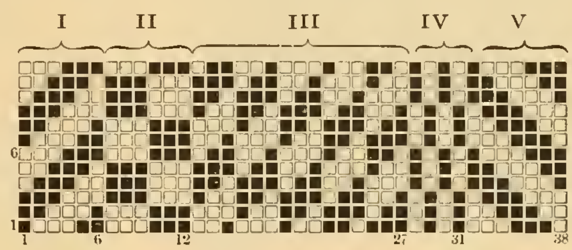


FIG. 489.

Weave Fig. 489 represents a perfect combination of five different weaves produced with a repeat of 38 warp-threads and 6 picks. Warp-threads 1 to 6 are interlaced with the regular $\frac{3}{\quad}\frac{}{3}$ twill. Direction of twill from the left to the right. Warp-threads 7 to 12 are interlaced with the common 6-harness $\frac{3}{\quad}\frac{}{3}$ basket-weave. Warp-threads 13 to 27 have for their weave the skip twill derived from the regular 6-harness $\frac{3}{\quad}\frac{}{3}$ twill by means of "take three threads successively and skip two." Warp-threads 28 to 31 are interlaced with the common rib-weave $\frac{3}{\quad}\frac{}{3}$ warp for face. Warp-threads 32 to 38 are interlaced with the filling by means of the $\frac{3}{\quad}\frac{}{3}$ 6-harness twill. Direction of twill from the right to the left.

Weave Fig. 490 illustrates another perfect combination of two weaves from two different divisions of weaves. In the same the combination of the regular 8-harness twill $\frac{4}{\quad}\frac{}{4}$, used for six successive warp-threads, and the 16 harness corkscrew, used for 18 successive warp-threads, is shown.

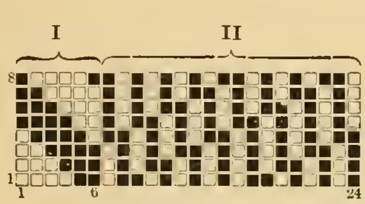


FIG. 490.

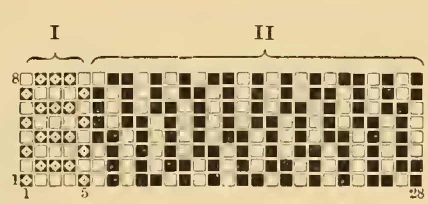


FIG. 491.

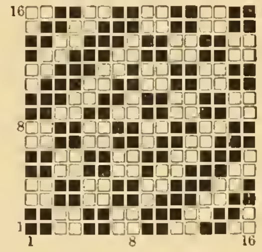


FIG. 492.

Weave Fig. 491 illustrates the same corkscrew as used in weave Fig. 490 combined with a rib-weave, filling for face. Warp-threads 1 to 5 are required by the rib-weave and warp-threads 6 to 28 are called for by the corkscrew. Repeat: 28 warp-threads and 8 picks.

The next step for figuring in this system of weaves is by *combining two weaves in the shape of alternate squares* of any size desired.

In the construction of these weaves we must be careful in the selection of the places for joining the two original weaves in the direction of the warp as well as the filling, so as to omit any unnecessarily long floating of either system of threads.

Fig. 492 illustrates the combination of

8 threads on 4-harness basket-weave and
8 threads on the $\frac{}{2}\frac{2}{\quad}\frac{}{2}\frac{3}{}$ 9-harness twill.

16 threads repeat, warp and filling ways.

By carefully examining the combined weave we will find the twill and basket so selected as to form a clear break between.

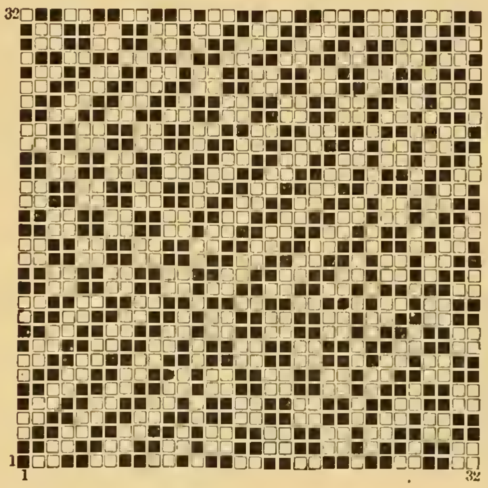


FIG. 493.

4 × 12. Basket.	4 × 12. Twill.	4 × 4. Basket.	4 × 4. Twill.
4 × 12. Twill.	4 × 12. Basket.	4 × 4. Twill.	4 × 4. Basket.
12 × 12. 4-harness Basket.	12 × 12. 4-harness Twill.	12 × 4. Basket.	12 × 4. Twill.
12 × 12. 4-harness Twill.	12 × 12. 4-harness Basket.	12 × 4. Twill.	12 × 4. Basket.

FIG. 494.

In weave Fig. 493 we illustrate four different combinations of two weaves in each direction of threads.

The arrangement observed is clearly indicated in diagram Fig. 494.

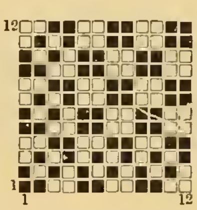


FIG. 495.

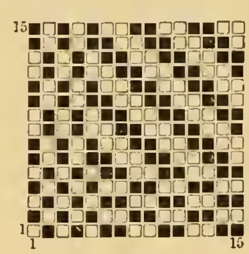


FIG. 496.

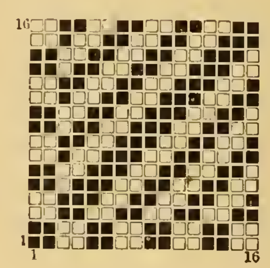


FIG. 497.

Another method of figuring in the present system of weaves is the checking off of a weave of a given size (mostly square) with another weave, both weaves to harmonize in their methods of interlacing.

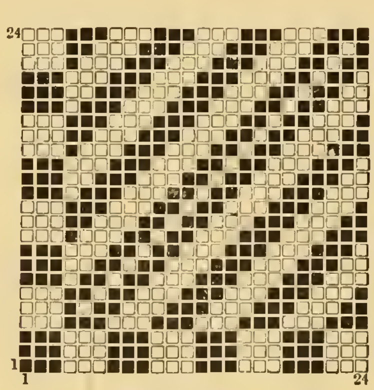


FIG. 498.

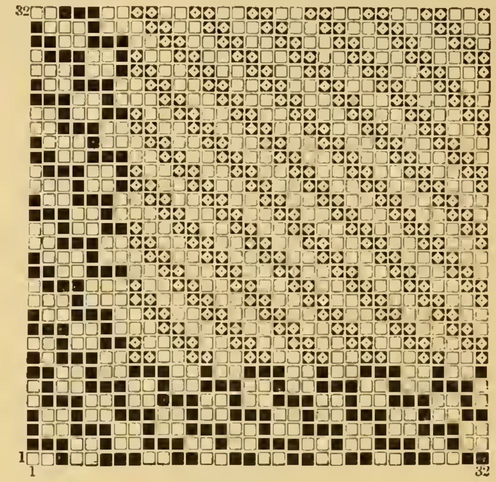


FIG. 499.

Figs. 495, 496, 497, 498 and 499 are designed to illustrate a few of these combinations.

Weave Fig. 495. Repeat: 12 warp-threads and 12 picks. In this weave 8 threads, warp and filling, interlaced on the 4-harness basket-weave, are checked off by the () 4-harness granite-weave, 4 threads for each system.

Fig. 496 represents 11 threads, warp and filling, interlaced with the ^{2}——$_{2}$ 4-harness twill and overchecked with a common rib-weave. In the place where warp and filling rib meet the interlacing is done in plain weave. Repeat: 15 warp-threads and 15 picks.

Fig. 497 represents 14 warp-threads and 14 picks interlaced in twill and overchecked with 2 threads of basket-weave. Repeat: 16 warp-threads and 16 picks.

Fig. 498 represents 21 warp-threads and 21 picks interlaced in twill and overchecked with 3 threads basket-weave. Repeat: 24 warp-threads and 24 picks.

Fig. 499 illustrates 25 warp threads with an equal number of picks, interlaced on the ^{2}——$_{2}$ 4-harness twill and overchecked with 7 warp-threads and 7 picks of the granite-weave. Repeat: 32 warp-threads and 32 picks.

Figured Effects upon Fabrics interlaced with Derivative-weaves Produced by Arrangement of Two or More Colors in the Warp or the Filling, or in Both at the Same Time.

Throughout previous lectures explanatory of the plain weave, the twills, the rib-weaves, the basket-weaves, and the broken-twill-weaves, the importance of the color arrangement in connection with the method of interlacing for producing the effect in a fabric, has been frequently dwelt upon. In the manufacture of fabrics known as fancy cassimeres, ladies' dress goods, etc., these are of special importance, for the reason that these fabrics are subject to constant changes, both in design and effect, by the demands of fashion. A great variety of new styles in such fabrics might be designed alone by the different ways of interlacing warp and filling, yet the different color arrangements in the warp and filling will always be of great assistance to the designer.

Therefore, before proceeding with the course of lectures for constructing weaves for single-cloth fabrics of a special construction, and double cloth, etc., we will take up the subject of color effects in combination with plain weaves, fancy twill-weaves, granite-weaves, etc. Explanations accompanied by their respective illustrations of weaves, with resulting effects, will readily enable the student to comprehend their principle of construction.

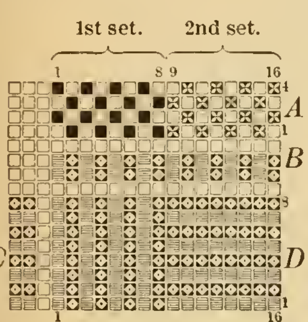


FIG. 500.

Design Fig. 500 shows at *A* 16 warp-threads arranged in two sets. Each set is interlaced with the filling (same for both sets) on the plain weave, and the connection between each set arranged so as to have the last warp-thread of the one set working the same as the first warp-thread of the second set. *B* shows the indications for the dressing, arranged for one thread light to alternate with one end dark, and equal at *C*, indicated for the filling.

(For hair-line and tricot effects combined, thread and thread, constructed on the regular plain weave, and repeated without interruption or change over the entire width of the fabric, see Fig. 20, page 15. For producing the change from tricot to hair-line and *vice versa*, the arrangement of two threads of one color is used in one place in the design which corresponds with the place in the fabric where the change from tricot to hair-line is required.)

In the present example, Fig. 500, the dressing is not disturbed, but the weave is arranged so as to have (as already mentioned) the first and last warp-thread of each set work equal.

Warp-threads 1 to 8 = 1st set, shown by ■ type.

Warp-threads 9 to 16 = 2nd set, shown by ⊠ type.

Warp-threads 8 and 9 are connecting threads, interlacing alike into the filling.

Warp-threads 16 and 1 are the second set of connecting threads, interlacing into the filling, and arranged to raise and lower on the pick opposite to the first set.

It will readily be seen that the changing or breaking off of the plain weave, by arranging two successive warp-threads to interlace in the same manner, will reverse the tricot effect to a hair-line effect, and *vice versa* (on a regular arrangement in the warp of one end light to alternate with one end dark over the entire width of the fabric). See *D*, Fig. 500 for effect.

This arrangement of working two successive warp-threads can also be extended to the filling, producing some of the most novel effects for ladies' dress goods and similar light-weight fabrics.

Such effects and their construction are illustrated in the following designs, Figs. 501 to 509.

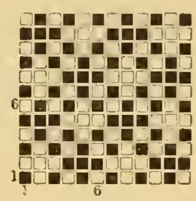


FIG. 501.
Motive.

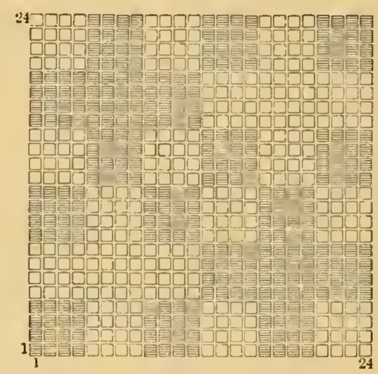


FIG. 502.
Ground-plan.

Fig. 501 is designed to illustrate a motive. Suppose the ■ indications in the same to represent the hair-line effects and the □ the tricot effects. Again, suppose every square in the motive to equal four threads in the warp and filling in the weave and effect.

An examination of Fig. 501 shows six squares each way for repeat, therefore $6 \times 4 = 24$ warp-threads and picks for the repeat of the required weave and effect.

Fig. 502 illustrates the ground-plan and represents a four-fold enlargement of 501.

In Fig. 502 those parts of the design requiring hair-line effects (according to the motive) are indicated by ⊟ type and those requiring tricot effects by □ type.

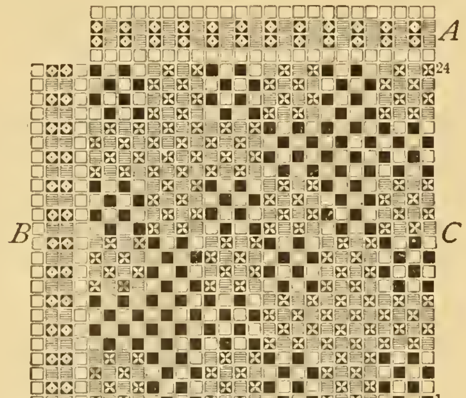


FIG. 503.
Weave.

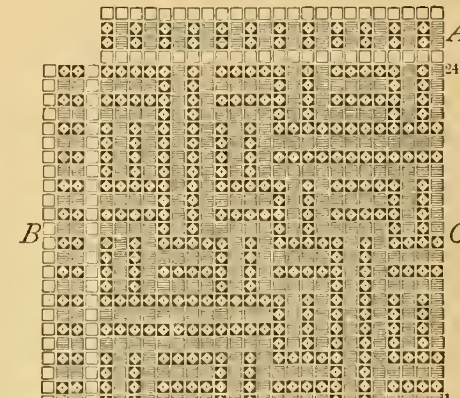


FIG. 504.
Effect in Fabric.

Fig. 503 illustrates at *A* the dressing, one end light to alternate with one end dark; *B* the same arrangement for the filling, and at *C* the applying of the plain weave to the ground-plan 502, arranged as explained before. The weave for the part of the fabric requiring the hair-line effect is represented by ⊠ and the weave for the tricot effect by ■.

Diagram Fig. 504 illustrates the effect visible in the fabric. *A*, arrangement of warp, one end light to alternate with one end dark; *B*, the same arrangement for the filling; *C*, the effect produced.

FIG. 505.

Fig. 505 is a motive for another effect. Use 8 warp-threads and the same number of picks for each small square in the motive. Type ■ for the tricot effect and type □ for the hair-line effect.

Fig. 506. *A*, the indications for the dressing; *B*, the same for the filling; *C*, the weave. Fig. 507 represents the effect as produced in the fabric.

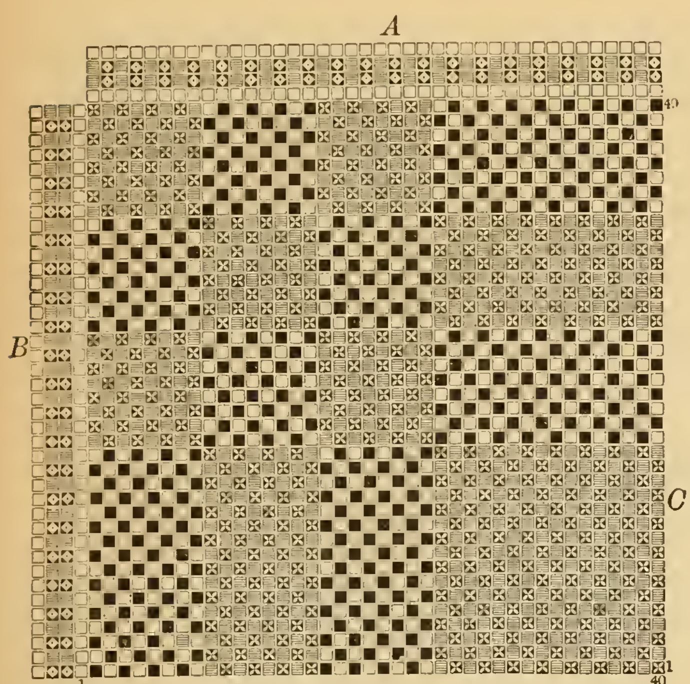


FIG. 506.

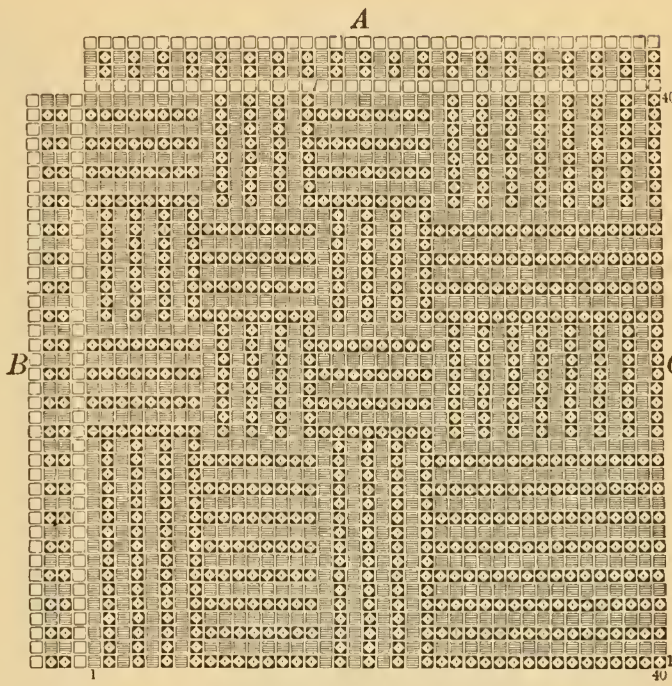


FIG. 507.

Fig. 508, motive.

Fig. 509, effect obtained by using 6 warp-threads and 6 picks for one small square in motive. Repeat: 36 warp-threads, and the same number of picks.

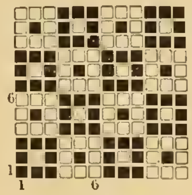


FIG. 508.

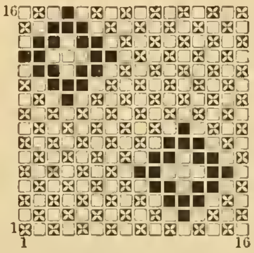


FIG. 510.

16 harness and 16 picks for repeat.

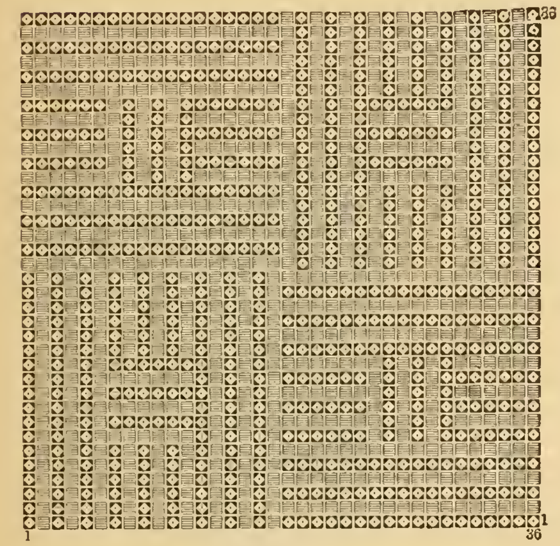


FIG. 509.

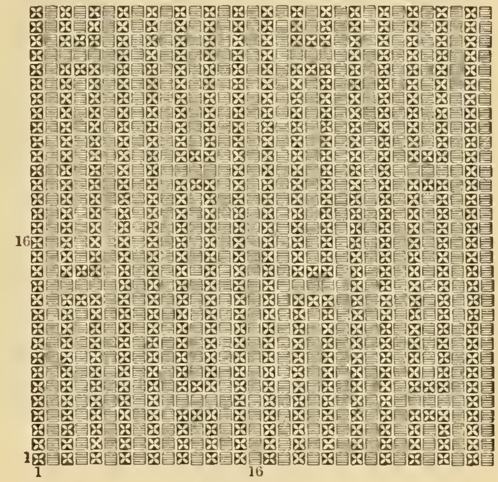


FIG. 511.

Novel effects are also obtained by figuring upon the plain weave. For example, weave Fig. 510 produces effect Fig. 511, by means of 1 end light or color No. 1, to alternate with 1 end dark, or color No. 2.

Effect Fig. 513 is produced upon a fabric interlaced with weave Fig. 512. Arrangement for warp and filling: 1 end light, or color No. 1, to alternate with 1 end dark, or color No. 2.

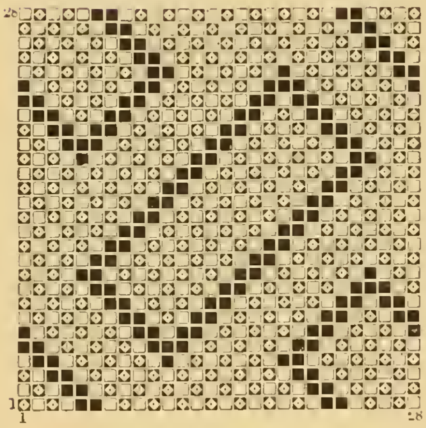


Fig. 512.
28 harness and 28 picks for repeat.

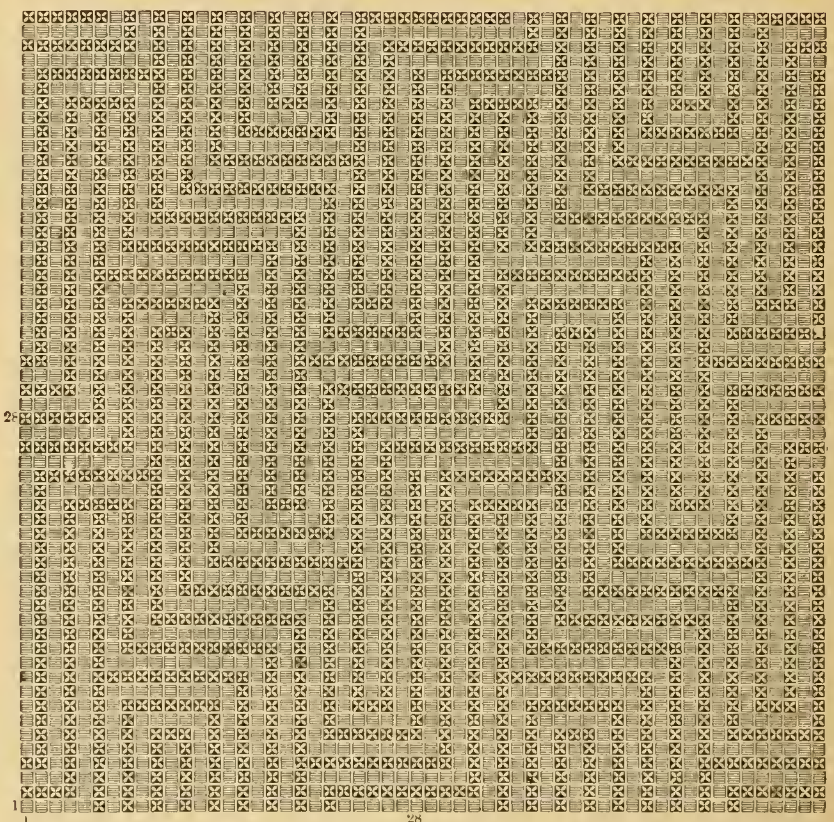


Fig. 513.

The same arrangement of using alternately light and dark threads will produce on a fabric interlaced by weave 514 the effect shown in Fig. 515.

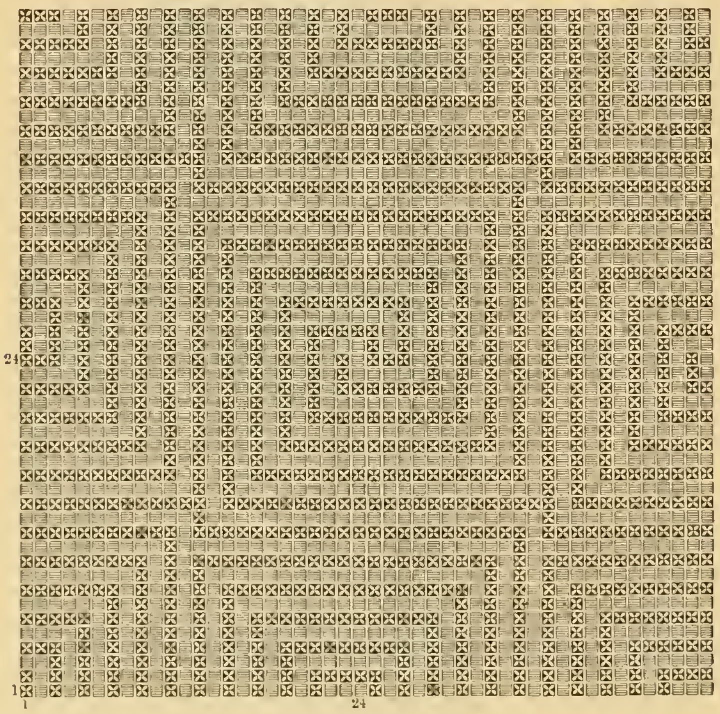


Fig. 515.

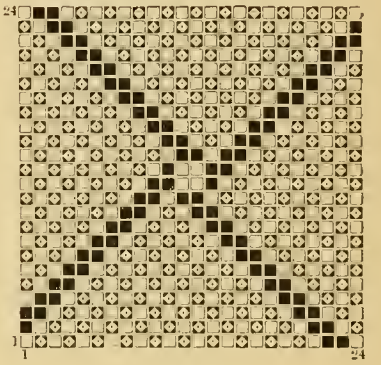


Fig. 514.

The effect illustrated in Fig. 516 is produced upon a fabric which has the warp and filling (arranged 1 end light, or color No. 1, to alternate with 1 end dark, or color No. 2) interlaced with the broken twill weave Fig. 517.

The same arrangement of colors in warp and filling (1 light, 1 dark) used upon weave Fig. 518 (broken twill) will produce design Fig. 519 for effect in the fabric.

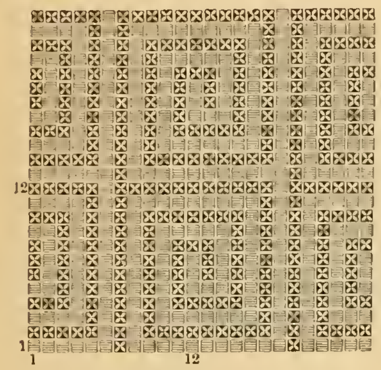


Fig. 516.

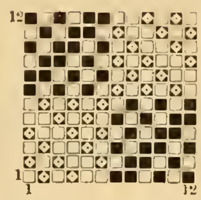


Fig. 517.

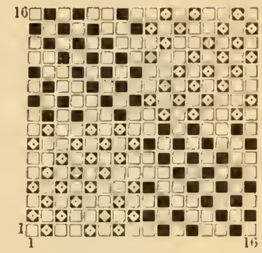


Fig. 518.

Repeat: { 16-harness, 16 picks.

Fig. 520 illustrates the fancy color arrangement applied to a fancy twill.

A, the weave, 8 harness and 8 picks repeat.

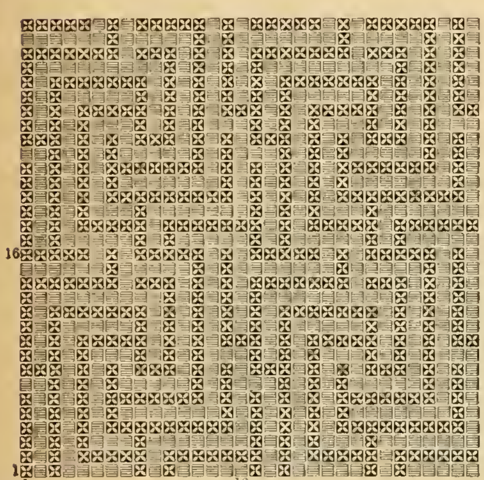


Fig. 519.

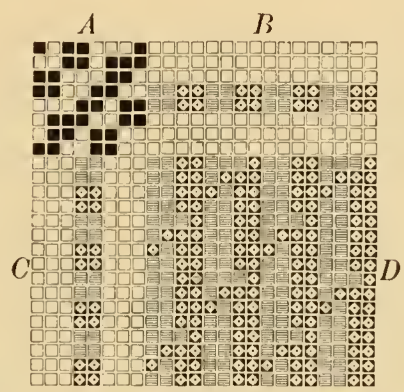


Fig. 520.

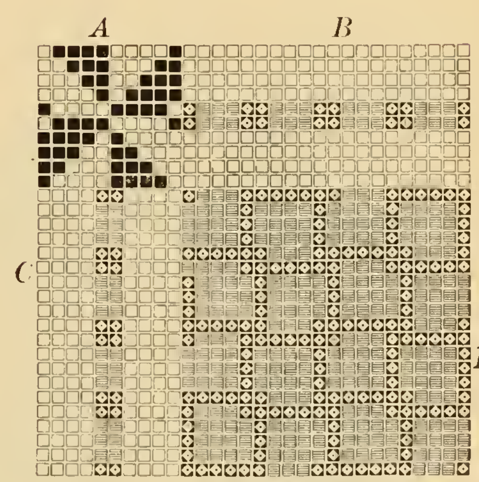


Fig. 521.

B, the arrangement of the warp, 2 threads light to alternate with 2 threads dark.

C, the arrangement of the filling, the same as the warp.

D, the effect produced.

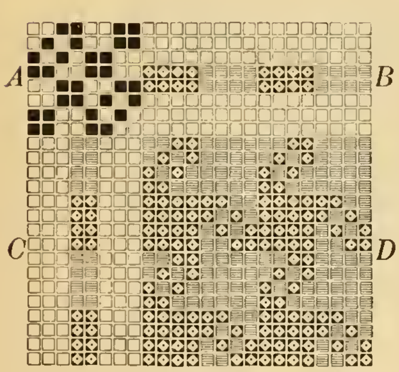


Fig. 522.

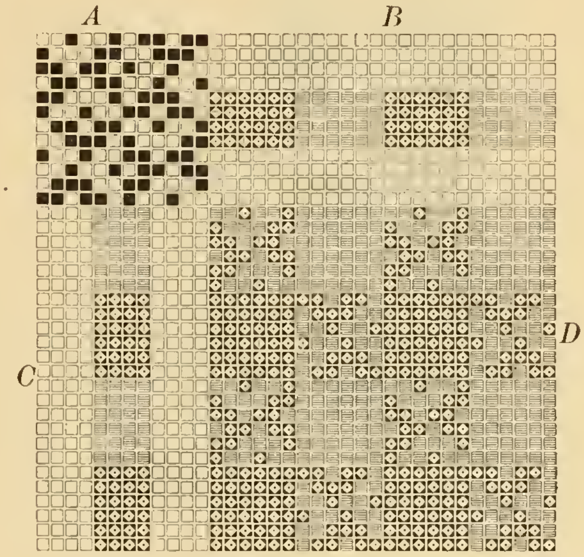


Fig. 523.

Figs. 521, 522 and 523 illustrate three specimens of effect produced upon fabrics interlaced on granite-weaves. In each figure *A* represents the weave, *B* the dressing, *C* the arrangement of the filling, and *D* the effect produced.

Single-Cloth Weaves for Fabrics of a Special Construction and Peculiar Character.

HONEYCOMB-WEAVES.

The Principle of Constructing Honeycomb-Weaves and the Peculiarities of Fabrics Interlaced with them.

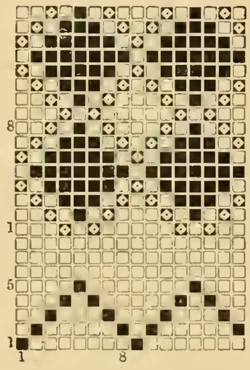
In these weaves squares are to be formed by floating (more or less) part of the warp and filling threads. These warp and filling threads will float on the face opposite to the back of the fabric; also on the place where the longest floating warp and filling thread interweaves, will be formed a groove on the back of the fabric and *vice versa* on the face. Hence we get the peculiar appearance of the fabric known as honeycomb. The difficulty for the designer consists in so arranging the weave that when the warp floats on the face, the centre point of this float will form the centre point for the filling float on the opposite side of the fabric. And again, when the centre point of the filling float is taken into consideration on the face of the fabric and we put a needle straight through the fabric on the designated spot, the point of the needle will meet the centre of the warp float on the rear side of the fabric.

Different methods are observed in designing these weaves.

Honeycomb-Weaves Designed on Point Draws.

■ and ◘ Raisers; □ Sinkers.

Fig. 524 shows the plainest honeycomb-weave, executed on 8 warp-threads and 8 picks repeat, with the "point draw" for 5-harness below it.



Point Draw for 5-harness.

FIG. 524.

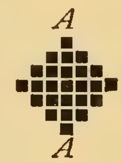


FIG. 525.

FIG. 526.

Fig. 525 illustrates the floating of the warp in above design, thread *A A* forming the centre of the float, which gradually decreases in the adjoining warp-threads.

Fig. 526 illustrates the floating of the filling in design Fig. 524, pick *B B* forming the main float, which decreases in the adjoining picks.

By these designs it appears that the warp float is two threads longer (7 picks) than the filling float (5 ends).

Fig. 527 illustrates the honeycomb-weave, designed for 10 threads in each system. The main float in the warp covers 9 picks, and the filling float forms the square in the fabric with a pick floating over 7 ends.

The point draw for this weave requires 6-harness.

Fig. 528 shows the honeycomb-weave, designed for 12 threads, warp and filling ways. The heaviest float in the warp covers 11 picks, and the greatest filling float covers 9 warp-threads. The point draw for this weave requires 7-harness.

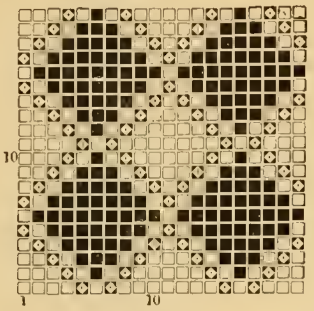


FIG. 527.

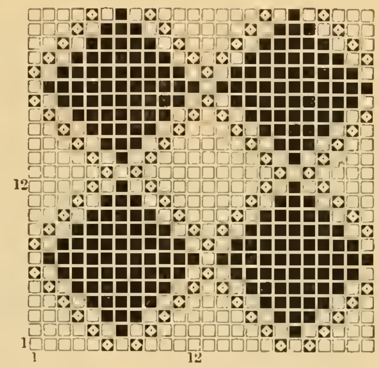


FIG. 528.

Fig. 529 is the honeycomb-weave designed for 14 ends in warp and filling, with a main float in the filling covering 11 warp-threads.

Point draw for this weave requires 8-harness.

Fig. 530 illustrates the honeycomb-weave for 16 ends, repeat in warp and filling, being about the largest arrangement of this weave used on a high texture.

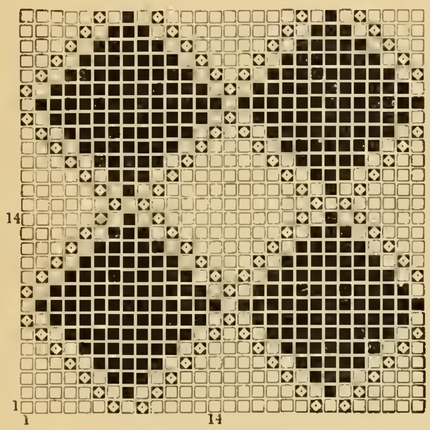


FIG. 529.

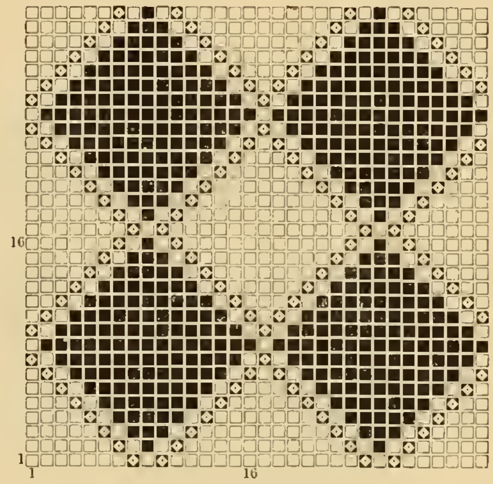


FIG. 530.

Main float of warp covers 15 picks, and main float of filling covers 13 warp-threads on the face of the fabric.

Point draw requires 9-harness.

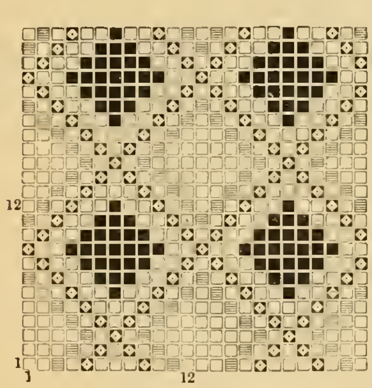


FIG. 531.

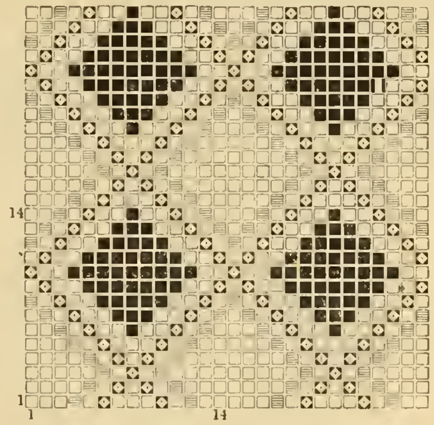


FIG. 532.

A second style of honeycomb-weaves is designed after the following method: Run on the designing paper, over the repeat of weave wanted, a check formed by a twill one thread up. This check must stand on one corner, each corner forming in this manner one of the point harnesses for the weave. Next put into every other square (in a diagonal direction) the required warp float. Every square so alternated remains empty or may be further outlined by one row of twill (raisers).

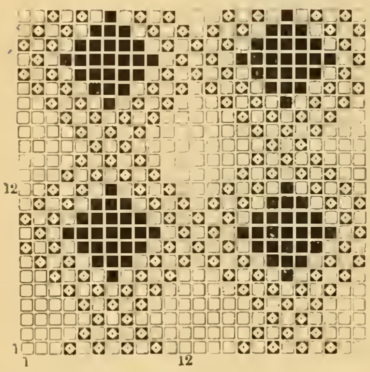


Fig. 533.

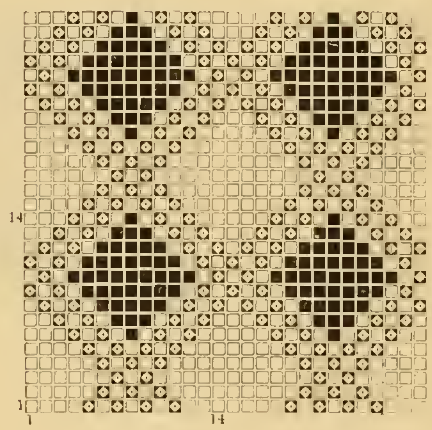


Fig. 534.

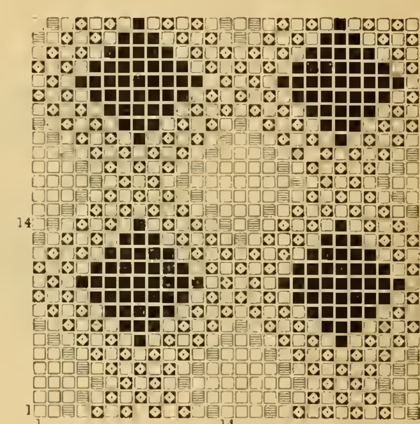


Fig. 535

Figs. 531 and 532 are designed to illustrate this style of honeycomb-weaves.

Fig. 531. Repeat: 12 ends warp and 12 picks.

Point draw: 7-harness.

Fig. 532. Repeat: 14 threads warp and 14 picks.

Point draw: 8-harness.

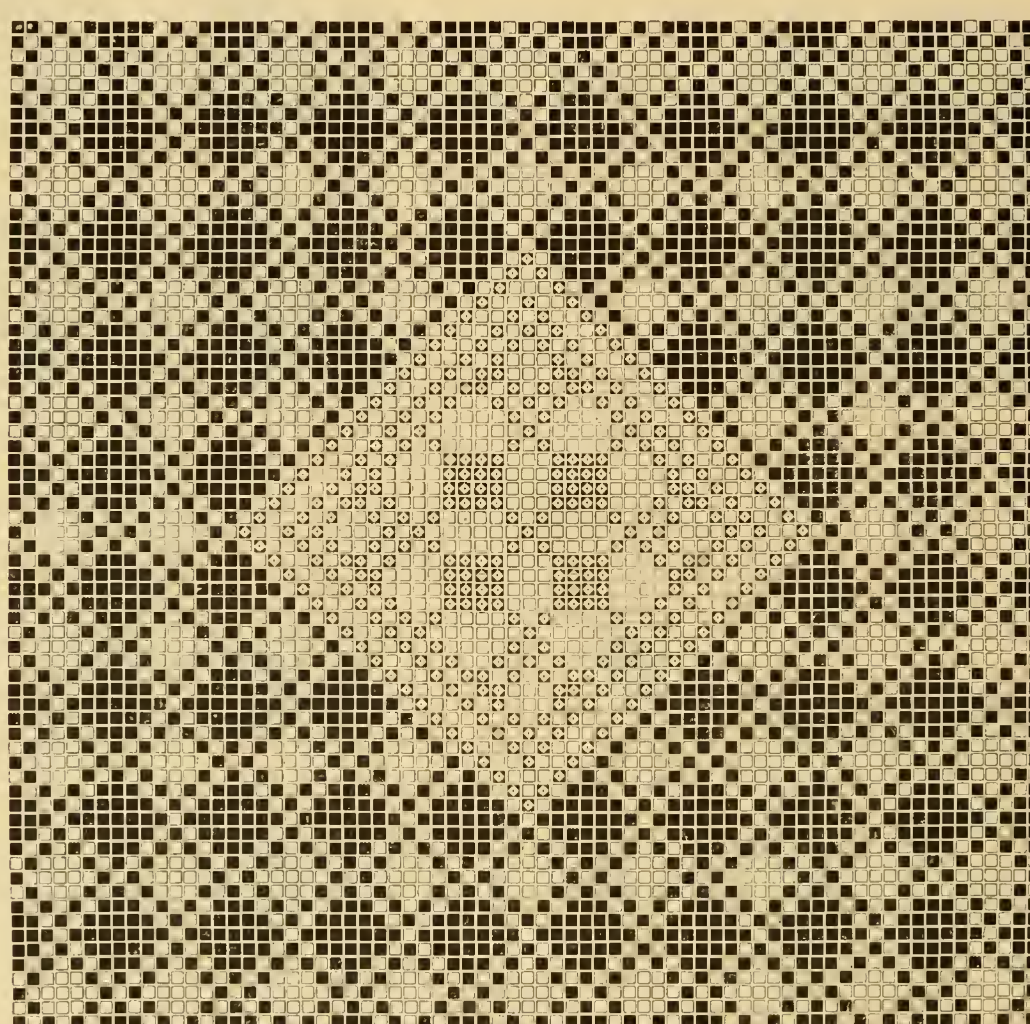


Fig. 536.

We now pass to a third style of honeycomb-weaves, having a double line of twills for the main square. In this manner Figs. 533 and 534 are executed.

Fig. 533 has for its repeat 12 warp-threads and 12 picks.

Fig. 534 has for repeat 14 warp-threads and 14 picks.

These honeycomb-weaves have also the filling float sometimes outlined by one row of twill, as illustrated in design Fig. 535, which is taken in its foundation from Fig. 534.

Figs. 536 and 537 illustrate fancy combinations of the honeycomb-weave for groundwork with point twills for the figure.

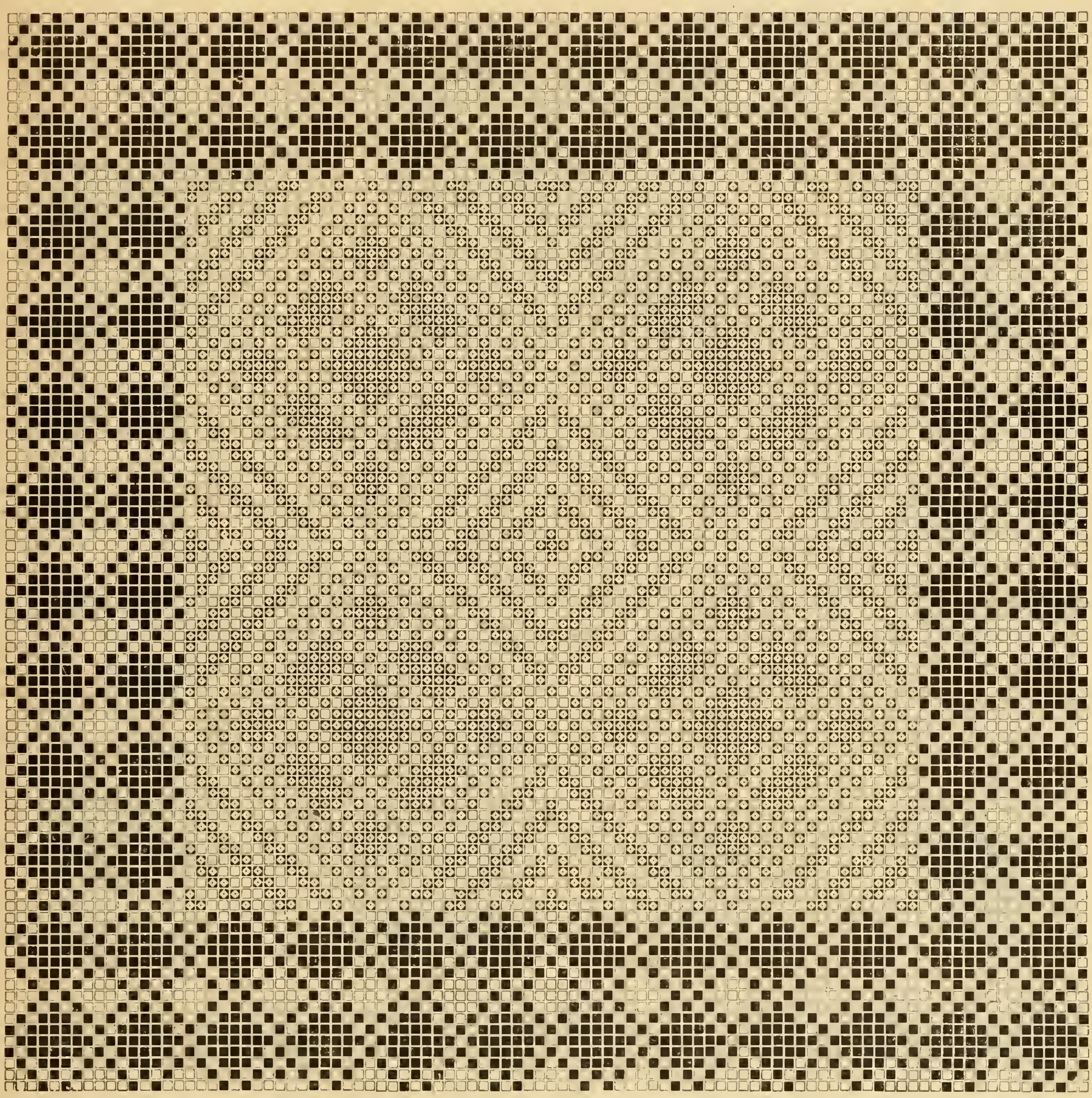


Fig. 537.

A fourth division of the honeycomb-weaves embraces those known as "star effects."

The appearance of these weaves in the fabric is of a different character from those previously described. The effects produced by these weaves in the woven fabric are quite novel, and a careful study of the annexed designs will not only give a thorough understanding of their construction, but will greatly aid in developing new ideas for weaves in this line of fabrics. The point draw, which has been used to such a decided advantage in the first three divisions, is not used in this.

Figs. 538, 539 and 540 are different weaves designed on this principle.

Fig. 538. Repeat of pattern: 16-harness and 16 picks.

Check *A* contains in its 8 ends repeat, a twill running in a direction from left to right, the twill line being formed by the warp upon filling ground.

Check *C* is the same weave, warp and filling exchanged, and direction of twill reversed.

Check *B* and *D* are bound in plain for forming the groove.

Fig. 539. Repeat of pattern: 28 harness and 28 picks. This weave is an enlargement of the preceding one and explains itself.

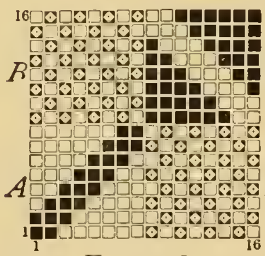


Fig. 538.

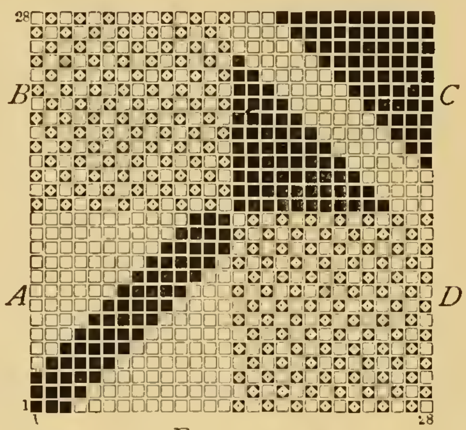


Fig. 539.

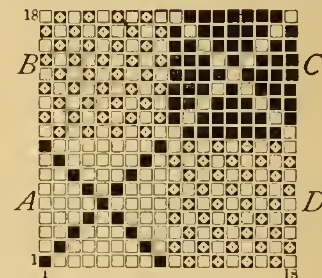


Fig. 540.

Fig. 540. Repeat: 18 warp-threads and 18 picks. This weave contains in its principle, in check indicated by *A*, the × of a common twill filling face on 9 threads for each system. Check *C* contains the same arrangement except that the warp changes place with the filling. Checks *B* and *D* are interlaced plain for forming the groove.

A fifth division of the honeycomb-weaves is created by forming squares with a certain number of warp and filling threads, floating (equal long floats for each thread in either system) regular distances. Figs. 541, 542, 543 and 544 are designed to illustrate this system.

Fig. 541. Repeat: 12 warp-threads and 12 picks. Can be reduced to a 4-harness "section draw."

Fig. 542. Repeat: 12 warp-threads and 12 picks. Can be reduced to a 4-harness "section draw."

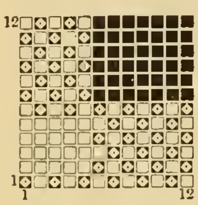


Fig. 541.

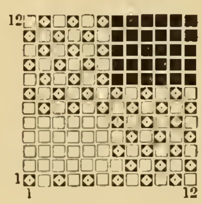


Fig. 542.

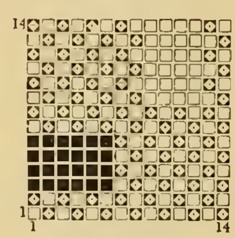


Fig. 543.

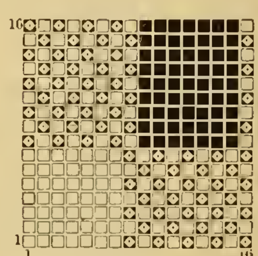


Fig. 544.

Fig. 543. Repeat: 14 warp-threads and 14 picks. Can be reduced to a 6-harness "section draw."

Fig. 544. Repeat: 16 warp-threads and 16 picks. Can be reduced to a 5-harness "section draw."

IMITATION GAUZE.

These weaves are used for such fabrics as dress goods, curtains, ladies' aprons, canvas cloth, etc. In designing these weaves the end to be gained, is to have 3 to 4 warp-threads and also 3 to 4 picks intersect each other very easily, while the next following warp and filling thread form a complete break from the one ahead, and so can be readily kept apart for some distance. In the warp these breaks are separated by the reed by leaving one, two, three or more dents empty. The threads required for a close working are drawn in one dent. To give a clear explanation of the matter, Figs. 545 to 553 have been designed.

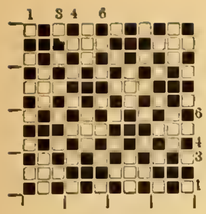


FIG. 545.

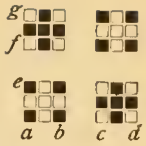


FIG. 546.

Fig. 545 illustrates the 6-harness imitation plain gauze-weave; the lines for the warp (|) indicate the break, and so the place in the reed where one, two or three dents are to be left empty. Warp-threads, 1, 2, 3 are drawn together in one dent, as also warp-threads 4, 5 and 6.

Examining the weave, filling-ways, the break appears between picks 3—4 and 6—7, etc. Picks 1, 2, 3 intersect easily, and also in their turn after the break, picks 4, 5, 6, to be followed again by a break; picks 6 to 7 equal to 6 to 1.

Fig. 546 represents a general analysis of the weave, which will at once convey an idea of the method of arrangement and operation.

Warp.
- *a* to *b*, = 3 warp-threads for 1st dent.
- *b* to *c*, = space for *one* (or two or more) empty dents.
- *c* to *d*, = 3 warp-threads for the 3d dent (or 4th, 5th, etc.).
- From *d* to repeat of weave again (= *a*) leave space (empty dents) equal to the one left from *b* to *c*.

Filling.
- *a* to *e*, = 3 picks for close work.
- *e* to *f*, = space for open work, equal to *b*, *c* in warp.
- *f* to *g*, = 3 picks for close work.
- From *g* to repeat of weave again (= *a*) leave space equal to the one left from *e* to *f*.

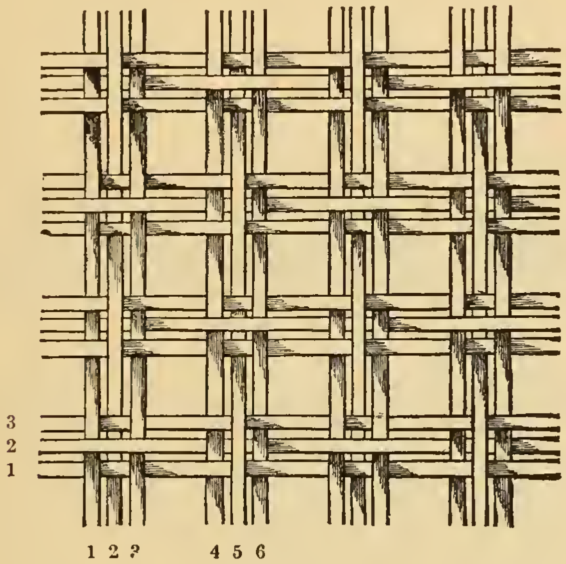


FIG. 547.

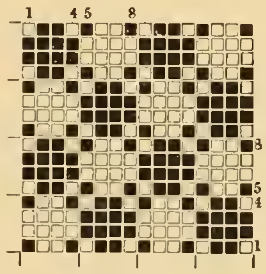


FIG. 548.

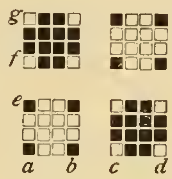


FIG. 549.

Fig. 547 illustrates the enlargement of a fabric produced on weave Fig. 545, under the previously explained rules. As this figure cannot help but to explain itself, we will consider the imitation gauze-weave, produced upon 8-harness and 8 picks repeat, which is shown in Fig. 548.

The lines for the warp (|) indicate operations as explained by Fig. 545, the break, hence the place for one, two or more empty dents, so as to form the open work in the warp. Warp-threads 1, 2, 3 and 4 are drawn together in one dent, also warp-threads 5, 6, 7 and 8, etc. In the filling the break appears between picks 4—5 and 8—9, equal 8—1.

Fig. 549 represents the analysis of the weave with regard to appearance in the fabric.

Warp.—*a* to *b*, 4 warp-threads drawn in one dent. *b* to *c*, for one empty dent (or two or more). *c* to *d*, 4 warp-threads drawn again in one dent. From *d* to repeat of weave (= *a*) leave the same number of empty dents as left from *b* to *c*.

Filling.—*a* to *e*, 4 picks, close work. *e* to *f*, space for open work, equal to *b* to *c*, and *d* to *a*, in warp. *f* to *g*, 4 picks, close work. From *g* to repeat of weave again (= *a*) leave space equal to the one left from *e* to *f*.

Fig. 550 illustrates the enlargement of a fabric produced on weave Fig. 548, under the rules already mentioned.

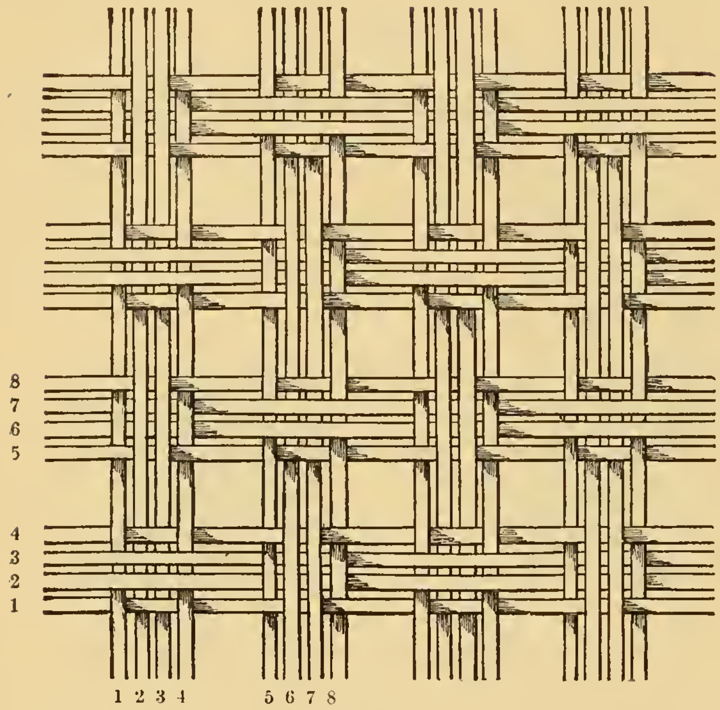


Fig. 550.

Figured Imitation Gauze.

The first step for figuring imitation gauzes is to produce stripes of the same in connection with part of the fabric woven in the common manner. With regard to wear, imitation gauzes will be less durable than real gauze; yet as to

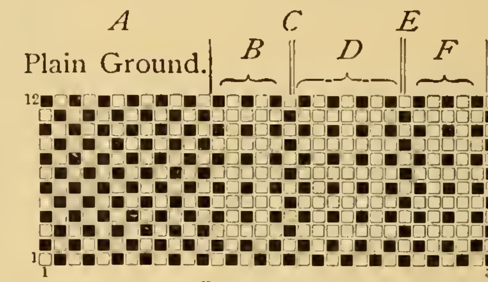


Fig. 551.

general appearance, very novel designs are produced in the former. Fig. 551 illustrates the weave for such a combination of common, plain and imitation gauze forming stripes. *A* is the common plain interlacing part, *B* the close-reeded part, *B* to *C* and *C* to *D* forming open work (separated by thread *C*). *D* is the close-reeded part, *D* to *E* and *E* to *F* forming open work (separated by thread *E*). *F* close-reeded part. Repeat of weave: 32 warp-threads and 12 picks.

The second movement in figuring is the forming of checks.

Fig. 552 illustrates such a design, forming in the fabric checks interlaced on the common

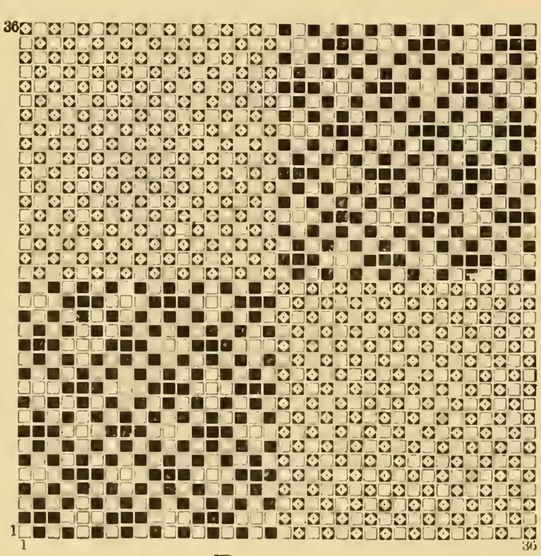


Fig. 552.

plain weave to alternate with checks produced by imitation gauze; 36 warp-threads and 36 picks forming the repeat. Reeding: 3 threads in one dent, 2 dents empty, and over again.

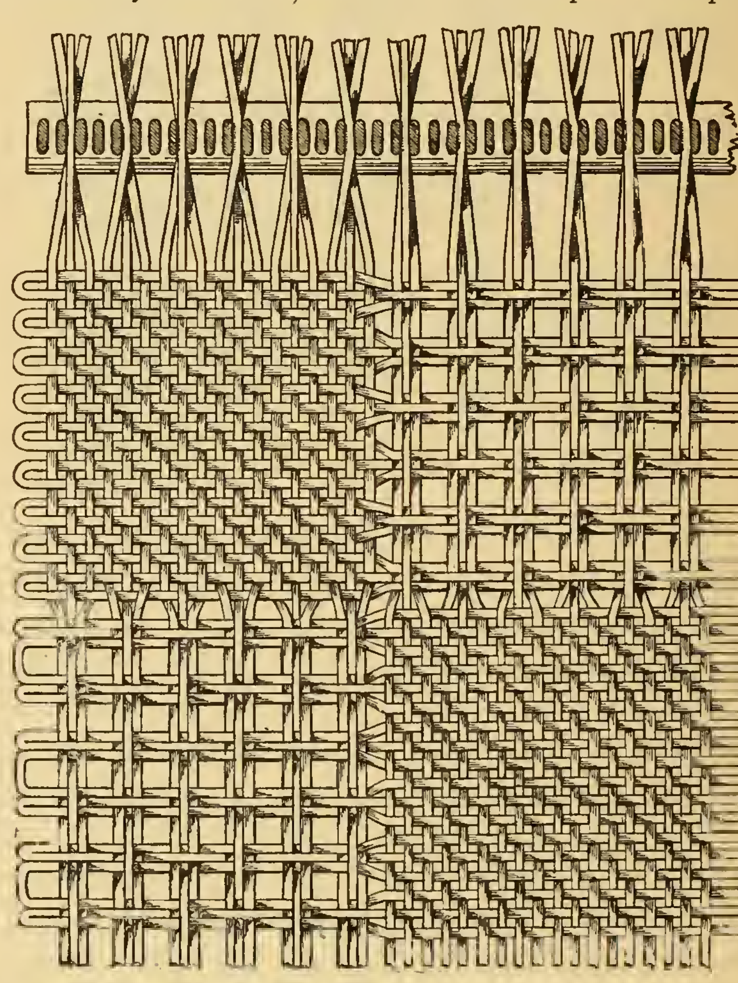


Fig. 553.

Diagram Fig. 553 illustrates the plan of the fabric woven with weave Fig. 552. This method of combining the plain weave and imitation gauze for forming figures can also be applied to ornamental or floral designs.

Combination of Weaves for Fabrics Constructed with One System of Warp and Two Systems of Filling.

The object in designing these weaves is twofold—either to produce additional bulk to a purely single-cloth fabric, or to produce figuring otherwise impossible to be obtained on purely single cloth.

Combining Two Systems of Filling with One Kind of Warp, for increasing the Bulk.

As seen by the above heading, two systems (or kinds) of filling are essential to the construction of these fabrics. One filling (the face filling) forms with one system of the warp the face of the fabric, while the other filling (the backing) forms, by an additional interlacing in the warp before mentioned, the back of the fabric. The latter filling is solely applied to the single cloth, as mentioned, for the purpose of increasing the thickness, and might properly be considered only as a lining. To increase the thickness of a fabric in this manner is of great advantage to the manufacturer, and is thus used very extensively in the manufacture of "heavy-weight" woolens, etc. The weave employed for the face of the fabric (interlacing the warp and the face filling) is generally of a more artistic construction than the weave used for interlacing the backing into the above-mentioned fabric.

It will readily appear that the warp-threads in these fabrics must resist to a certain extent more strain than the filling, and for this reason should be composed of a better stock, in addition to a harder twist. The backing must contain only a small amount of twist, so that the bulk of the thread (without considering its additional heavier size) will always be larger than the harder-twisted face-filling or the warp. The "soft" twist in the backing will also produce a soft handling fabric. Among the materials for producing a proper backing, which may be used with advantage in addition to wool, are the cheaper articles, such as shoddy, mungo, card-waste, roving-waste, etc.

In constructing the weaves, we must first deal with the face-weave (interlacing warp and face filling), and this in a manner independent of any additional backing; as it applies to any weave for single cloth.

The backing must only form an addition, separately introduced into the face fabric and for purpose originally intended, unless a special effect, such as "tricot," etc., is required.

The most frequently used proportions for backing to face filling are: One pick face to alternate with one pick back and two picks face to alternate with one pick back. Seldom do we find 3 picks face to alternate with 1 pick back; or irregularly, as 2 picks face, 1 pick back, 1 pick face, 1 pick back, 5 picks in repeat, etc., etc.

In using the arrangement "one face pick to alternate with one backing" be careful to use a size of the latter not much heavier (if any at all) than the former. If using a backing of a too heavy size, it will influence the closeness of the face filling and produce an "*open face*" appearance in the fabric.

As mentioned before, the backing should be of no consideration in the construction of the single cloth, and this with respect to its weave as well as to its texture, *i. e*, the same number of picks required in a single-cloth fabric must be retained for face picks if a fabric containing face and back filling is constructed. Thus, for example: A fabric on the single-cloth system requiring 44 picks per inch will require, if arranged in its filling "1 pick face to alternate with 1 pick back," 88 picks per inch. Again, if 2 picks face are to alternate with 1 pick back, use 66 picks per inch, etc., etc.

In both examples given, we suppose the size (*i. e.*, thickness) of the warp and face filling to remain undisturbed.

Rules to be Observed in Designing these Weaves.

The weave for the back filling must be selected without disturbing the face. The back filling in its method of interlacing must pass readily underneath the face pick previously interwoven; also, allow the next succeeding face pick to cover any part not covered by the previously interwoven face pick.

To produce this result the warp-threads used for binding the back filling must be in the lower shed, in the face pick preceding the backing as well as the one following it.

Another point, which properly comes under the present rules, but which has been treated to a certain extent before, is, to arrange regular transpositions of face and back picks.

If the face-weave contains a far-floating filling, the binding of the backing into the warp-threads should be arranged as nearly as possible in the centre of this float.

To produce good work, and perfect cloth, every warp-thread should be used in rotation according to the weave for binding the back; because, if some warp-threads should be omitted, they will get less tension through weaving, and give trouble. A bad shed will result, etc., with a possibility of spoiling the fabric. If we should be obliged to omit some of the warp-threads from the binding in the back, we must be careful to arrange those used in a regular and well-distributed manner.

Among points worth considering in the manufacture of the present kind of fabrics we note: If the weave (or system) for interlacing the backing to the warp is of a short repeat, that is, no large floats of the backing, we must use a soft-twisted back filling. Should we use a very hard-twisted yarn, the possibilities are that the backing will "show through" on the face.

To use a backing with the least possible twist (yet sufficiently so to avoid "tender" goods) will also be of advantage during the finishing process, as most fabrics to which the present system of weaves applies require a soft well-covered back.

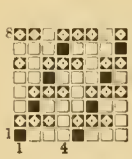


Fig. 554.

Fig. 555.

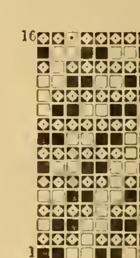


Fig. 556.

Care must also be exercised in selecting the material for the backing with due consideration of the proportional amount of binding.

The heavier in size the backing is, the earlier will imperfections appear.

We will next consider a few of the most frequently used combinations of weaves for these fabrics.

Let us first consider the weave Fig. 554. The arrangement to be observed in combining face and back filling is to take one of each system alternately. For the face-weave (picks, 1, 3, 5, 7) select the 4-harness $\frac{1}{3}$ twill (see ■ type). The interlacing of the back filling arrange with the $\frac{3}{1}$ 4-harness twill (see ▫ type). Repeat of complete weave: 4 warp-threads and 8 picks.

For a proper understanding of the present weaves, two different characters of type are used, one for indicating the face filling (■) and one for indicating the backing (▫).

Diagram Fig. 555 illustrates the section cut of a fabric interlaced on weave Fig. 554.

Weave Fig. 556 shows the 4-harness even-sided twill arranged for "backing cloth." For the intersecting of the backing the 8-harness $\frac{7}{1}$ twill is used. Thus one repeat of the interlacing of the backing equals two complete repeats of the face-weave.

Fig. 557 illustrates the section of a fabric interlaced with weave Fig. 556. The back stitches on to the regular 8-harness $\frac{7}{1}$ twill, as mentioned before, and, in consequence, runs its points of interlacing to the face in one twill line of the latter, leaving the second undisturbed. This, in turn, shows every alternate twill line on the face of the fabric (into which the backing binds) more prominently than the other. To prevent this, it is advisable to use the weave shown in Fig. 558, being the same face as previously used, except having the 8-harness satin applied for interlacing the backing.

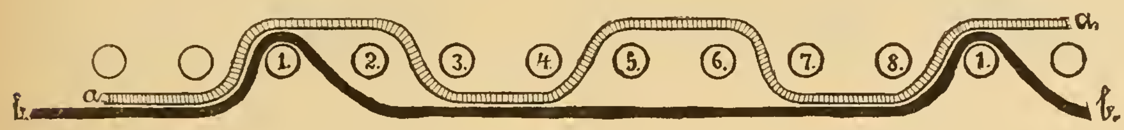


Fig. 557.

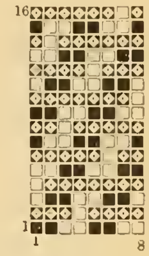


Fig. 558.

The latter weave combines face and back by alternately exchanging the points of interlacing from one twill line of the face to the other; thus in one repeat of the complete weave it has four points of interlacing in each twill line of the face. This method of arranging a weave produces a smooth face, one twill line showing as prominently as the other over the entire surface of the fabric.

Fig. 559. Repeat: 12 warp-threads and 24 picks. Face-weave: $\frac{3}{3}$ 6-harness twill. Weave for interlacing the backing: 12-harness satin. This weave, like weave Fig. 558, produces a smooth face.

An illustration of a fancy twill, arranged for backing, is given in weaves Figs. 560 and 561.

Fig. 560 represents the face-weave. Repeat: 16 warp-threads and 16 picks.

Fig. 561 illustrates this face-weave arranged for a backing cloth, one pick face to alternate with one pick back. Repeat: 16 warp-threads and 32 picks. The weave used for interlacing the backing to the face-fabric is the $\frac{4}{1}\frac{10}{1}$ 16-harness twill.

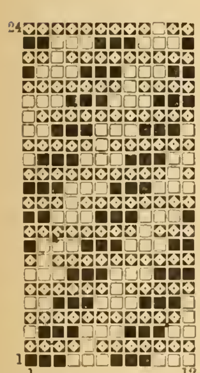


Fig. 559.

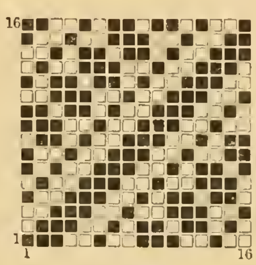


Fig. 560.

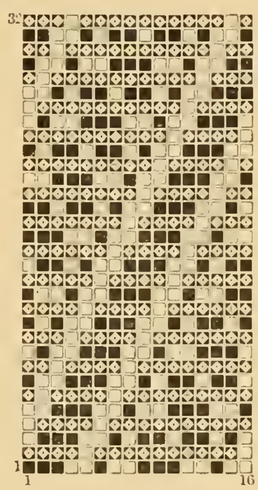


Fig. 561.

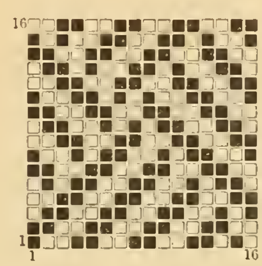


Fig. 562.

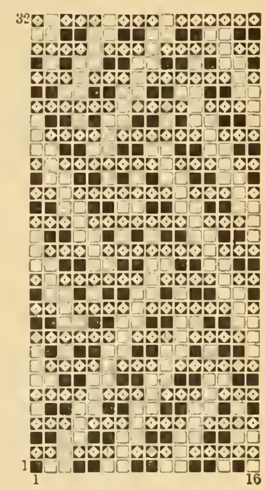


Fig. 563.

Fig. 562 illustrates an entwining twill. Repeat: 16 warp-threads and 16 picks. This twill is illustrated as applied for backing in weave Fig. 563, one pick face to alternate with one pick back.

In applying backing to similar "entwining-twills," as also to "broken-twills," be careful to arrange the same so as to have the points of interlacing follow the twill lines in the face-weave running in the direction from left to right, as well as from right to left.

Granite-weaves constructed from the satins are well adapted for the application of a backing. In this case the satin which was used in the construction of the face will be the weave required for the backing.

For example, see weaves Figs. 564 and 565.

Fig. 564 illustrates a common granite-weave, which is shown with a backing applied in Fig. 565.

Weave Fig. 564 (single weave). Repeat: 8 warp-threads and 8 picks.

Fig. 565, the previous weave with a backing applied. Repeat: 8 warp-threads and 16 picks.

Fig. 566. Diagram of the section cut of a fabric interlaced on weave Fig. 565. a = face filling; b, backing.

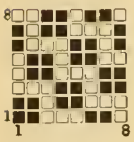


FIG. 564.

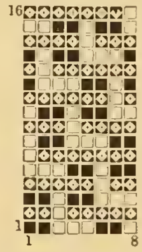


FIG. 565.

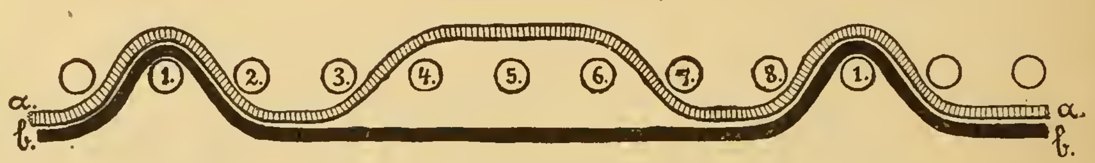


FIG. 566.

In fabrics in which the arrangement of one face pick to alternate with a backing will produce too heavy a cloth—in fabrics in which the arrangement of combining the backing to the face-weave cannot be properly effected, and in fabrics in which it is desired to have used a much heavier size of yarn for the backing than is used for the face filling, the arrangement just given cannot be followed. It must be changed to 2 picks face and 1 pick back.

This proportion of face and back is very extensively used in the manufacture of woolen fabrics.

Producing the backing of a heavier size will (taken in the average) allow of a cheaper material (waste) being used. It also tends to a greater production of cloth by using less picks per inch; a larger quantity of roving per set of cards in a given time, more pounds of yarn per spindle, etc., etc. Another point much in favor of the present designated proportion of face and back filling is the advantage of getting a full face with less picks per inch than by using the proportion of one pick face to alternate with one pick back.

Weave Fig. 567 illustrates the combination of the ^{3}——$_{3}$ 6-harness twill with the ^{11}——$_{1}$ twill, but using only every other warp-thread. Repeat: 12 warp-threads and 18 picks.

If the proportion of one face pick to one back pick produces a cloth too heavy, and the two face picks to alternate with one back pick produces a cloth too light, or should the size of the backing yarn be too heavy for one face and one back, or too fine for two face and one back, we must use the average of both; thus—

2 picks face,
1 pick back,
1 pick face,
1 pick back,
—
5 picks in repeat.

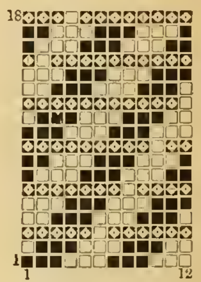


FIG. 567.

Should a fabric require a proportional arrangement, of less weight than that produced by 2 face 1 back, use 3 picks face to alternate with 1 pick back, etc., etc.

Combining Two Systems of Filling with One Kind of Warp for Figuring with Extra Filling upon the Face of the Fabric.

In these weaves the extra filling is brought at certain intervals upon the face of the fabric for forming additional fancy effects. In woolen and worsted fabrics, for men's wear, these effects are generally limited to stripes and checks, whereas if used for dress goods they are often of a very elaborate design.

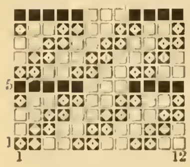


FIG. 568.

Weave Fig. 568 represents a stripe effect, produced by an extra filling (back filling) introduced after four successive ground (face) picks. ◘ face picks (ground), ■ figure picks (back). The weave employed for the ground fabric is the common 4-harness twill ^{2}——$_{2}$. Repeat: 12 warp-threads and 5 picks. ◘ and ■ for raisers, □ for sinkers.

Design Fig. 569 illustrates the figuring with an extra filling for forming a small spot figure.

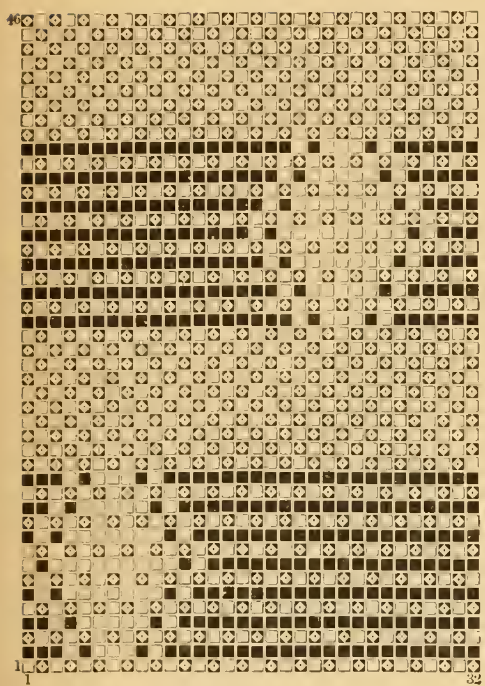


Fig. 569.

This extra filling is similar (except the floating, which is more extended) to the previously illustrated example of floating on the back of the fabric and is interlaced with the face fabric in a manner to produce the desired effect; in the present instance producing small spots. This extra filling, floating to a great extent on the back of the fabric, is generally removed by cutting off those floats around the place where they interlace with the face fabric.

Another style of fabric which is constructed on this system of weaves are union fabrics, comprising certain kinds of shawls, Chinchilla and Ratinè overcoatings, etc.

In weaves for this description of fabrics the interlacing of the face filling with the warp is the same as the one used for interlacing the backing. The warp, which is in most cases of cotton, rests imbedded between the two kinds of filling.

Fig. 570 illustrates the combination of the 5-harness satin filling up for face and the 5-harness satin warp up for back; thus the same weave will form the face and back. Repeat: 5-harness and 10 picks.

Fig. 571 represents a like combination of the 8-harness satin filling up for face, warp up for back. Repeat: 8-harness and 16 picks.

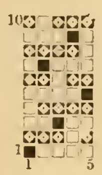


Fig. 570.

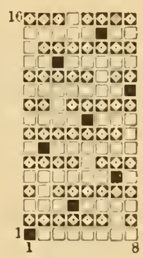


Fig. 571.

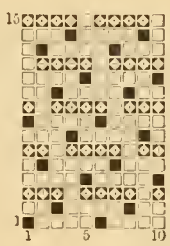


Fig. 572.

Fig. 572 illustrates the 5-harness satin filling up for face and the same weave, warp up, for back. Arrangement for exchanging face and back filling is 2 picks face, 1 pick back. Repeat: 5 warp-threads and 15 picks.

Swivel-Weaving.

For fabrics in which the figures are produced with an extra filling and these figures, as seen on the face, are far apart, as in figured dress goods, ribbons, etc., these figures are produced upon the ground structure of the fabric by using a loom having a "swivel lay" attached.

The object of "swivel-weaving" is to save material in fabrics having small figures for the design, and to give to such figures a more prominent appearance in the fabric than can be produced by the common method of weaving by floating the filling on the back when not required for figuring on the face. There is a further advantage in the designing, for no disturbance of the design is necessary.

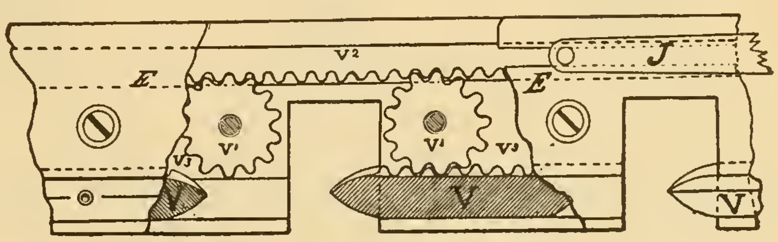


Fig. 573.

Again, in cases where, in the ordinary process of weaving, the figure-filling would show through on the face, and thus must be cut off, this method of weaving omits the cutting away of the loose filling on the back; and in this case the swivel arrangement contributes to the strength of the fabric.

Fig. 573 is an illustration of a swivel fitted in a movable frame to be attached to the regular batten of a loom.

The method of weaving fabrics figured by the swivel arrangement is as follows: After the common shuttle carrying the ground filling is interwoven, a separate shed of the warp is opened for the introduction of the swivel shuttles (instead of passing a common shuttle all the way across the loom) carrying the filling which has to form the figures on the fabric at intervals of two or more inches. Each figure in the fabric is formed by its own shuttle (filling); hence it is apparent that by the swivel arrangement we can have different colors in the same shed across the fabric. In using a fly-shuttle in common weaving the filling from the latter has to be used in every figure, whereas by the swivel method every figure may have its own color.

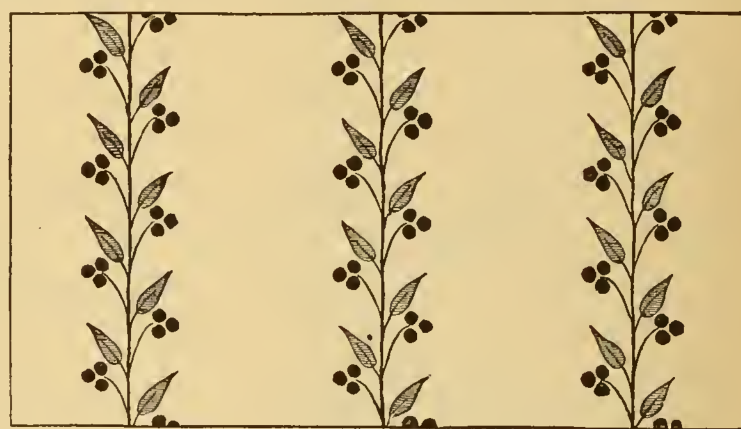


Fig. 574.

The swivel is used to the best advantage in the production of small spot figures.

In Figs. 574 and 575 such effects are shown.

As the shuttles of the "swivel" are all of a given size, and are arranged in certain distances, they require the design to be arranged accordingly. By examining Figs. 574 and 575 we find the distances between the figures to outmeasure completely the spaces occupied by the figures themselves, which point it is necessary as a *standard rule* to keep steadily under consideration in designing. One and three-quarter inches is about the smallest width of the shuttle, thus two inches is the smallest distance possible to be used by a shuttle of such a size; but generally a wider

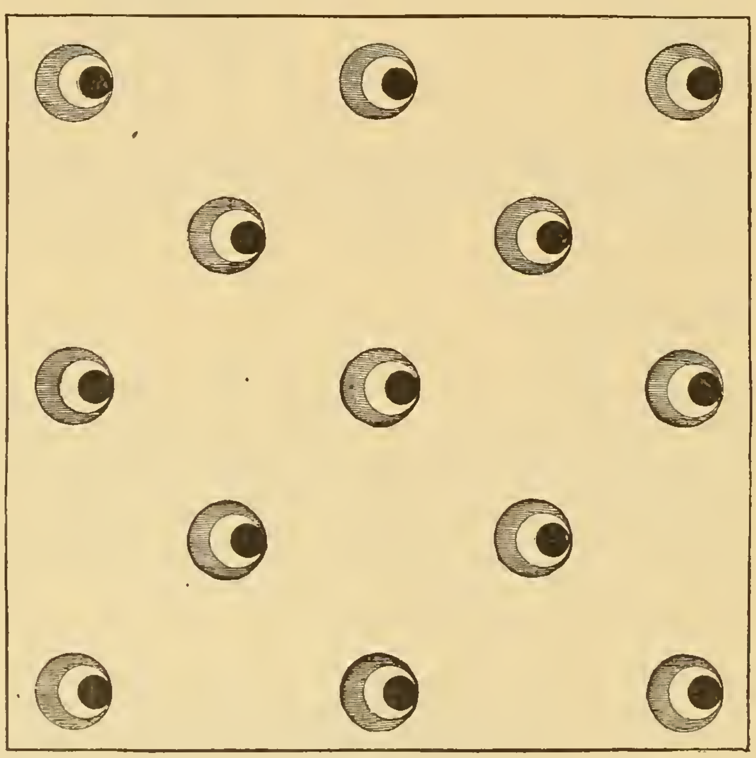


Fig. 575.


Fig. 576.

distance between the figures is allowed so as to get a more perfect fabric. The general rule to be observed in designing for these fabrics is to have the distance between the figures about thrice as wide as the space occupied by the figure itself.

In these designs the ground filling forms the general design for a ground or all-over effect, while the filling introduced by the swivel shuttles only contributes to the coloring up of particular effects.

Circular swivels are used for fabrics where very close-set figures are required. These swivels are specially constructed for these effects.

Combination of the Swivel Effect with Figuring through the Warp.

In some fabrics (but only where the most exquisite designs, richness and fineness of material are employed) this method is applied, hence we have to use the following four distinct systems of threads in producing the fabric:

1st. One kind of warp to form a general ground fabric with

2d. The regular ground filling;

3d. One kind of warp to produce, on the two systems mentioned, the foundation parts of a design, into which the filling from the

4th, swivel shuttles forms the figure spots.

Fig. 576 is executed on this method. In this we find the white grounds for systems 1 and 2. The stems, leaves and buds, only outlined in design for system 3, whereas the two shaded flowers have to be produced through system 4, or the swivel shuttle. Design Fig. 576, illustrating only one effect, has to be arranged for practical use according to the fabric for which it is required.

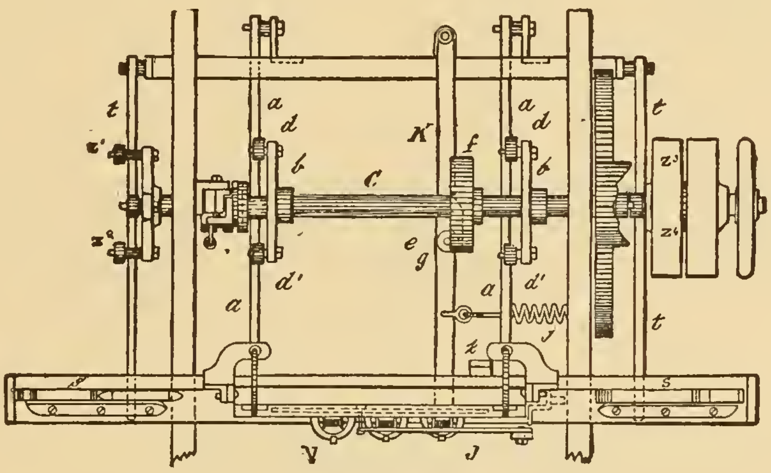


FIG. 577.

Another combination of the swivel arrangement with figures produced with the common shuttle, but of a yet more complicated nature, is procured by combining systems of threads as follows:

1st	system:	ground warp.
2d	"	ground filling (common shuttle).
3d	"	figure warp.
4th	"	figure filling (common shuttle).
5th	"	the filling from the swivel shuttle.

Swivel Loom.

The foregoing explanation of the theory of swivel weaving requires in practice a loom which must be capable of two different movements—namely, the plain or fly-shuttle movement, and the swivel and plain weaving movements combined—to produce the figure or pattern in the body of the fabric while the latter is being woven.

For illustrating the method of operation in such a loom diagrams Figs. 577 to 580, representing the J. Wadsworth swivel loom, are given, similar letters referring to like parts in each figure.

The before-mentioned two movements are carried on in the following manner: First, the loom having been adjusted for plain weaving, the cam-shaft *C* is in the position shown in Fig. 577, which illustrates a view of part of the loom, partly broken out, looking down upon the same. As the cam-shaft revolves the roller projections z^4 z^3 at the right-hand end of said shaft, and the similar projections, z' z^2, at the other end of the cam-shaft, alternately depress the treadles *t t*, which in turn operate the picker-sticks *s s*, to throw the fly or body shuttle back and forth across the loom, as in ordinary weaving. The rollers z', z^2, z^3 and z^4 must be so placed in relation to

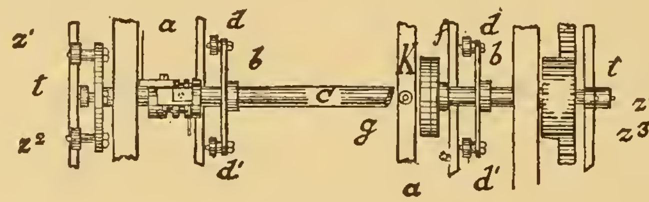


Fig. 578.

each other that they will act alternately, first operating the picker-stick at one side of the loom and then the picker-stick at the other side of the loom, and so on. The fly-shuttle is thereby caused to pass across the loom four times during one revolution of the shaft *C*. This is the plain-weaving motion of the loom producing the body of the fabric, and is the first motion referred to above. The next operation is the introduction of the swivel-shuttles for the purpose of weaving figures or patterns. This is accomplished by shifting the shaft *C* with its attached cams and rollers along the line of its horizontal axis from right to left, so that it will occupy the position shown in Fig. 578. The harness and other portions of the loom not essential to a full understanding by the student are omitted from the drawings. By the shifting of the cam-shaft a new set of cams and levers is brought into action, and the operation of certain of the devices which were in action before the shifting of the shaft is arrested, while a portion of the devices which were in action before the shifting of the shaft remains in action after the shaft has been shifted.

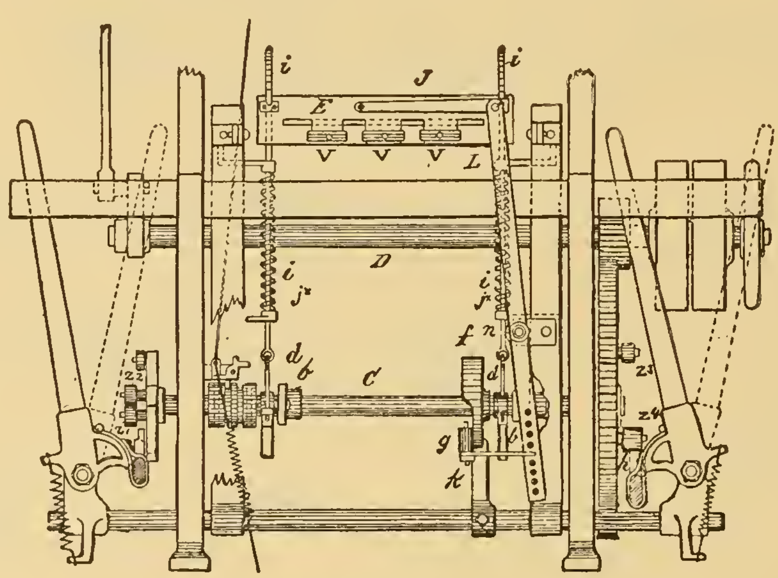


Fig. 579.

The new cams and levers thus brought into play, acting in connection with the devices which remain in operation after the shifting of the shaft, as stated, give the second movement previously mentioned—namely, the combined plain and swivel movement.

In diagram Fig. 579 the front view of the loom is illustrated, in which a portion of the plate at the left-hand end of the loom is cut away to enable the rollers z' z^2 the more readily to skip or miss the treadle. In place of the shots of the fly-shuttle, the swivel-shuttles are called into action by means of the second change effected by the shifting of the cam-shaft—namely, that by which the arms *b b*, with their attached rollers *d d'*, are caused to operate the treadles *a a* and to give to the rack *E*, containing the swivel-shuttles *D D D* the necessary downward motion, and by which at the same time the cam *f*, through its connections *K L J*, is caused to drive the swivel-shuttles horizontally to weave the desired figure or pattern. The action of the fly-shuttle must alternate with that of the swivel-shuttle. The operation then is as follows, reference being had to Figs. 578 and 579. As the cam-shaft *C* revolves the roller z^4 depresses the treadle to operate the picker-stick, thus throwing the fly-shuttle from right to left. During the next quarter-turn of the shaft the roller z' would operate the picker-stick at the left side of the loom to return the fly-shuttle were it not that by the shifting of the cam-shaft this roller is thrown out of gear. In its stead, the rollers *d d*, attached to the arms *b b*, are brought into contact with the treadles *a a*, and, depressing the same, pull downward the rods *i i* (against springs $j^\times j^\times$, arranged around the same), and the attached rack *E*, containing the swivel-shuttles *V V V*, is thus brought into position for the working of the swivel-shuttles with the warp. Almost simultaneously with this downward movement the swivel-shuttles are driven longitudinally from right to left by means of the cam *f*, acting in connection with the levers *K* and *L*, rod *J*, and the rack-and-pinion mechanism. By referring to Figs. 579 and 580 it will be seen that on the outer edge of the wheel *f*, and extending half-way around the circumference of the disk, is a collar, *e*, having its ends beveled. As the shaft *C* revolves, carrying with it the cam *f*, the roller *g*, which is attached to the lever *K*, coming into contact with the collar *e*, is thrown outward, carrying with it the lever *K*, which in turn operates the vertical lever *L*, moving on the pivot *n*. To the free end of the lever *L* is attached the rod *J*. Rod *J* is connected with rack-bar V^2, see Fig. 573, which rack-bar is sup-

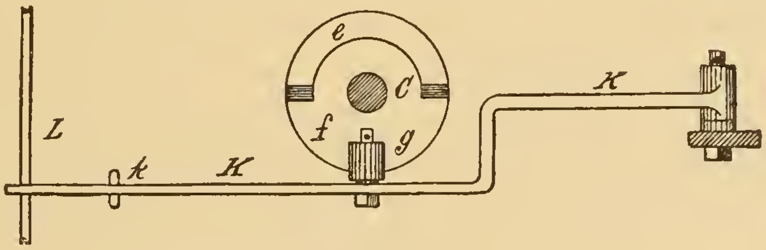


FIG. 580.

ported in the rack *E*, and is in engagement with pinions V', which in turn engage teeth V^3 upon the swivel-shuttles *V V V*. As the lever *K* is thrown from right to left, the swivel-shuttles are driven in the same direction. This longitudinal motion occurs almost simultaneously with the up-and-down movement mentioned before. The roller *g* is kept in close contact with the cam *f* by means of the spring *j*, and is prevented from being operated by the cam when the cam-shaft has been shifted for plain weaving by the stop *k*. (Shown in Figs. 578 and 580.) By the time this double motion has been accomplished the shaft has made another quarter-turn, the rollers *d d* have released the treadles *a a*, and the springs around the rods *i i* throw upward the rack *E* and the shuttles *V V*, to remove the same from the working level and allow the fly-shuttle to pass without interference. The cam-shaft having now entered upon the third quarter of its revolution, the roller *z* depresses the treadle *t* on the left-hand side, thereby operating the picker-stick *s* to throw the fly-shuttle back again across the loom from left to right, the roller z^3 at the other end of the shaft at the same time passing inside the corresponding treadle *t* without operating it. The cam-shaft now begins the last quarter of its revolution. The roller z^2 misses the treadle *t* on the left-hand side, as before explained. The rollers *d' d'* depress the treadles *a a* for the purposes before described, and the roller *g*, having traversed the collar *e*, leaves the same and is thrown to the right by the spring *j*, thereby, by means of its attached levers and rod, causing the swivel-shuttles to make a shot from left to right. This completes one revolution of the cam-shaft, and the operation is repeated as often as may be desired for the weaving of the figure or pattern. When it is desired to return to the plain weaving, the shaft *C* is shifted back again from left to right, and the action of the loom is then the same as that first described.

Combination of Weaves for Fabrics Constructed with Two Systems of Warp and One System of Filling.

Weaves for this division of fabrics are obtained by the combination of two (or more) foundation or derivative weaves. They are designed for three purposes.

1st. For using two systems of warp and one system of filling in producing double-faced fabrics, such as ribbons, etc., etc.

2d. For using an extra warp as backing for heavy-weight worsted and woolen fabrics.

3d. For figuring with an extra warp upon the face of a fabric otherwise interlaced with its own filling and warp.

Two Systems of Warp and One System of Filling for Producing Double-faced Fabrics.

These weaves are largely used in the manufacture of ribbons and similar fabrics used for trimmings, in which one side of the fabric has to be of a totally different color from the other. Such fabrics (mostly of silk) require a great many ends in the warp, as only one-half or two-thirds will form one side of the fabric; the remaining half or one-third forming the other. In addition to the difference in color for each side we can also change the quality of the stock, or the nature of the stock itself; hence we may use a finer quality of stock for one side (the face), and a lower quality of stock for the other (the back); and again we may use silk for one side (the face) and cotton for the other (the back).

In selecting weaves for these fabrics, we generally use the combination of a regular satin weave, warp for face, with its corresponding satin-weave, filling for face. Technically we classify the warp which shows on the upper side of the fabric as the "face-warp," and its mate, or the warp forming the lower side of the fabric, as the "back-warp." As mentioned at the beginning, only one system of filling is used for interlacing both systems of warps.

In combining both warps into one fabric in this way, it is necessary to observe the following Rule: *The raising of the backing warp over the filling must always be done at a place in which two face-threads raise next to it* (one on each side of the backing warp as raised). Diagram Fig. 581 is designed to illustrate this method. Three warp-threads and four picks are represented.

Warp-threads 1 and 3 illustrate the face warp; warp-thread 2 represents the back-warp.

In examining the latter warp-thread, we find its point of interlacing with the filling situated in pick 2.

Face warp-threads 1 and 3 are also raised on pick 2, as required by the rule (given before) for combining both systems of warps. A careful examination of the diagram will show a second point possible for perfectly intersecting the back warp-thread (number 2) into the filling at pick number 3. Picks 1 or 4, if used, would produce imperfectly stitched places, as in the first-mentioned spot face warp-thread 3 is down, and in the latter-mentioned spot face warp-thread 1 is down. To give an illustration of these weaves Figs. 582, 583 and 584 have been designed.

1st warp-thread.	2d warp-thread.	3d warp-thread.	
		■	4th pick.
■		■	3d pick.
■	●	■	2d pick.
■			1st pick.

Fig. 581.

Weave Fig. 582, repeat: 8 warp-threads and 4 picks, has for its foundation the combination of the 4-harness broken-twill, warp up for *face* (■), and the 4-harness broken-twill, filling up for *back* (□). The arrangement of the warp for face and back in this weave and weaves Figs. 583 and 584, is one end face to alternate with one end back.

Weave Fig. 583, repeat: 10 warp-threads and 5 picks, has for its foundation the combination of the 5-harness satin, warp up, for *face* (■), and the 5-harness satin, filling up, for back (⊡).

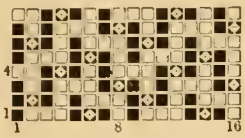


FIG. 582.

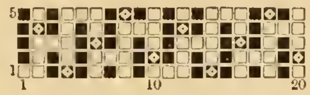


FIG. 583.

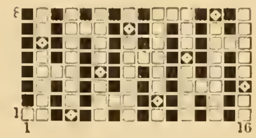


FIG. 584.

Weave Fig. 584, repeat: 16 warp-threads and 8 picks, has for its foundation the combination of the 8-harness satin, warp up for face (■), and the 8-harness satin, filling up for *back* (⊡).

In the same manner as these three examples of weaves are arranged for explaining the present system other combinations of satins or twills can be designed.

Using an Extra Warp for Backing for Heavy-weight Worsted and Woolen Fabrics.

These weaves are used to obtain a thickness of the fabric by using a lower stock for the back, as, for example, a wool back for worsted goods.

They may be designed with one of the following arrangements for the warp:

1 end face.	2 ends face.	1 end face.
1 end back.	1 end back.	1 end back.
–	–	2 ends face,
2 ends repeat, or	3 ends repeat, or	1 end back.
		–
		5 ends repeat,

or any other similar arrangement.

In stitching the back warp to the face fabric it is necessary to observe the following points:

1st. The backing-warp has to be raised over the filling, in every instance, between two face-ends, so that the face-threads will afterwards cover the backing ends. Should we have to deal with any face-weave in which only one end-warp raises at the time (satins filling up) we must raise the backing-warp near this one end-face, either to the right or left hand.

2d. We must select for the backing a weave as regular as possible, such as satin-weaves, broken-twills, etc., so that every warp-end gets the same amount of binding and therefore of tension.

3d. If there are more intersections of the face-warp with the filling (in a certain number of picks) than intersections with the back-warp (in the same number of picks as before) we must work each warp from a separate beam. The face-warp, if intersecting oftener than the back-warp (on the same number of picks) requires more material ("takes up more") than the less intersecting back-warp.

Two warp-beams must also be used if the material for the face and back-warp is of a different nature, such as wool and cotton or worsted and wool spun yarn, etc. The number of intersections of face and back-warp in such a case can be equal.

4th. If using the arrangement "one end face-warp to alternate with one end back-warp," never use a heavier size of warp-yarn for the back-warp than you use for the face-yarn. Such a selection will prevent the back-warp from showing upon the face. If using "two ends face to alternate with one end back," a proportionally heavier yarn can be used for the back-warp. Great care must be exercised in selecting the stock for the face-warp and back-warp for fabrics requiring "fulling" during the finishing process. The material in the back-warp, which can be of a cheaper quality, must have, as nearly as possible, the same tendency for fulling as the "stock" which is used in the face-warp.

In selecting the weave for the back-warp, we should be guided by the required appearance of the face in the fabric. For example, a twill-weave can be used for the interlacing of the back-warp if the face-weave is a prominent twill. If the face-warp is interlaced into a twill of short repeat, as $\frac{2}{1}$ 3-harness twill, $\frac{2}{2}$ 4-harness twill, etc., etc.; or if the face-warp interlaces on a plain-weave, rib-weave, basket-weave, granite-weave, etc., etc., thus showing small broken-up effects upon the face of the fabric, a satin-weave must be used for the interlacing of the back-warp. In woolen fabrics requiring fulling, the back-warp, by reason of its lesser amount of intersection as compared with the face-warp, is apt to show by impressions the points of intersecting of the back-warp on the

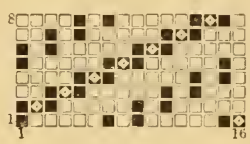


Fig. 585.

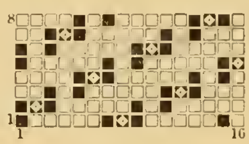


Fig. 586.

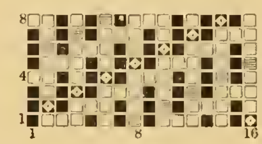


Fig. 587.

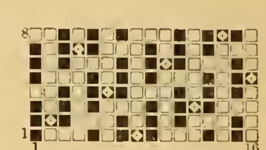


Fig. 588.

face cloth. For this reason a twill-weave, which is used for interlacing the back-warp, might possibly show its lines of impressions running over the face of the fabric, whereas if a satin is used in the present example for interlacing the back-warp, the impressions, if visible on the face of the fabric, will be well distributed and harmonize in every respect with the weave used for the interlacing of the face-warp.

Weave Fig. 585 illustrates what might be called an imperfect combination. The $\frac{2}{2}$ 4-harness twill forms the face upon every alternate warp-thread; the $\frac{1}{7}$ 8-harness twill, the weave for the back-warp. It will readily be seen that the repeat of the $\frac{1}{7}$ 8-harness twill, taken in equal proportions with the $\frac{2}{2}$ twill, will require two repeats of the latter. The interlacing of the back-warp into the face-twill will thus only occur with every other face-twill, and proportionally make every other face-twill appear more prominently.

Weave Fig. 586 illustrates a perfect selection of weaves, the $\frac{2}{2}$ 4-harness twill forming the face upon every alternate warp-thread with the 8-harness satin-weave (filling for face) as the weave for the back-warp. A careful examination of this weave will show the method of perfectly combining the back-warp with the face fabric by stitching the former alternately (exchanging) into each twill line of the two repeats of the 4-harness twill, forming one repeat.

Repeat of weaves Figs. 585 and 586 is 16 warp-threads and 8 picks.

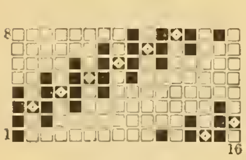


Fig. 589.

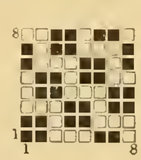


Fig. 590.

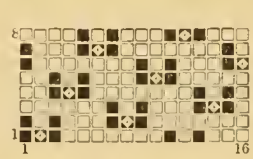


Fig. 591.

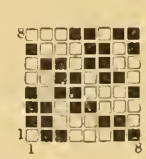


Fig. 592.

Fig. 593

Weave Fig. 587 illustrates by taking ■ and ▣ for raisers, ▫ and □ for sinkers, an imperfect selection of weaves, as demonstrated and explained by example Fig. 585.

By exchanging the 8-harness $\frac{1}{7}$ twill (back-weave) in Fig. 587, to the 4-harness twill $\frac{1}{3}$ (■, ▪ and ▣ for raisers, □ for sinkers), we produce a perfect combination; the back-warp interlacing with the face fabric regularly in every face twill-line; thus, if producing any impressions, such will be uniformly visible.

Repeat, if using the 8-harness $\frac{1}{7}$ twill of weave for back warp: 16 warp-threads and 8 picks; if using the 4-harness $\frac{1}{3}$ twill for weave of back-warp: 8 warp-threads and 8 picks.

Weave Fig. 588 shows a perfect combination of weaves, the $\frac{3}{1}$ 4-harness twill for face-warp and the $\frac{1}{7}$ 8-harness satin for back-warp. Repeat: 16 warp-threads and 8 picks.

Weave Fig. 589 shows another perfect combination of weaves. The $\frac{4}{4}$ 8-harness twill is used for the face and the $\frac{1}{7}$ 8-harness twill for the interlacing of the back-warp. Repeat: 16 warp-threads and 8 picks.

Weave Fig. 590 represents a granite-weave. Repeat: 8 warp-threads and 8 picks.

Fig. 591 illustrates the combination of weave Fig. 590 for face-warp with the 8-harness satin for the back-warp, face and back-warp exchanging alternately. Repeat: 16 warp-threads and 8 picks.

Fig. 592 represents a common granite-weave designed for 8 warp-threads and 8 picks in its repeat.

Weave Fig. 593 illustrates the latter applied as a backing warp. Repeat: 12 warp-threads and 8 picks. Arrangement of warp: 2 threads face-warp to alternate with 1 thread back-warp.

The next arrangement for combination of face and back-warp is found in 1 end face, 1 end back, 2 ends face, 1 end back = 5 ends in repeat.

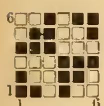


Fig. 594.

Weave Fig. 595 is constructed in this manner, and has for its face-weave Fig. 594 (repeat: 6-harness and 6 picks). Weave Fig. 595 has for its repeat, 10 warp-threads and 6 picks.

Fig. 595.

Figuring with an extra Warp upon the Face of a Fabric otherwise interlaced with its Regular Warp and Filling.

This method of combining two systems of warps with one filling is extensively used in the manufacture of textile fabrics devoted to women's wear. One system of warp and the filling produces the ground structure of the fabric, and then the second system of warp is employed to produce the figure upon this ground structure.

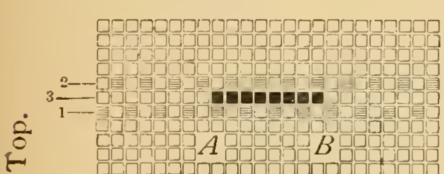


Fig. 596.

Weave to Longitudinal Section. Fig. 597.

As a peculiarity of this second system of warp, we mention that it is only visible on the face of the fabric at certain places (according to the design), while at other times it is made to float on the back or is stitched in certain places not visible on the face.

To give a thorough explanation of the general principles involved in this system, Figs. 596 to 609 are given.

Fig. 596 illustrates a part of a weave. The warp-threads indicated by 1 and 2, shown by ⊟ type, represent two ground warp-threads interlacing into the filling in "common plain." Warp-thread indicated by 3 and shown by ■ type represents the figuring thread. The latter is 8 picks down, 8 picks up, 8 picks down. *A* indicates the place where the figure warp raises on the face of the fabric, and *B* indicates the place where the former returns for floating on the back.

Fig. 597.

(Section corresponding to Fig. 596.)

Examining the longitudinal section, Fig. 597, we find the same numbers and letters used.

No. 1 warp-thread, ground fabric, is indicated by a dotted line (⊟ in the weave).

No. 2 warp-thread, ground fabric, is indicated by a fine line (⊟ in the weave).

No. 3 warp-thread, the figure-thread is indicated by a heavy line (■ in the weave).

Places *A* and *B* in the longitudinal section indicate the respective places marked by corresponding letters in part of a weave Fig. 596.

Fig. 598 illustrates two warp-threads of a four-leaf twill, ground fabric, having in its centre a figure warp-thread, which also is stitched in certain places to the ground fabric, but so that the stitchings are not visible on the face.

Warp-thread No. 1 reads 2 picks up, 2 picks down, } 6 times over, } Ground threads.

Warp-thread No. 2 reads 1 pick down, 2 picks up, 1 pick down, } 6 times over, } Ground threads.

Warp-thread No. 3 reads 1 pick down,
1 pick up (binder),
4 picks down,
7 picks up (figure effect on face),
8 picks down,
1 pick up (binder),
2 picks down.

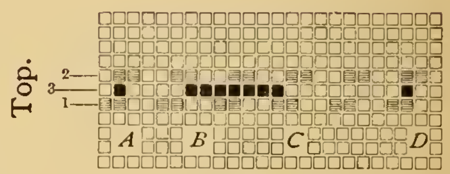


FIG. 598.
(Weave to longitudinal section Fig. 599.)

Letter *A* indicates the binding at pick No. 2.
Letter *B* indicates the raising to face at pick No. 7.
Letter *C* indicates the lowering to back at pick No. 14.
Letter *D* indicates the binding at pick No. 22.

Examining the longitudinal section Fig. 599, we find the same numbers and letters used, so as to give a perfectly clear comprehension of the matter.

No. 1 warp-thread is indicated by a dotted line, ground fabric (▪ in the weave).

No. 2 warp-thread is indicated by a fine line, ground fabric (▪ in the weave).

No. 3 warp-thread is indicated by a heavy line, representing the figure-thread (represented by ▪ in the weave).

FIG. 599.
(Section corresponding to Fig. 598.)

Places marked *A* and *D* clearly indicate the binding of the figure-warp. By the nature of the operation the same is pulled down below the ground fabric and covered by the two warp-threads nearest to it.

B represents the raising of the figure-warp; *C* represents the lowering of the figure-warp.

Fabrics made with Loose Texture without Binding the Figure.

If a fabric is constructed with a thin or loose texture, the floating warp-threads are apt to show through on the face, hence the latter threads have to be cut off after the fabric leaves the loom. In this case a second point has to be considered:

If the figure-thread (No. 3) as shown in Figs. 596 and 597, after producing the figure on the face, simply passes to the rear, there will be nothing else to keep the figure-threads upon the ground fabric but the slight pressure of the ground-warp upon the figure-warp, at the place where the latter intersects the former. As this would be insufficient to enable the fabric to resist the least wear and tear, we must bind the figure-warp close into the ground fabric all around the edges of the design. The best weave to be employed for this purpose is the "plain," which by two or three repeats will give sufficient strength to the figure-warp to allow it to be cut off on the back. (Cut not too close to the place of binding.)

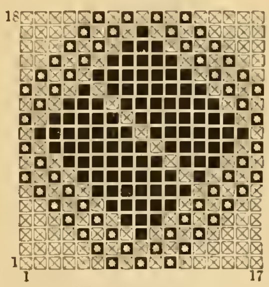


FIG. 600.

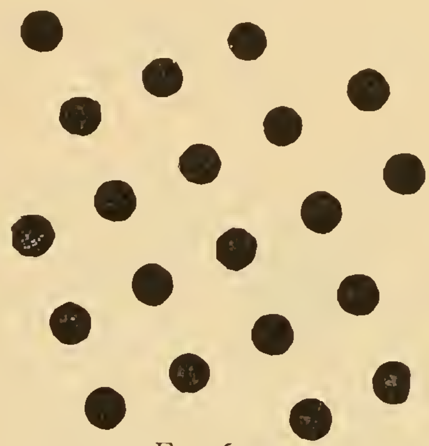


FIG. 601.

Fig. 600 is designed to illustrate this point in general, as well as to illustrate a second point, in which this binding is used for producing a second effect to the main design itself. In the illustration this binding forms a shaded effect around the main design.

This binding may also be used for shading in floral designs, where in some cases the colors have to appear to their full extent. Some cases may require the same color only in a subdued form, while others may require that it shall be scarcely visible.

To get these effects you have to bind your figure-warp into the ground cloth to a sufficient degree and in such order as is required. The weave must be selected according to the required effect, whether heavy twills, fine twills, satin-weaves or cotton-weave, etc.

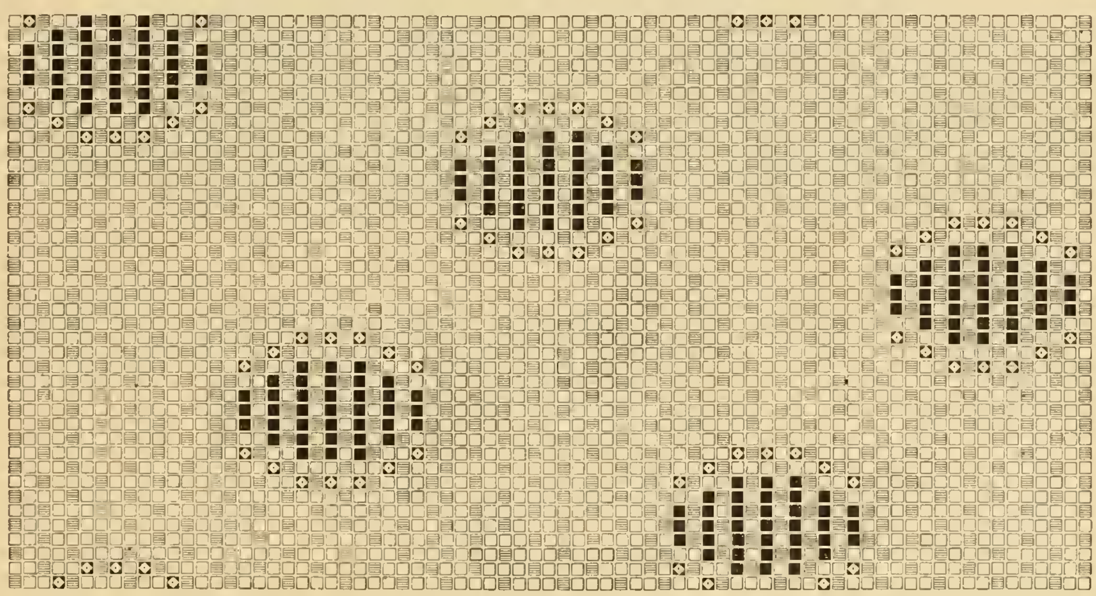


FIG. 602.

Fig. 601 represents a sketch for a design which is practically worked out on the ▫ designing paper in Fig. 602, to be used on a common harness-loom for a dress-goods fabric, produced on two systems of warp, one system of filling; ground fabric, "plain;" figure as formed by the extra warp—circular spots, distributed after the principle of the five-leaf satin.

The warp is arranged—

1 end ground, } 7 times over, 14 ends.
1 end figure, }
1 end ground, 1 end

15 ends in one repeat.

Fig. 603 illustrates one spot (as used in Fig. 602), shown without the ground-warp, and thus represents the spot effect as visible on the face of the fabric.

In weave Fig. 602 the ▤ type indicates the "raisers" for the ground-warp, the ■ indicates the effect of the figure-warp as produced upon the before-mentioned ground-structure. The ▣ indicates the additional binding of the figure-warp to the ground-structure.

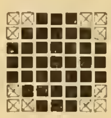


Fig 603.

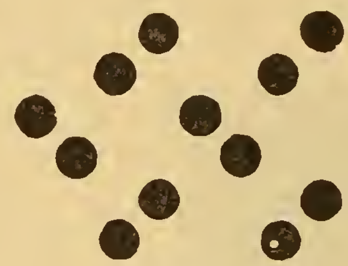


Fig. 604.

As mentioned at the beginning, the plain ground fabric is not always used. Very frequently we have used the "twilled" face. For this reason Figs. 604 and 605 are designed, representing the sketch of the fabric and the weave. The arrangement of the "motive" in the sketch is after the principle of the four-leaf broken-twill. The weave of the ground fabric consists of the four-harness (even-sided) twill $\frac{2}{\quad}\frac{}{2}$. The ▤ in Fig. 605 represents the ground fabric; the ■ in Fig. 605 represents

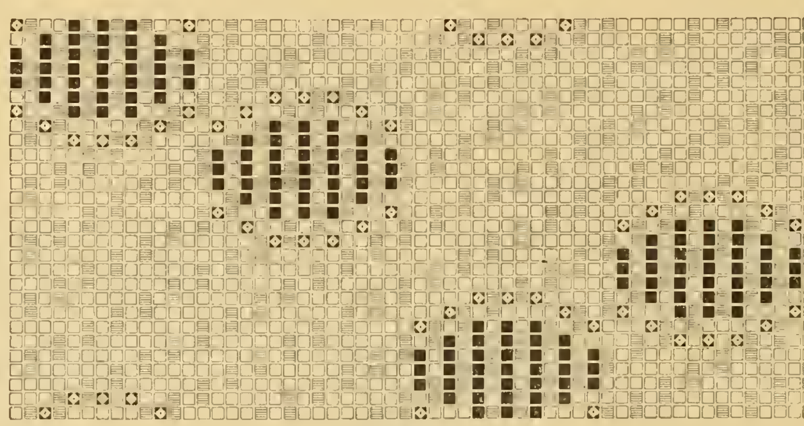


Fig. 605.

the figure produced upon the former; the ▣ indicates the additional binding of the figure-warp to the ground structure.

The warp is dressed—

1 end figure,
1 end ground,
—
2 ends in repeat.

It does not always occur that only one color is used for the figure-warp. Very often differ-

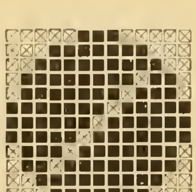


Fig. 606.

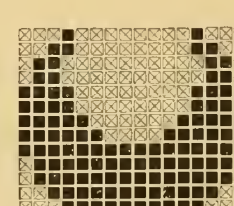


Fig. 608.

ent combinations are employed; but, in whatever shape, form, quality or size, the principle of the construction of the fabric will remain the same as if only one color should be used.

We now pass to fabrics where the floating of the figure-warp is omitted, such as fabrics in which the extra warp is bound to the ground fabric. In constructing fabrics of this character the "plain" weave, which has been used so extensively in weaves previously illustrated for interlacing the ground structure of the fabric, is omitted.

The smallest weave which can be used for the present purpose is the 3-harness $\frac{2}{\quad 1}$ twill, but generally the 4-harness even-sided twill is used as the smallest repeat of a weave. In this manner Figs. 606 and 607 are constructed, representing a motive and the complete weave for

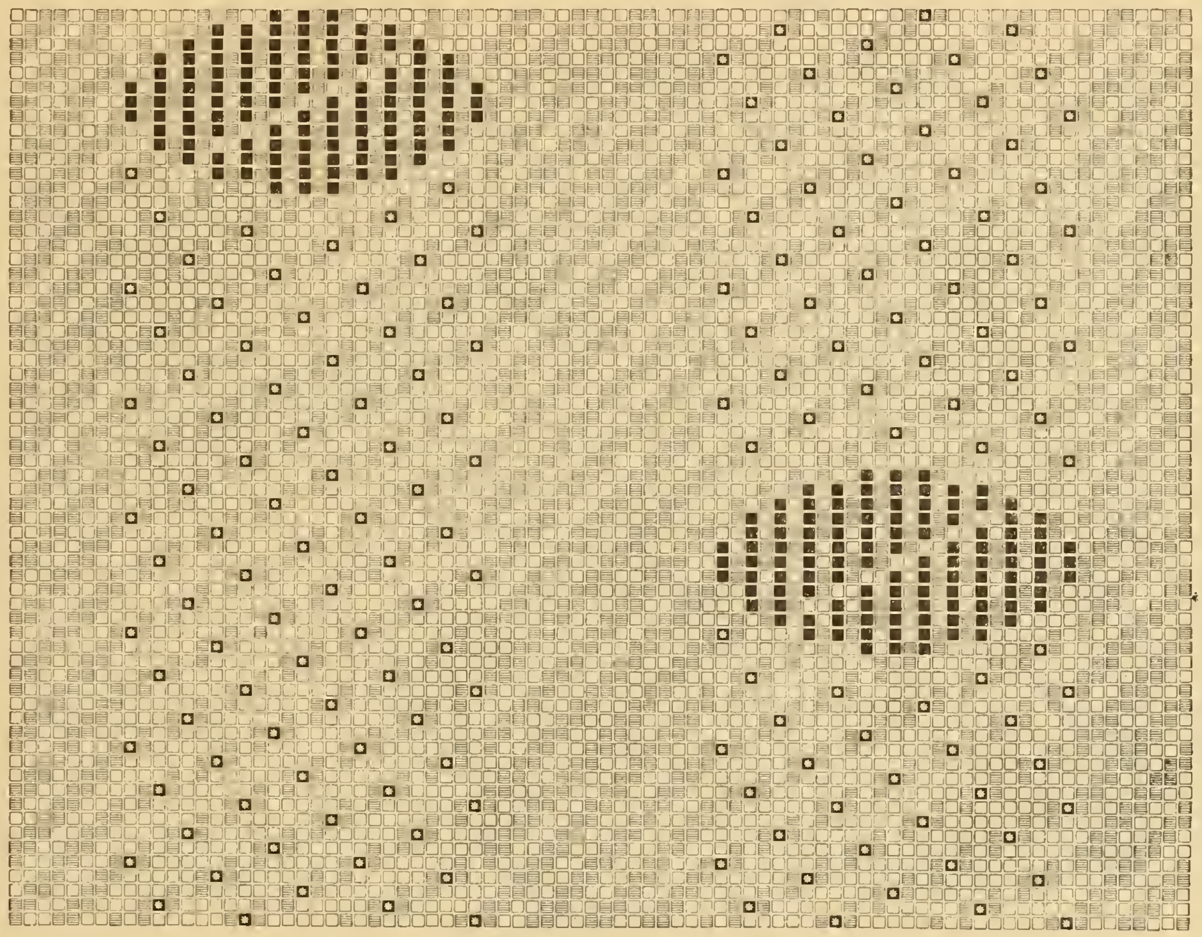


Fig. 607.

a figured dress-goods. The motive, Fig. 606, calls for 13 threads in warp and filling, hence the dressing of the warp for weave Fig. 607 calls for

1 end ground, } 13 times
1 end figure, } over, = 26 ends.
15 ends ground, 15

41 ends in repeat.

The ⊟ is for ground warp, the ■ for figure-warp, and the ◘ represents the places for binding the figure-warp to the ground structure. This stitching is done with the regular eight-leaf satin.

Weave 607, calling in its complete extent for 82 ends, can be reduced by cross-draw to 30-harness.

Fig. 608 represents a motive, a crescent, arranged in Fig. 609, for 96 ends repeat. The motive calling for 16 ends for figure, will necessitate the following dressing:

1 end figure, } 16 times
1 end ground, } over, = 32 ends.
16 ends ground, 16

48 ends in repeat.

Comparison of the Size of the Materials as used for Ground-warp and Figure-warp.

The first condition required by the figure-warp is to produce a design solid in appearance on the ground fabric. To produce this effect the texture is required to be as close set as possible; and the figure-warp must be made of sufficient thickness, so as to cover the interstices between each other as nearly as possible. The general arrangement for changing ground and figure-warp is the alternate arrangement between both (1 and 1). Again, care must be exercised not to have the ground-warp of a heavier size than is necessary; for the figure-threads have not only to fill the places between the ground-threads, but also to cover them actually; hence the diameter

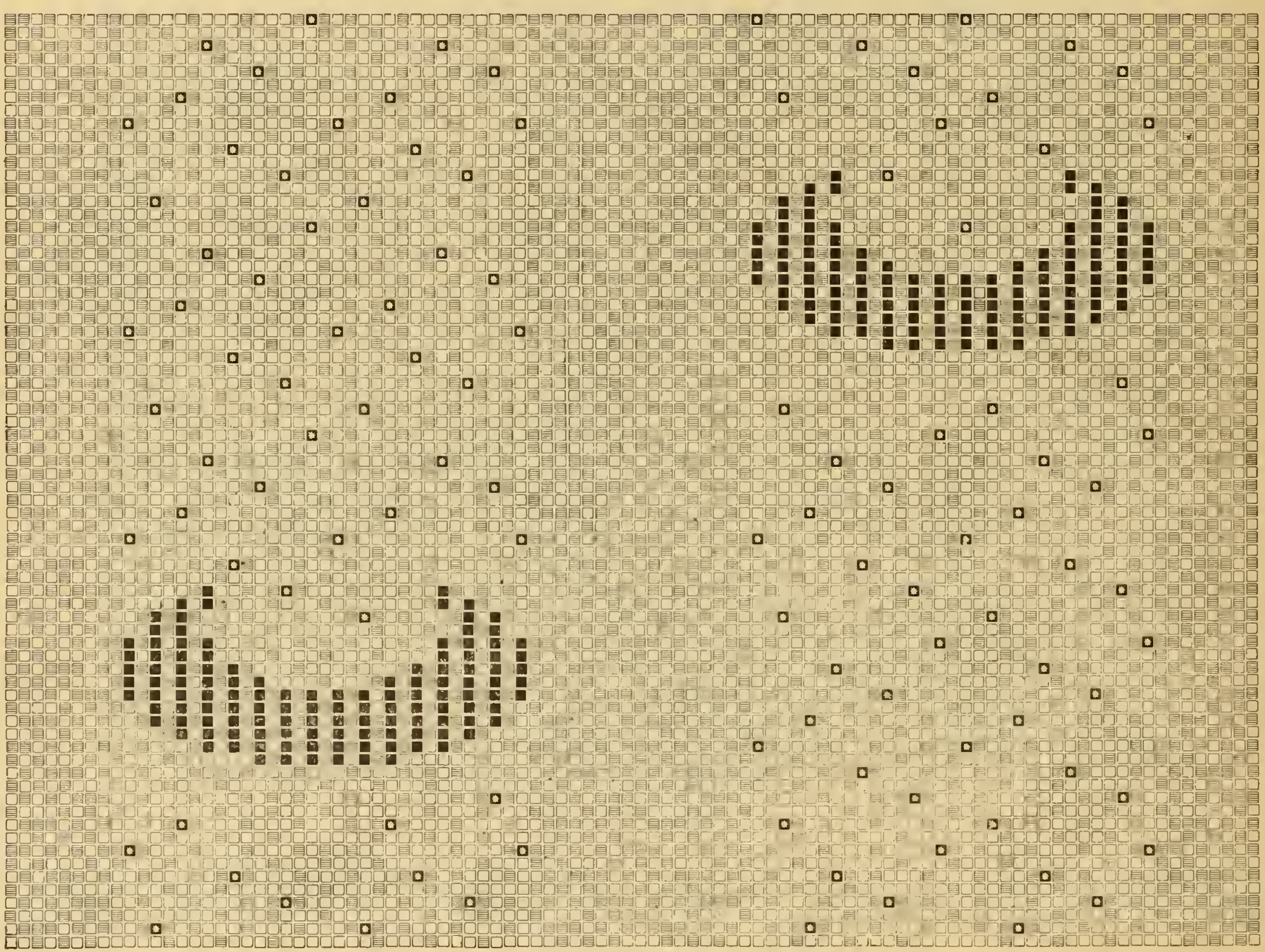


Fig. 609.

of the figure-warp must equal the diameter of the ground-warp, plus the space between each ground-thread.

Comparison of the Twist in the Materials as used for Ground-warp and Figure-warp.

As a general rule, the ground-warp is of a harder twist than the figure-warp. The latter is generally only twisted enough to weave well. There are two reasons for this arrangement of the twist. 1. The ground-fabric has to stand the strain in weaving; hence, must be of a harder arrangement in twist. 2. The figure-warp has to cover the design; hence the loose twist will assist in this work.

Necessity of having Two Beams for Weaving.

In almost every case in producing the textile fabrics here explained, we are compelled to employ two beams, one beam for the ground-warp, one beam for the figure-warp. The reason for using two beams is found in the difference of the weave (for the figure-warp is less interlacing than the ground-warp) as well as in the difference of the materials used for ground-warp and figure-warp.

Another system of weaving for producing figures upon the face of a single-cloth fabric is that known as

Lappet Weaving.

This method of producing figures upon the face of a fabric was very extensively used prior to the introduction of swivel weaving and the invention of the Jacquard loom. The method of operation in this system of weaving is that of passing an independent set of threads through a series of needles set in a frame, situated between the reed and the shuttle-raceway of the lay. This frame is arranged so as to slide horizontally to and fro, regulated by the "pattern-wheel," and the needles are depressed at proper moments to allow the figuring-thread to interweave with the ground-cloth by passing the shuttle and its filling over the figuring-thread. This method of interweaving the figuring-threads is, in looms of older construction, arranged to have the needles which guide the figuring-thread operated on from below, as is illustrated in diagram Fig. 610. The needles *a* (only the first shown) are fixed in the guide-frame *b*. The needles have a thread, *c*, passed through the eye *d* near their point. *e* represents the reed, *f* and *g* the shed formed by the warp of the regular cloth, *h* the woven part of the fabric, and *i* the shuttle.

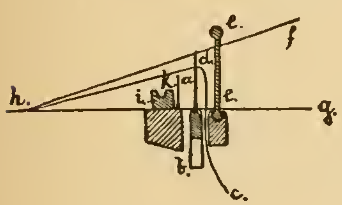


Fig. 610.

The method of interlacing is as follows: When frame *b* is raised the needles pass through the warp at the rear of the shuttle *i* and guide-pins *k*, but in front of reed *e*, so that by inserting the filling by means of the shuttle the figuring-thread gets interlaced with the regular cloth structure. Next the frame guiding the needle is lowered and the latter moved to the right or to the left as required by the design to be produced. This horizontal moving of the frame, according to design to be produced, is effected by grooves *l* in a ratchet-wheel *m*, illustrated in Fig. 611. The pin *n*, fastened to the end of the connecting lever *o*, being worked alternately from side to side of the groove, regulates the distance in moving the needles for the figuring effect required.

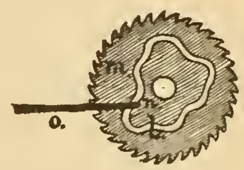


Fig. 611.

This method of operating the frame which guides the needles requires a fresh one for every new design. This ratchet-wheel moves one tooth for each pick, and the number of teeth it contains is regulated by the length of the design.

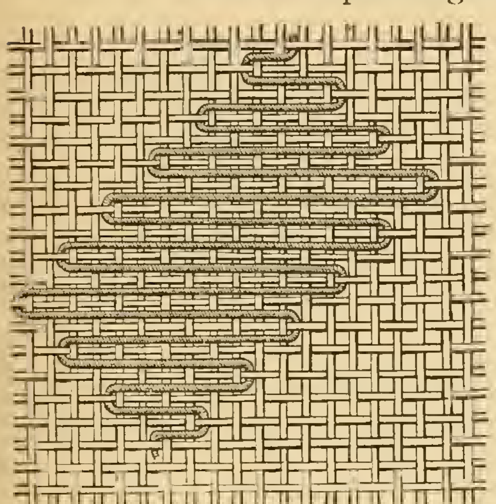


Fig. 612.

Diagram Fig. 612 clearly illustrates (enlarged as to size of threads) the method of interlacing the figuring-threads into the ground structure. The figuring-thread is represented shaded, ground warp and filling outlined.

Fig. 613 is the same effect arranged in 3 repeats in a fabric sample. As previously mentioned, the frame containing the needles for guiding the figuring-warp is placed in some attachment to these looms, situated above the shed formed by the regular warp.

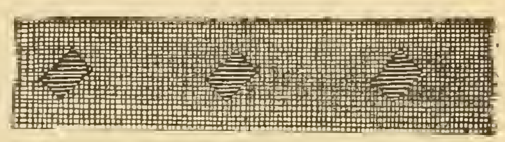


Fig. 613.

Diagrams Figs. 614, 615, 616, 617, 618, 619 and 620 illustrate a loom and the method of operation for lappet weaving as extensively used in the manufacture of elastic web fabrics, such as suspender webbing, also ribbons, tapes, and narrow goods generally. It can be arranged, however, for wider "figured" fabrics. This loom is patented by Mr. G. H. Hodges.

Fig. 614 is a side elevation of the lathe and pattern-wheel; certain parts of the lathe being represented as broken off.

Fig. 615 is an end elevation of the lathe, pattern-wheel and ratchet mechanism for operating the pattern-wheel.

Fig. 616 is an elevation of the pattern-wheel detached, showing the side opposite that represented in Fig. 615.

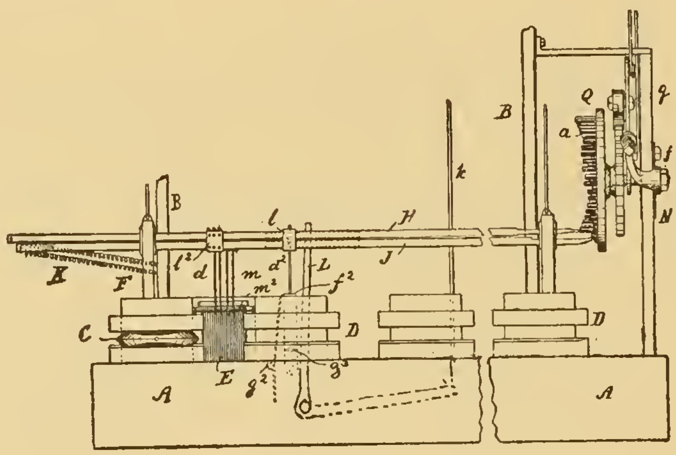


FIG. 614.

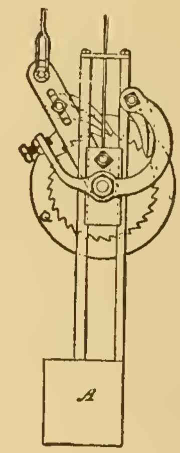


FIG. 615.

Fig. 617 is a sectional view representing the needles elevated.

Fig. 618 is a like view representing the needles depressed.

Fig. 619 is a front elevation, partly broken away, of a lappet loom of the present construction.

Fig. 620 is an end elevation of the loom, the devices for connecting the needle-bars with their actuating levers, and also the mechanism for actuating, the pattern-wheel being omitted in order to avoid confusion and to better illustrate the features shown in this figure. Like letters of reference indicate corresponding parts in the different figures of the drawings. *c* represents the figuring-threads; *U*, the woven fabric; *A*, the lathe; *B B*, the pendulous arms by which the same is suspended; *C*, the shuttle; *D*, the shuttle-race; *E*, a section of the reed.

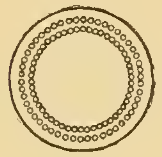


FIG. 616.

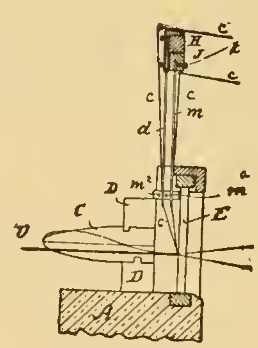


FIG. 617.

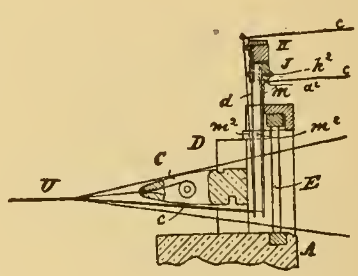


FIG. 618.

The web *U* is ornamented by means of threads *c*, which pass from spools (not shown) mounted on the loom through the guides and thence respectively through the eyes of the needles *d m* and into the web.

Guards m^2 are employed to prevent the needles from being sprung or drawn out of proper position by the strain on the threads *c* during the process of intersecting the same in the fabric. These guards consist of rigid wires arranged horizontally in front of the needles near the upper portion of the reed and firmly secured at either end to a fixed portion of the lathe or shuttle race in such a manner that when a needle is bent a trifle outwardly or toward the front of the lathe by the action of its thread it will strike one of the guards, the vertical movements of the needle not being interfered with thereby. The needles work vertically and pass through the unfilled warp-threads between the path or race of the shuttle, the reed, the pattern-wheel and needles swinging with the lathe. Lateral movements of the needles in one direction or to the left are caused by drawing up the horizontal arm of the lever *L* by means of the rod *k*, thereby bringing the vertical arm of this lever into contact with projections on the pawls causing the latter to engage the teeth and slide the bars or holders *H J* to the left, the reverse lateral movement of the needles to the right being caused by the action of the springs *K* when the vertical arm of the lever *L* is withdrawn from the projection *i* by depressing the rod *k*. The clamp *l* is returned to its normal position after the vertical arm of the lever *L* is withdrawn by means of the springs g^2, its movement toward the right being arrested by the stop g^3, which determines the oscillation of the socket f^2. When the vertical arm of the lever *L* is withdrawn from the projections on the pawls and strikes the curved arms of the pawls, the pawls are thereby disengaged from the teeth on the bars *H J*, permitting said bars to be forced

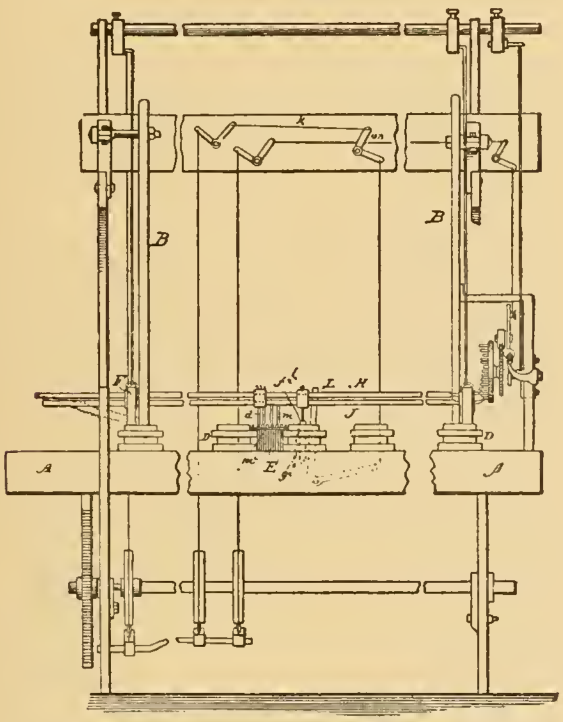


FIG. 619.

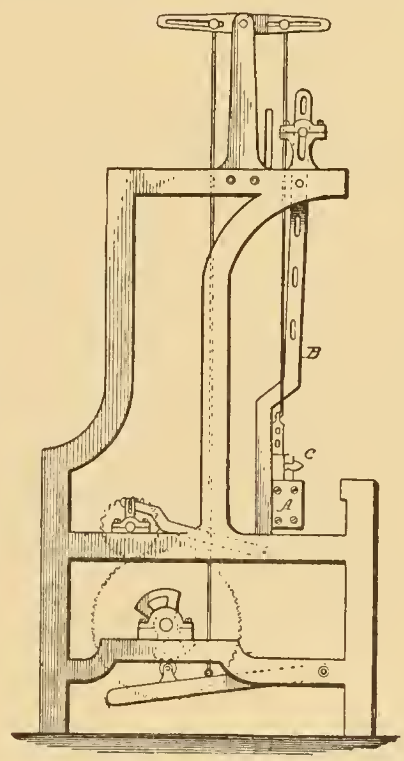


FIG. 620.

by the springs *K* against their respective pins in the wheel *Q*; but as the pins are of unequal lengths one of the bars will travel toward the right a greater distance than the other, thus changing the relative position of the needles *d m* with respect to the web *E*. It will be obvious, however, that when the vertical arm of the lever *L* strikes the projections on the pawls both the pawls will be caused to engage the bars simultaneously and both move in unison to the left.

In order to more clearly understand the method of intersecting the threads *c* in the web *U*, and thereby ornamenting the same, the operation of the principal parts shown during one full revolution of the main driving-wheel of the loom, or one complete traverse of the lathe is described. The lathe being at the front of the loom, the shuttle at the right-hand side of the fabric, and the needles, needle-bars, and pattern-wheel elevated, with the needles threaded, and the bars against their respective pins in the pattern-wheel, if, now, the loom is started up the lathe will be moved or swung back from the breast-beam, and at the first quarter of its traverse the needles, needle-bars and pattern-wheel will be lowered, and the needles carrying their threads will pass through the warp-threads and remain down while the lathe passes through the second and third quarters of its traverse. After the lathe has passed through the first quarter of its traverse, and while it is making its second and third quarters the shuttle is passed from right to left of the web, completing its passage at about the centre of the third quarter of the traverse of the lathe. The needles begin to rise as the lathe enters upon the fourth quarter of its traverse, their upward movement being completed before the lathe completes its fourth or last quarter. The lathe then continues to advance to the front to beat up the filling, and while completing the fourth or last quarter of its course the lever *L* is actuated through the rod *k*, and the needles carried to the left, after which the pattern-wheel is revolved one notch or step to change the position of its pins with respect to the bars or holders *H J*, after which the lever *L* is withdrawn from the projections of the pawls and striking the arms of the pawls disengages them from the bars *H J*, and permits the springs *K* to move the bars to the right into contact with the pattern-wheel, and thereby change the position of the needles preparatory to repeating the operation. The needles *d* are secured to the needle-bar or holder *H* by a screw-clamp, and the needles *m* in the bar *J* by screws; but any other suitable means may be employed for this purpose. Any desired number of needles and needle-holders may also be employed.

Mr. Hodges in his patent further mentions that "instead of using the rows of pins, annular cam-shaped flanges may be employed on the wheel *Q*, against which the bars *H J* may abut, if desired.

"The movements of the needles may be so timed as to cause them to work 'pick-and-pick,' or pass through the warp-threads at each throw of the shuttle or otherwise, as desired. The pawls and lever *L* afford a convenient means for locking the bars *H J* together, and moving them away from the pattern-wheel conjointly.

"A proper tension and take-up mechanism (not shown) must be used with each of the threads *c*.

"But one shuttle and one reed are shown in the drawings, but it will be understood that several may be employed in the same loom; also, that one or more needles may be employed with each shuttle and reed as desired.

"It is preferable to have the threads carried by the needles of a different color or colors from those composing the warp and filling of the fabric; also, that in commencing the weaving the needle-threads should be drawn some distance through the eyes of the needles, in order that the loose ends of the threads may be caught and secured in the fabric by the filling."

TRICOT WEAVES.

Under the general name of tricot are classified fabrics presenting rib-effects. The weaves of the tricot fabrics are more or less elastic, according to the uses to which they are to be put. If, for example, the stuffs are to be used for trousering the tricot weaves will be much less likely to bag at the knees than other fabrics. If used for ladies' dress goods, cloakings, etc., they will tend to give the garment a nicer and closer fit to the person of the wearer.

Tricot weaves are graded into tricots forming rib-effects in the direction of the filling and tricots forming rib-effects in the direction of the warp. We will consider the former first.

Tricots with Rib-Effects in the Direction of the Filling

Are employed largely for stuffs for dress goods, cloakings, overcoatings, suitings, etc. The arrangement of the weave most frequently employed is 2 picks face and 2 picks back; but this may be changed to 1 pick face and 1 pick back, or to 2 picks face and 1 pick back, according to the size of the rib required in the fabric. As a general rule, the heavier the back filling used, the more prominent the rib-effect will be.

Fig. 621 is the 4-harness (filling) tricot weave, 2 picks for face to alternate with 2 picks for back. Repeat: 4-harness, straight draw, 8 picks. This weave has for its foundation the 4-harness broken-twill, 2 picks, warp up, to alternate with 2 picks, filling up.

Fig. 622 is the 3-harness (filling) tricot weave, 2 picks for face to alternate with 2 picks for back. Repeat: 3-harness, straight draw, 12 picks. This weave has for its foundation the 3-harness twill, 2 picks, warp up, to alternate with 2 picks, filling up.

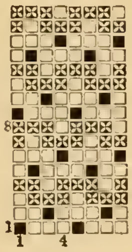


Fig. 621.

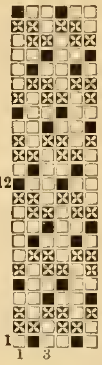


Fig. 622.

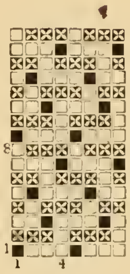


Fig. 623.

Fig. 623 represents the 4-harness (filling) tricot weave, 1 face pick to alternate with a backing pick. 4-harness, straight draw, 8 picks, repeat of pattern. This weave is composed of the 4-harness broken-twill.

Fig. 624, 4-harness (filling) tricot weave, 2 picks face to alternate with 1 pick back. Repeat: 4-harness, straight draw, 12 picks. In designing this weave, observe the following rule: The warp-thread which is lowered in the back pick must be raised in the next following face pick.

Tricots Forming Rib-Effects in the Direction of the Warp.

This division of tricot weaves includes an endless variety of effects in trouserings, suitings, etc., both in wool and worsted goods. A few ends of the regular warp twisted over with organzine silk, or a few fancy-colored threads of worsted wool or sewing silk spread over the fabric (on warp ends showing on the face) will give good effects.

Fig. 625, 8-harness warp, tricot weave. Repeat: 8-harness, straight draw, 4 picks. Harness 1, 3, 5 and 7 are for the face, and hence the harness where the fancy end has to be drawn on.

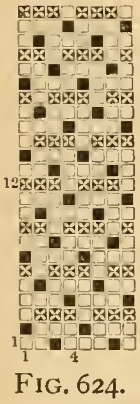


Fig. 624.

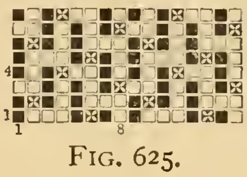


Fig. 625.

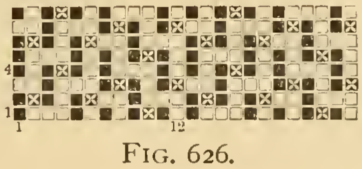


Fig. 626.

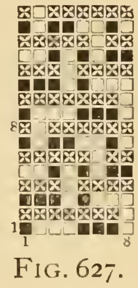


Fig. 627.

Fig. 626, 12-harness warp, tricot weave. Repeat: 12-harness, straight draw, 4 picks. Harness 1, 3, 5, 7, 9 and 11 are for the face, hence for the fancy ends.

Sometimes we have to make these long tricots extra heavy, which may be done by adding an extra backing pick every alternate pick. Fig. 627 is an example. Repeat: 8-harness, straight draw, 8 picks.

In Fig. 628 a specimen of a tricot weave is given which by the proper arrangement of its texture produces a fabric containing a considerable amount of elasticity, in fact, a fabric very closely imitating what is known as "Jersey cloth."

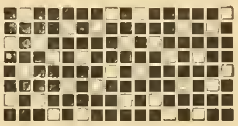


Fig. 628.

As mentioned, it is not upon the weave alone that we must depend for imparting this elasticity to the fabric. The result also follows from use of materials for the yarns of the proper "counts" and quality and upon their arrangements. The following dressing must be used for the previously given design:

2 threads of 2-ply cotton (forming after finishing the body of the fabric).
2 threads of single worsted (forming the face of the fabric after finishing).
—
4 threads in pattern.

The fillings to be fine, soft, single worsted (forming the back in the fabric after weaving and finishing).

Both kinds of warp will be visible on the face after weaving, but during the changes the fabric undergoes in finishing the cotton warp will disappear from the face, taking its place in the body of the fabric.

These fabrics must be made very wide in the loom. Thus, in the case of a 54-inch finished fabric, the goods must be woven 92 to 100 inches wide in the loom, according to the texture and quality of the material used. (Fabrics made with weave Fig. 628 require the selvages to be sewed together when they are fulled.)

Double Cloth.

Under double cloth we comprehend the combining of two single cloths into one fabric. Each one of these two single cloths is constructed with its own system of warp and filling, while the combination of both fabrics is effected by interlacing some of the warp-threads of the one cloth into the other at certain intervals.

The objects for the making of the double cloth are manifold. Among these may be mentioned: To reduce the cost of production for heavy-weight fabrics by using cheaper material for the cloth forming the back; to increase the strength of certain grades of fabrics; to increase the bulk of a fabric; to produce double-faced fabrics; to produce fancy effects by the system of combining or exchanging both single cloths.

As mentioned before, a separate warp and filling is required for each cloth, and so likewise in preparing the design a separate dealing with each is required.

In diagram Fig. 629*a* the section of two single-cloth fabrics is shown.

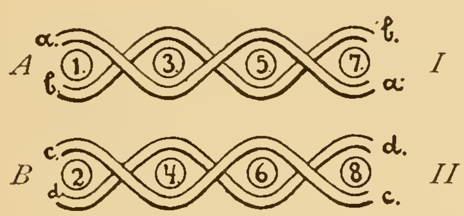


FIG. 629*a*.

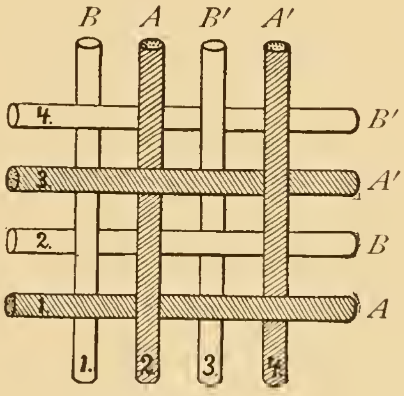


FIG. 629*b*.

In Diagram Fig. 629*b* the plan of two single-cloth fabrics, situated above each other, is shown. Warp-threads 2 and 4 and picks 1 and 3 form one cloth (shown shaded), while warp-threads 1 and 3 and picks 2 and 4 form the other (illustrated in outlined threads).

Examining the section, Fig. 629*a*, and the plan of interlacing, Fig. 629*b*, it is found that each warp-thread interlaces with its own system of filling, and thus each cloth is formed independent of the other. These are, with a few exceptions, such as seamless bags, etc., stitched (or combined) together so as to form one fabric.

The proportion of face warp and face filling to back warp and back filling to be used may be as 1 end face to 1 end back, or 2 ends face to 1 end back, or 2 ends face to 2 ends back, or 3 ends face to 1 end back, etc., etc.

One proportion for the two kinds of warp and a different proportion for the two kinds of filling may also be used, for example:

Warp { 2 ends face = $\frac{2}{3}$ face, 1 end back = $\frac{1}{3}$ back,
— 3 ends in repeat.

Filling { 1 pick face = $\frac{1}{2}$ face, 1 pick back = $\frac{1}{2}$ back,
— 2 picks in repeat, etc., etc.

As mentioned before, the stitching has to bind these two single-cloth fabrics together, in fact, to unite the same into *one* fabric. The warp of the bottom fabric may have to bind into the face fabric, or the face warp into the bottom fabric. In both cases the warp of the one has to interweave more or less with the filling of the other.

In fabrics where each side is of a different color, and the color of the face fabric shall not disturb the back, nor the color of the back cloth the face, great care must be exercised in the manner of combining both cloths. For this purpose we must select for binding, points where warp and filling interlace less frequently, as this will reduce the chances of the thread used for interlacing on one cloth showing upon the other.

The binding of both cloths into one fabric also has an influence with regard to the feel (handling) of the fabric, for the oftener we combine (stitch) a certain number of ends of warp and filling the harder and firmer the fabric will feel; again, if not sufficient stitching is used the fabric produced will be loose or spongy.

The amount of binding for both cloths can only be learned through practical experience, yet the rules for binding are the same for wide as well as close-stitched fabrics.

Rules for Designing the Present System of Double Cloth.

1st. *Indicate the back warp and back filling on your squared designing paper.* (At your first few exercises stripe off these threads with a light color so as to readily distinguish one from the others.)

2d. *Put the weave for the face cloth upon its own system of threads* (omitting every backing thread as if it were not in the design).

3d. *Put the weave for the lower cloth* (back cloth) *upon its own system of threads.*

4th. *Raise all the face warp on every backing pick.*

5th. *Combine both single cloths, thus far constructed separately, into one fabric.*

Observe the following rules in combining: The places for combining both fabrics must be distributed as regularly as possible over the entire fabric. Select the amount of binding for the two cloths according to the character of the fabric the weave is designed for.

In combining the two fabrics by raising the back warp over the face filling at certain places, divide the arrangement as equally as possible for each backing thread. If in certain weaves every backing warp-thread cannot be used, arrange the omission of threads uniformly, such as every other or every third thread, etc.

In combining the two fabrics through certain face warp-threads resting in the lower shed of the backing pick, observe the rules given for the back warp.

In using the back warp for binding in the face cloth (as is generally done) the back warp-thread must be arranged to rise at places where the face warp-thread, situated on each side nearest to it, rises at the same time.

It is advisable to have the raising of the back warp into the face fabric arranged to occur immediately before, or right after, the same back warp-threads have been or are to be raised by the weave in the backing cloth.

In using the face warp for binding in the lower cloth, select for points of stitching spots (sinkers) in which the warp-thread is down in the two adjacent face picks.

Be careful not to disturb the general effect of the face cloth by arranging perfect points of combinings, but in wrong places. For example: Take the ^{2}——$_{2}$ 4-harness twill for face-weave. Suppose one repeat of the back fabric requires two repeats of the face-weave. Requiring a smooth face, and one face twill to show as prominently as the other, the stitching must be arranged alternately for each face twill, because by continuing to use only the one repeat of a twill in rotation, this twill will show more prominently than the other.

To thoroughly understand the foregoing rules for designing double cloth, a study of Figs. 630, 631, 632, 633, 634, 635, 636 and 637 is advised. They represent both weaves for the single cloths and their principle of combining until the weave for the double cloth is perfected. Each rule is illustrated in successive rotation as laid down.

Fig. 630 illustrates the 4-harness (*e*) twill ^{2}——$_{2}$, designed for 4 repeats, warp and filling ways; hence for 16 warp-threads and 16 picks.

Fig. 631 is the plain weave for 8 warp-threads and 8 picks.

Fig. 632 represents one repeat of the 8-harness satin, filling face.

In giving our rules for designing double cloth rule 1 calls for *the indication* of the *two single-cloth fabrics*, as each must be treated separately from the other.

Fig. 633, which is designed for illustrating the present rule, explains itself as "two ends for the one single cloth to alternate with one end from the other, warp and filling ways." This will equal, in the present example, 2 ends face to alternate with one end back.

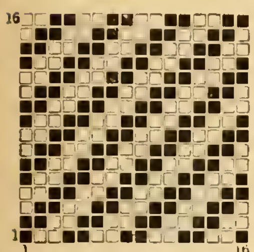


FIG. 630.

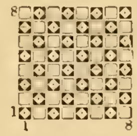


FIG. 631.

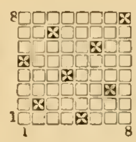


FIG. 632.

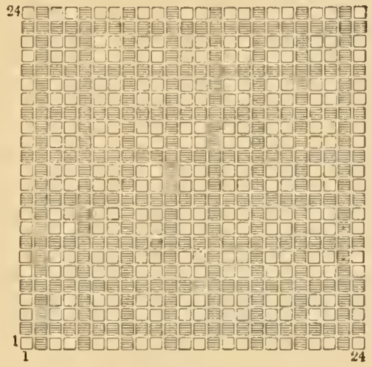


FIG. 633.

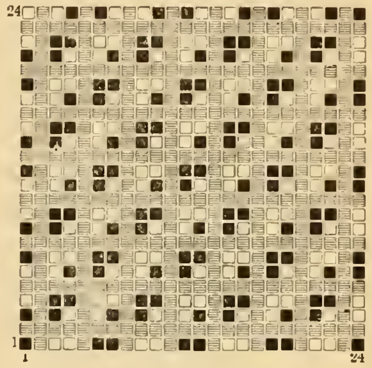


FIG. 634.

Fig. 634 illustrates the application of the second rule as given: "*Put weave for the face cloth upon its own system of threads.*" In this example the 4-harness twill shown in Fig. 630 is applied for face-weave to the plan "2 face 1 back."

Fig. 635 illustrates the succeeding rule (3d) as applied to example, Fig. 634. "*Put the weave for the lower fabric upon its own systems of threads.*" The weave selected for this example is the one shown in Fig. 631 (common plain). The next rule (4th) calls for *the raising of the face warp on every backing pick.* This is illustrated in Fig. 636. These four rules, as observed thus far and illustrated in Fig. 636, produce two separately constructed fabrics. Two-thirds of the number of warp and filling-threads form the face cloth, and the remaining one-third of warp and filling form the lower cloth. Rule 5 calls for the combining of these separately constructed fabrics, either by using the back warp for interlacing with the face filling or the face warp with the back filling. The first mentioned method is used in the present example.

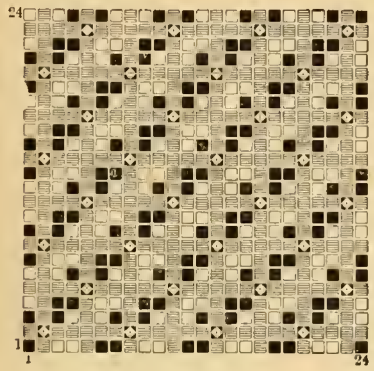


FIG. 635.

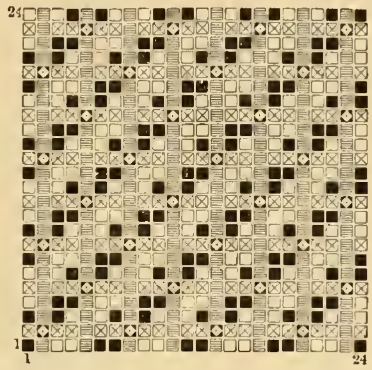


FIG. 636.

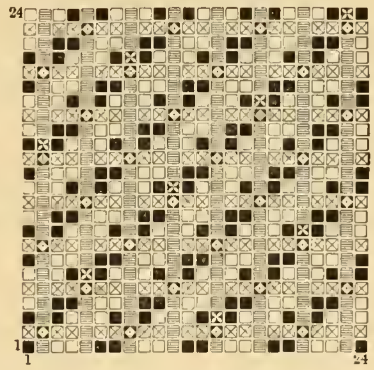


FIG. 637.

Fig. 637. The arrangement for combining (stitching) is after the principle of the 8-harness satin shown in fig. 632.

In designs Figs. 630 to 637 the character of type used for each figure is as follows:

■ indicates the weave for face cloth.

▣ indicates the weave for back cloth.

⊞ indicates the arrangement for combining both cloths for the double cloth.

▤ indicates the back warp and filling-threads from face system.

⊠ indicates the raising of the face warp on the backing pick.

The next thing to be studied is the relation of the warp to the filling and the weave. If both cloths (face and back) are equal in every respect (quality of stock, counts of yarn, proportion of warp and filling and its arrangement, and weave used for the face and back-cloth) no difficulties need be experienced in designing the same. But on the other hand, if, any of these points, as mentioned, differ in one cloth from the other, great care must be exercised.

We will next proceed to give a few examples of different kinds of double cloth; also complete explanations of them from their foundation to the complete weave.

In the following examples, Fig. 638 to Fig. 688, the different characters of type used give the following indications:

Raisers.
- ■ = the weave for the face-cloth.
- ▣ = the weave for the back-cloth.
- ⊠ = the stitching of both fabrics, back-warp into face filling.
- ▢ = the raising of face-warp on backing picks, as required for forming the lower cloth.

Sinkers: ⧄ = the stitching of both fabrics, face-warp into the back filling.

A. Double-Cloth Weaves having for their Arrangement One End Face to Alternate with One End Back in Warp and Filling.

This system of double cloth is mostly used in fabrics in which the quality, size and weave of the two cloths (face and back) is nearly, if not entirely equal, as in reversible overcoating, etc.

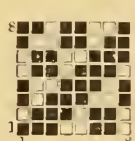


FIG. 638.

FIG. 639.

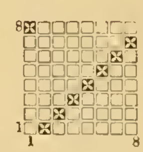


FIG. 640.

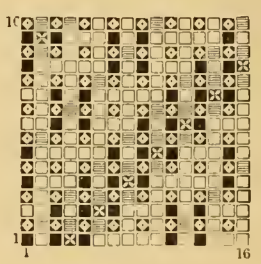


FIG. 641.

Fig 638 represents the weave for face (8-harness fancy-twill).

Fig. 639 represents the weave for back ($\frac{3}{2}\frac{1}{2}$ 8-harness twill).

Fig. 640 represents the arrangement for combining both cloths through the back-warp, interlacing with the face filling ($\frac{1}{7}$ 8-harness twill).

Fig. 641 is a complete double-cloth weave, constructed out of Figs. 638, 639 and 640. Repeat: 16 warp-threads and 16 picks.

FIG. 642.

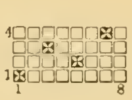


FIG. 643.

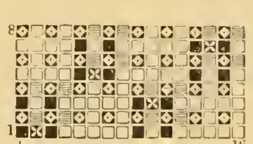


FIG. 644.

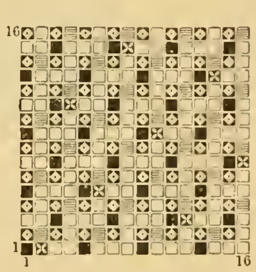


FIG. 645.

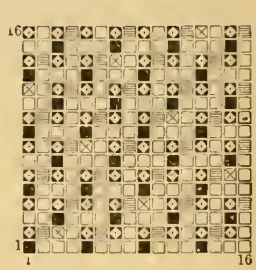


FIG. 646.

Another example illustrating double cloth constructed "one face, one back" in warp and filling, is shown in weave Fig. 644. It contains the common 4-harness basket, illustrated separately in Fig. 642, for its face and back weave.

The method of interlacing observed is the stitching of the back-warp into the face-cloth, as shown by ⊠ for raisers in the full design, as well as in the extra plan Fig. 643.

Weave Fig. 645 illustrates the combining of two plain woven cloths into one fabric by binding the back-warp into the face-cloth. It will be seen that the points where the back-cloth interlaces into the face will show on the surface, but as only one thread raises at a time in a plain weave, the required points in Rule 5 (*i. e.* to have for the intersection of the back-warp with the face-cloth, a place where the face warp-threads on each side nearest to the back warp-thread raise at the same time) can never be found, and we must use the weave as mentioned above, or as to whichever side of the fabric is required to be the clearest, we may use the arrangement of the "double plain," as shown in weave Fig. 646. In this the face is arranged to bind the lower fabric as indicated by ⊠ for sinkers. The raising of the back-warp in the face-cloth in weave Fig. 645, as well as the lowering of the face-warp in the lower cloth, as in Fig. 646, are arranged

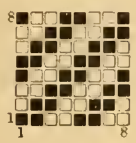


Fig. 647.


Fig. 648.

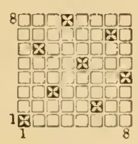


Fig. 649.

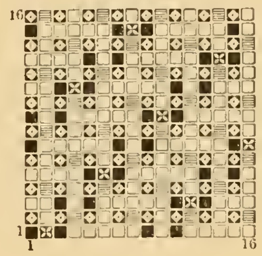


Fig. 650.

after the 8-harness satin (filling face). In the present examples, Figs. 645 and 646, the question may arise as to which method should be preferred?

Taken in the general average of fabrics constructed on this double plain weave, or similar weaves, in which only single threads raise at a time, such as filling-face satins, etc., the preference should be given in favor of the first named weave.

Repeat of designs 645 and 646 is: 16 warp-threads and 16 picks.

Another example of this system of double cloth is shown in Figs. 647 to 650.

Fig. 647 represents the face-weave.

Fig. 648 represents the weave for the lower fabric.

Fig. 649 illustrates the method of binding both cloths into one fabric.

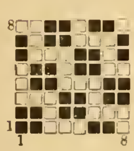


Fig. 651.

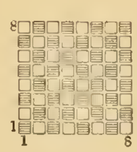


Fig. 652.

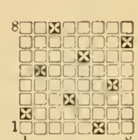


Fig. 653.

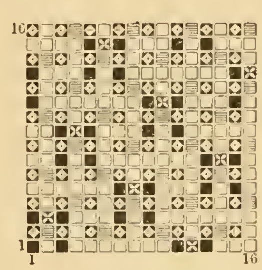


Fig. 654.

Fig. 650 shows the complete design.

Repeat: 16 warp-threads and 16 picks. Face-weave is the 2——2 4-harness twill; back-weave is the plain.

The stitching of the back into the face-cloth is arranged after the 8-harness satin, filling up.

Weaves Figs. 651 to 654 illustrate the combining of an 8-harness "granite-weave" with the plain weave for double cloth, each taken alternately, warp and filling ways.

Fig. 651 illustrates the granite-weave (8-harness) to be used for the face.

Fig. 652 is the plain weave to be used for the back of the double cloth.

Fig. 654 shows the complete double-cloth weave derived by combining both cloths with the 8-harness satin, Fig. 653, using the back-warp for binding into the face-cloth.

Double Cloth Composed with Different Proportions of Face and Back-threads.

B. Warp: 1 end face to alternate with 1 end back.
Filling: 2 ends face to alternate with 1 end back.

In this manner weave 655 is constructed. Repeat: 16 warp-threads and 12 picks. Weave

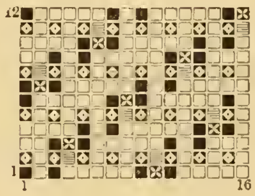


Fig. 655.

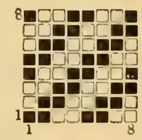


Fig. 656.


Fig. 657.

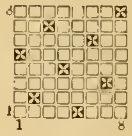


Fig. 658.

for face-cloth is the 4-harness ^{2}——$_{2}$ twill, Fig. 656. Weave for the back-cloth is illustrated separately (same kind of type as used in complete weave) in Fig. 657.

The combining of both cloths is effected by the 8-harness satin, Fig. 658.

C. Warp: 2 ends face to alternate with 1 end back.
Filling: 1 end face to alternate with 1 end back.

Designing a double-cloth weave under this proportion is illustrated by weave Fig. 659. Repeat: 6 warp-threads and 8 picks. Weave for face-cloth is the 4-harness ^{2}——$_{2}$ twill (Fig. 660).

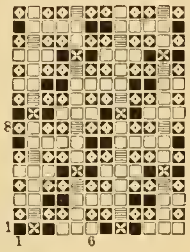


Fig. 659.


Fig. 660.


Fig. 661.


Fig. 662.

The back-cloth is worked on plain, as represented in Fig. 661, and the combining is effected by the back-warp in the face-cloth raising every other back warp-thread on every other face-pick (Fig. 662).

The next arrangement for double cloth is—

D. Warp and filling: 2 ends face to alternate with 1 end back.

This proportion for using face-threads to backing-threads in warp and filling has been represented before, in the examples given for illustrating the rules for designing double cloth. At present this system of using face to back-threads is mentioned in its proper place under the heading of "Different Proportions of Face and Back in Double Cloth."

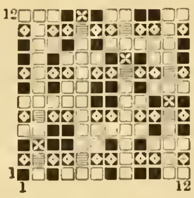


Fig. 663.

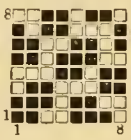


Fig. 664.


Fig. 665.


Fig. 666.

Fig. 663 represents the combination in double cloth of weave Fig. 664 used for the face, and weave Fig. 665 that used for the back. Both cloths are combined into one fabric after the motive of the ^{1}——$_{3}$ 4-harness twill (Fig. 666). Repeat of weave Fig. 663: 12 warp-threads and 12 picks.

Weave Fig. 667 illustrates the combination of the $\frac{3}{1}$ 4-harness broken-twill (Fig. 668) for the face-cloth and the $\frac{3}{1}$ 4-harness common twill for the lower cloth (Fig. 669). Both cloths are combined by motive, Fig. 670 (plain).

Repeat of the double-cloth weave: 12 warp-threads and 12 picks.

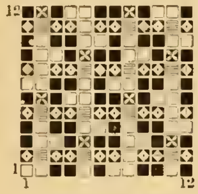


FIG. 667.


FIG. 668.


FIG. 669.


FIG. 670.

This character of the double cloth (2 threads face to alternate with 1 thread back) is that most frequently used in the manufacture of worsted and *woolen* goods. In designing double cloth by this arrangement for 4-harness basket or similar weaves, as also combination weaves of basket and twill effects, etc., always remember that the back-warp must be arranged to work in the centre of the two face warp-threads working alike, as this gives us the only chance for properly binding back to face. For example:

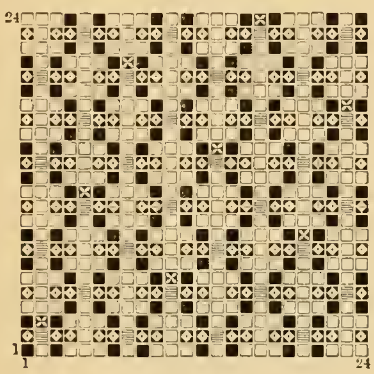


FIG. 671.

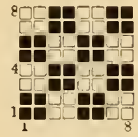


FIG. 672.


FIG. 673.

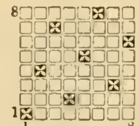


FIG. 674.

Fig. 671 illustrates the weave for a double-cloth fabric, which has for its face the 4-harness basket (arranged as previously mentioned). It has the common plain weave for the backing, and the stitching is done with the 8-harness satin.

Fig. 672, the face weave. Fig. 673, the back weave. Fig. 674, the stitching.

Repeat of weave Fig. 671: 24 warp-threads and 24 picks.

The next arrangement of proportional face and back for warp and filling is:

E. 2 ends face to alternate with 2 ends back in both systems of threads.

This method is illustrated in Fig. 675 which is composed of the 8-harness twill $\frac{4}{4}$ for face

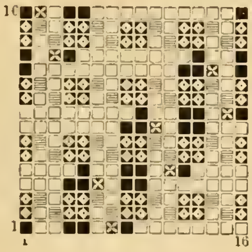


FIG. 675.

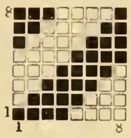


FIG. 676.

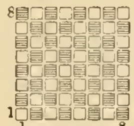


FIG. 677.

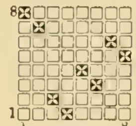


FIG. 678.

and the common plain weave for back-cloth. Both cloths are combined with the weave represented in Fig. 678.

Fig. 676 shows the face-weave. Fig. 677 shows the back. Repeat of the double cloth: 16 warp-threads and 16 picks.

F. Warp: 2 ends face to exchange with 2 ends back. Filling: 2 picks face to exchange with 1 backing.

These are used to a great extent in arranging 63° steep twills (diagonals) for double cloth. Figs. 679, 680, 681 and 682, illustrate such a case.

Fig. 680 represents a diagonal on 6-harness and 12 picks repeat, as used for face.

Fig. 681 shows the common plain as used for back.

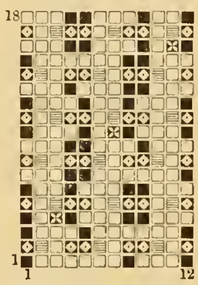


Fig. 679.

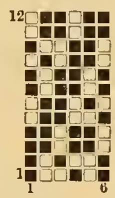


Fig. 680.

Fig. 681.

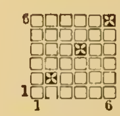


Fig. 682.

Fig. 679 illustrates the complete double-cloth weave, 12 warp-threads and 18 picks repeat. The combining of face and back cloth is shown separately in Fig. 682.

G. 3 ends face to exchange with 1 end back in warp and the filling.

These are illustrated in one example by weaves, Figs. 683 to 686.

Fig. 684 represents a 12-harness fancy twill to be used for face-weave.

Fig. 685 shows the common plain to be used for backing weave.

Both cloths are combined into one fabric with the ^{1}——$_{3}$ 4-harness twill shown in Fig. 686. Repeat of double-cloth weave, Fig. 683: 16 warp-threads and 16 picks.

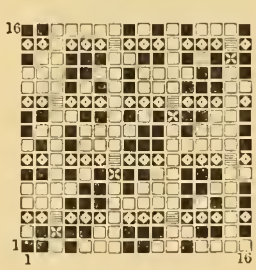


Fig. 683.

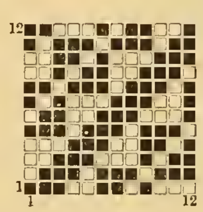


Fig. 684.

Fig. 685.

Fig. 686.

The foregoing 57 weaves have clearly demonstrated that double-cloth weaves may be designed in any combination, from 1 face, 1 back in repeat, to 3 face, 1 back; also that these proportions may be taken independently for warps or for filling in any weave. The binding has mostly been done by the back-warp, yet it has been shown that the face-warp can also be used. In closing this subject on the construction of the double-cloth weaves, a further example is shown in which *both methods of stitching* must be combined in one double-cloth weave.

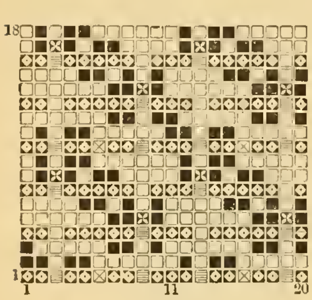


Fig. 687.

Fig. 687 represents such a double-cloth weave. Repeat: 20 warp-threads and 18 picks. The arrangement of the warp is:

3 threads face.
1 thread back.
5 threads face.
1 thread back.
10 threads in repeat.

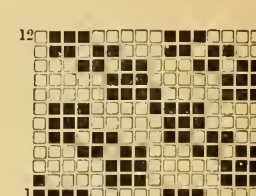


Fig. 688.

The filling intersects 2 picks face, 1 back, = 3 picks in repeat.

On examining the weave we find the centre thread of the 5 face-ends used for interlacing twice in one repeat of the weave in the back. The places of stitching the face-warp into the back are shown by ⊠.

Weave Fig. 688 represents the single-face cloth, being a granite-weave with fancy spot-effects (by the aid of warp-threads numbers 1 and 9.)

Double-Cloth Weaving without Stitching Both Cloths.

At the beginning of our lecture on the double cloth, and the purposes for which it is used when the two single cloths are not stitched together so as to form a new fabric, we mentioned the manufacture of seamless bags and fabrics constructed on similar principles. In manufacturing seamless bags a series of panels are formed, each composed of two separate cloths, a series of solid webbings uniting the cloths of the panels, and a series of divisions formed in the solid webbings, each of which are composed of two separate cloths. Diagrams Figs. 689, 690, 691, 692 and 693 are intended to illustrate the method of weaving such seamless bags. (Hardenbrook's patent.)

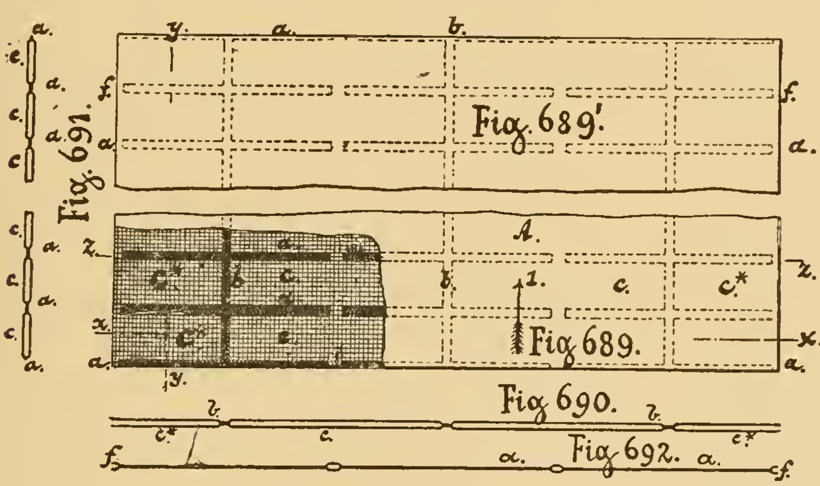
Figs. 689 and 689^1 represent a plan view of the fabric.

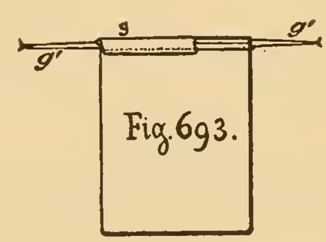
Fig. 690 is a transverse section of the same in the plane *x x*, Fig. 689.

Fig. 691 is a longitudinal section in the plane *y y*, Fig. 689.

Fig. 692 is a longitudinal section in the plane *z z*, Fig. 689.

Fig. 693 is a sectional side view of a bag when finished.





A (689) designates a fabric in which the arrow 1 indicates the warp. This fabric consists of a series of panels *c c**, each composed of two cloths, and of a series of transverse solid webbings, *a a*, and longitudinal solid webbings *b b*, in which the filling is interwoven with all the warp-threads of the fabric, producing purely single cloth with the latter at places mentioned. The outside edges, as to width of fabric in the loom, may either be temporarily closed with a few threads of plain working selvage, which may be liberated after the fabric has left the loom; or the fabric can be woven without specially uniting the two fabrics in such manner. The commencement and the ending of the weaving of the fabric in the loom is formed in each case by one of the transverse solid webbings *a* (single cloth). If the fabric is cut lengthwise through the centre of the longitudinal solid webbings *b b*, and through the centre of the divisions, and also transversely through the middle lines of the solid webbings *a a*, *f f*, a number of bags are produced, and it will be seen that the bags produced from the side portions, *c** *c**, of the fabric have selvages at their mouths, while all the others produced from the centre portions, *c c*, will have raw edges at their mouths).

The size and the shape of the bags is unlimited and is readily regulated by the changing of divisions (purely single-cloth weaving) or openings (double cloth not stitched).

From the explanations and illustration given it will readily be seen that in cutting up the fabrics represented in the drawings a number of bags are formed, the mouth of each being composed of two single cloths projecting beyond the solid webbing, so that they can be turned back upon the body of the bag (see Fig. 693) to form the tube *g*, for the reception of the drawing strings g^1, or simply hems to protect the raw edges.

Fig. 694.

Fig 694 illustrates the double plain weave (two plain woven cloths), without combining or stitching required to produce the openings, while the common rib-weave, Fig. 695, or the common plain weave Fig. 695² is used for forming the divisions in the fabric (purely single cloth.)

These bags are used mostly for tobacco, salt, flour, etc., or pockets for trouserings, coats, suitings, etc. Frequently seamless bags of a larger description are required to be made, extending in their length over the entire width of the loom. In such case the double plain weave is arranged for two successive picks in each cloth, as shown in Fig. 696. Warp-threads 2 and 4 and picks 3 and 4 forming the lower fabric, and warp-threads 1 and 3 and picks 1 and 2 forming the upper fabric.

Fig. 696.

Only one shuttle being used the filling will form the bottom of the bag at the point where the filling, after leaving one cloth, changes into the other cloth. For example, in the present weave, suppose we commence to insert the shuttle in pick 1 from the right to the left, or in the direction of arrow *S*, below the weave; the shuttle and its filling, after leaving shed 1 of the upper cloth, will return in the *same* cloth on its return (left to right), but will insert itself in the lower cloth on pick 3 by interlacing with the warp and filling of the lower fabric; returning in the same fabric at the opening of shed (pick) 4, ready to change again (combining both single cloth for forming the bottom of the bag) from the lower cloth to the upper (the starting point in the present example).

Before and after weaving the required width of the bag (double plain interlacing on one side of the fabric), the entire number of warp-threads are arranged to interlace on the common rib-weave shown in Fig. 695 (in purely single cloth).

Fig. 697.

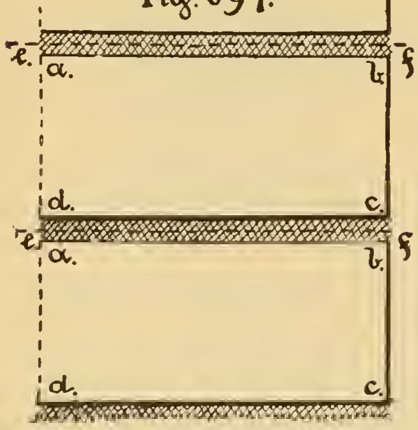


Fig. 697 illustrates itself, by the aid of the foregoing explanation, as follows: *a*, *b*, *c*, *d* inside size of bag produced on weave 696. The shaded part between the two bags represents the purely single-cloth fabric interlaced upon the common rib-weave (Fig. 695); *b* to *c* = bottom of the bag, *a* to *d* = opening of the bag. Dotted line *e to f* indicates the place for separating the fabric.

In the manufacture of hose and similar textile fabrics the weave given in Fig. 694 (double plain, one end face to alternate with one end back in warp and filling) is used.

Double Cloth Fabrics in which the Design is Produced by the Stitching Visible upon the Face of the Fabric.

Worsted Coatings.

Fabrics of this style are a division of the double-cloth in which the binding of both is arranged so as to form patterns of any required design. This binding of the two fabrics has to be done as firmly as possible all around the outline of the design. The double fabric has to become a single cloth, warp and filling ways, all along the outline of the figure or effect. It has to be bound not only at intervals as in the previously explained stitched double-cloth, but into one compact fabric throughout the entire length of the piece, upon the warp-threads, and across the fabric upon the filling ends which form the outlines of the figure.

Double-cloth fabrics in this arrangement of binding may be made as fanciful as required, but in the manufacture of worsted coatings and similar fabrics they are generally confined to striped and small check figures.

Textures for these Fabrics and Arrangement for Binding.

These fabrics are generally constructed on 2 threads face, 1 thread back.(binder), and the stitching is done with the back-warp binding over 2 face-picks. For example, take Fig. 698 for the motive of the design and Fig. 699 for the complete weave.

Repeat: 42 warp-threads and 24 picks.

It will be readily understood that the stitching of the back-warp in the face fabric will form impressions on the latter according to the figure employed for the motive of stitching the fabrics. Again, through the places where the double cloth is left unstitched, the fabric will get an em-

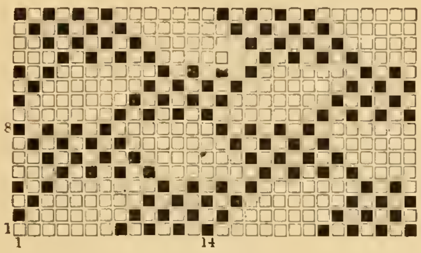


Fig. 698.

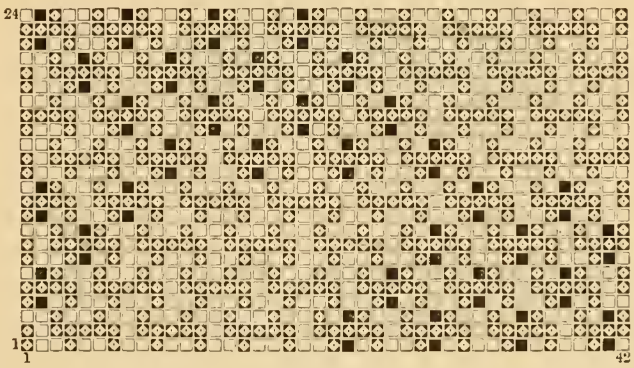


Fig. 699.

bossed effect, similar to that of 2 pieces of cloth embossed with the needle, the binding taking the place of the latter. The cut effect will be more prominent when 2 beams are used, one for the face-warp (ground) and one for the back-warp (binder), and putting more tension on the beam carrying the binder. The $\frac{2}{\quad}\frac{}{2}$ twill for the face, having the backing working on plain weave, may also be used.

Fig. 700. Motive of the effect.

Fig. 701. The complete weave to produce the same, executed on above stated principle Repeat: 36 warp-threads and 36 picks.

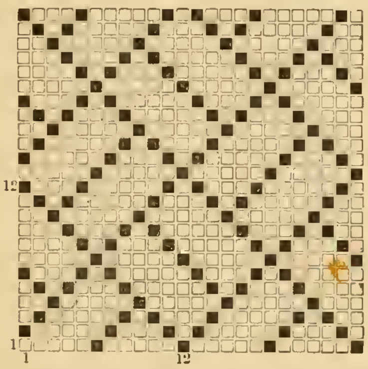


Fig. 700.

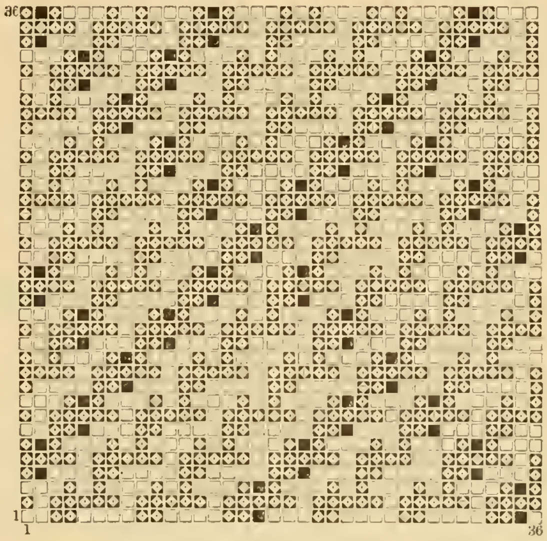


Fig. 701.

In worsted fabrics (also woolen fabrics) forming stripes composed of different weaves, in which it is desired to make the changing from one effect or weave to the other very prominent, by means of a deep or pronounced cut line, use a method similar to the one above explained, *i. e.* "the double-cloth fabric changing into single cloth at the respective last ends of the one weave or effect, and the first ends of the other." The only change observed in the present kind of fabrics, compared with those explained before, is found by combining both fabrics into one through lowering the face-warp into the back filling. In this manner designs Figs. 703 and 705 are constructed.

Fig. 702 represents the motive to weave Fig. 703, and Fig. 704 illustrates the motive for weave Fig. 705.

Fig. 703. Repeat: 18 warp-threads, 6 picks. ⊡ for raisers, □ and ▣ for sinkers.

Fig. 705. Repeat: 36 warp-threads and 6 picks. ⊡ for raisers, ▣ and □ for sinkers.

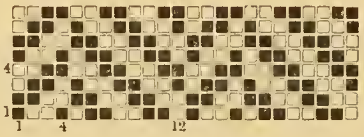


Fig. 702.

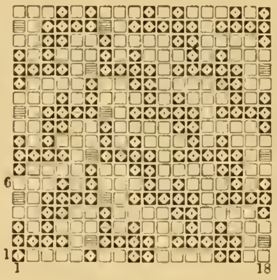


Fig. 703.

Matelasses.

These fabrics are chiefly used for ladies jackets or mantle cloth, hence the name "matelasses." The face fabric is mostly silk or fine worsted, the back all cotton, or cotton and woolen. The face and the back are also two separate fabrics, having an extra "wadding" pick between each, which will greatly help to enrich the embossed effect characterizing this line of fabrics. The figure is produced exactly on the same general principle as that explained before. In addition to this

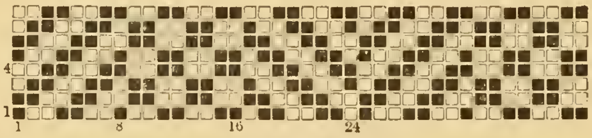


Fig. 704.

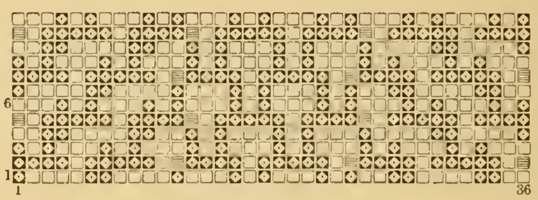


Fig. 705.

binding different weaves for the face effect may be employed by using twills and other weaves in floral and ornamental figures for design. In some of the lighter grades of these fabrics no interior or wadding filling is employed, but simply the two cloths as explained at the beginning of this article. In these fabrics nearly the same effect is obtained for the face appearance, though of course the figures do not stand out as prominently as when wadded, and the fabric is not as stout.

Quilts.

Plain Piqué Fabrics.

Another line of textile fabrics, constructed on the same principle as the coatings and matelasses, is found in quilts, bedspreads, toilet-covers and similar fabrics. These fabrics are generally made in white. In plain piqué fabrics the back-warp forms lines across the fabric. Fig. 706 shows a draft for such a fabric requiring 4-harness for face-warp, 4-harness for back-warp, = 8-harness.

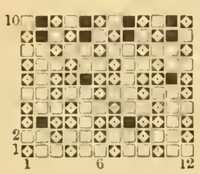


Fig. 706.

Repeat: 6 warp threads, 10 picks.

⊡ represents the face-warp, ▪ represents the back-warp.

Examination of the design shows:

Picks 1 and 2 interlacing the face-warp on plain weave. Pick 3 is a backing pick, in which the entire face-warp is raised, and also every other one of the back (forming in this manner the first pick of the plain weave for the back). Picks 4 and 5 are a repeat of picks 1 and 2. Pick 6 is a backing pick, in which the entire face-warp is also raised, and also the back warp-ends not raised in pick 3. Picks 7 and 8 are again a repeat of picks 1 and 2. Thus far the weave has formed two separate fabrics, each one worked on its own system of threads. By picks 9 and 10 these fabrics are united into one cloth by raising the back-warp into both picks and working the face-threads on the plain weave as was done before on picks 1, 2, 4, 5, 7 and 8. This combination of both fabrics gives us the required line across the fabric. If it is desired to produce this fabric for a heavier article, one or two "wadding" picks may be introduced between both fabrics, as in Fig. 707, through pick 5.

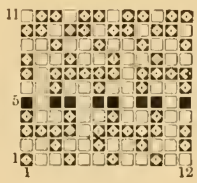


FIG. 707.

Picks 1 and 2 face.
" 3 back.
" 4 face.
" 5 interior (wadding.)
" 6 face.
" 7 back.
" 8 and 9 face.
" 10 back.
" 11 face.

In inferior qualities these fabrics are made by omitting the two backing-picks; hence the binder-warp has to float on the back. The wadding pick taken for these fabrics is of a very heavy size so as to prominently raise the rib effect.

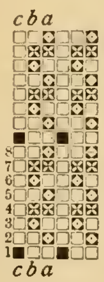


FIG. 708.

FIG. 709.

Such an example is shown in weave Fig. 708.
Repeat: 2 ends face, 1 end back in warp and 8 picks.
The arrangement of the filling is—

Pick 1 face, binder.
" 2, " 3 } face, regular.
" 4 wadding.
" 5, " 6 } face, the same as picks 2 and 3.
" 7 wadding.
" 8 face, the same as picks 2 or 5.

Diagram Fig. 709 illustrates the section cut of a fabric interlaced with weave, Fig. 708.

Figured Piqué.

These fabrics are also executed on the principle of the double cloth. Both cloths are quite plain in their weave, but the face is much finer than the back. White is the color in which they are generally made. A "wadding" pick may be used to give bulk to the cloth, and the embossed effect likewise characterizes these fabrics. The design for the fabric is also formed by binding both cloths together. The thicker the wadding and the larger the figure required to be designed, the more prominent will be the effect. In many of the lighter fabrics no wadding pick is used, but the two cloths are simply stitched together.

Fig. 710 illustrates a weave for these kind of fabrics (without a wadding pick). Fig. 711 is the motive of the stitching for effect in Fig. 710.

A consideration of the face-picks will show in every one of them some of the binder-warp up, according to the figure required.

This will easily explain the stitching of the fabric. As both warps are white, no change in color can be seen but the effect will be produced by the weave, as every binding back-warp thread will pull in the face of the fabric, in any place where it is raised on a face-pick, somewhat similar to the stitching together of two bulky fabrics with a sewing machine. Large designs, such as

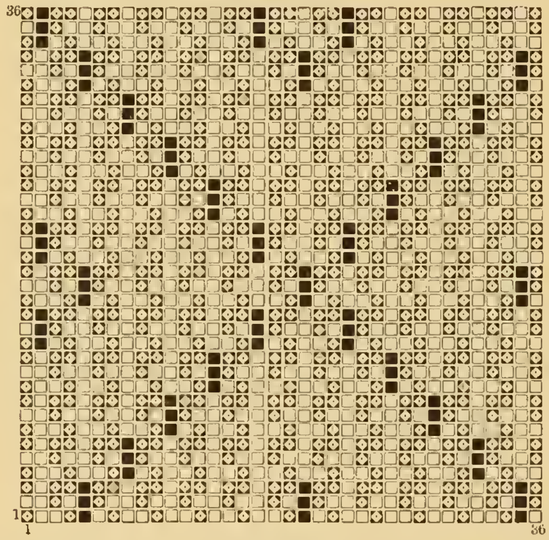


FIG. 710.

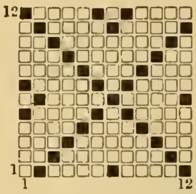


FIG. 711.

flowers, etc., are woven with the Jacquard. As these large figures have a long floating of the binder-warp (back-warp), while not being used for the outline of the figure on the face, the back warp-threads as a consequence float on the back; and as this floating is injurious to the fabric, we must use, in addition to the front-harness for the face-warp, a second set of front-harness for the back-warp (binder), through which the back-warp can be worked on plain.

Reeding these Fabrics.

Threads 1, 2 and 3 are drawn in the first dent of the reed; threads 4, 5 and 6 are drawn in the second dent.

RIB FABRICS.

Under this division are classified fabrics which, in their method of construction, have high prominent and elevated places exchanging with lower or compressed ones. This method of exchanging is generally arranged to run in the direction of the warp, but can be arranged for a diagonal direction, or even filling ways. The principle of construction of the weaves for these fabrics is nearly related to the common rib-weaves for single cloth.


FIG. 712.

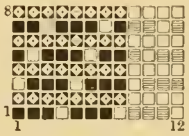


FIG. 713.

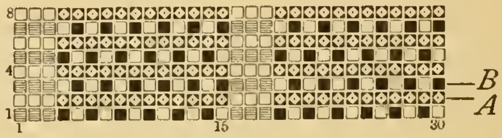


FIG. 714.

Weaves for rib fabrics forming their line (rib) effects in the direction of the warp are generally produced by floating every other pick for 4 to 12 (or more) threads, and then raising these threads so floated for two, three or more warp-threads. The picks situated between them are interlaced either in plain or twill weaves.

For example, Fig. 712. The foundation weave is the common plain weave. Picks 1 and 3 (and picks of uneven number) interlace in the entire repeat (12 warp-threads) on this plain weave, while picks 2 and 4 (and picks of even numbers) technically known as "rib-picks" float below the first 8 warp-threads and over the next (last) 4 warp-threads.

Fig. 713 illustrates a similar arrangement. In this weave the $\frac{3}{\quad 1}$ 4-harness twill is used for every pick of uneven number, while the picks of even numbers, the rib-picks, work the same as in the preceding example. Repeat: 12 warp-threads and 8 picks.

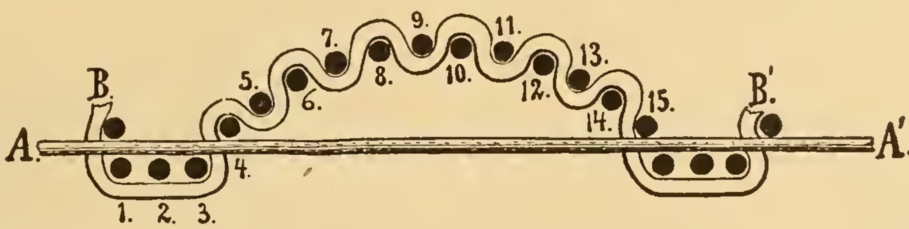


Fig. 715.

Fig. 714 illustrates an example in which every uneven numbered pick interlaces for 12 warp-threads on the common plain weave (floating below 3 warp-threads), while every even numbered pick (rib-pick) floats for 12 warp-threads on the back of the fabric and next forms the face-rib over 3 warp-threads.

Diagram Fig. 715 represents the section cut of a fabric woven with weave Fig. 714. A careful examination of it will show that warp-threads 4 to 15 inclusive must make interlacings with the filling which are not required by warp-threads 1, 2 and 3. To get perfect work and sufficient production it is advisable to have double beams—one beam to contain the first 3 warp-threads, the other the remainder. Repeat: 15 warp-threads and 4 picks.

Another division of rib-weaves is derived by omitting the special rib-pick, using instead of it, every pick to form partways (across the weave) rib-pick and partways regular weave. Every pick in rotation is arranged for "rib-pick" effect (floating on back) when the adjacent picks interlace on common weaving.

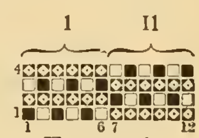


Fig. 716.

This method of alternately exchanging every pick in certain places for "rib-pick" when its preceding and following picks are used for forming the weave (on the face of the fabric), is consumed until the repeat is derived.

Fig. 716 represents such a weave, designed for 12 warp-threads and 4 picks repeat. The float of each pick (for "rib-pick") represents 6 warp-threads as illustrated by ▫ type.

For the remaining 6 warp-threads in the repeat of weave, every pick interlaces with the warp on the regular plain.

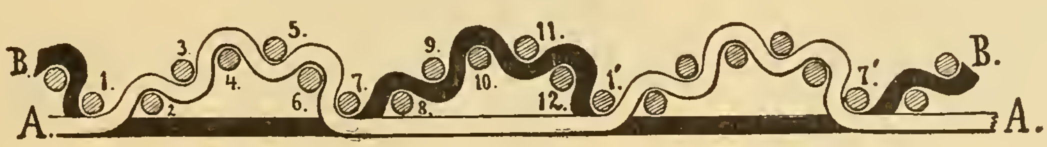


Fig. 717.

Diagram Fig. 717 represents the section of weave Fig. 716. This method of using every pick partways as rib-pick (float on back) and partways to interlace with the warp on a weave, and having this arrangement alternated in each adjacent pick will, in addition to the rib-effect produced, prove of great advantage in the manufacture of fancy trouserings, in which every other rib is required to appear in a different color. Using each pick (taken in rotation) with the alternate exchanging of two colors, each alternate pick the same, will (using one color for warp over the entire width of the fabric) produce the above mentioned effect. Such stripe effects will be yet more prominent if the warp in color arranegment is used according to the filling forming the weave.

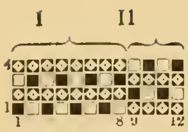


Fig. 718.

Weave Fig. 718 illustrates a rib-weave constructed on the same principle as weave Fig. 716. The distinction between them is the difference in size of ribs forming the new weave. Warp-threads 1 to 8 form the large rib I while the smaller rib II (½ the size of I) is formed by warp-threads 9, 10, 11 and 12.

Fig. 719 illustrates a rib-weave in which the 4-harness ^{2}——$_{2}$ twill is used for the face-weave, every pick being used for one-half the repeat in width of weave for floating, thus forming ribs of equal size.

Repeat of weave: 16 warp-threads, 8 picks.

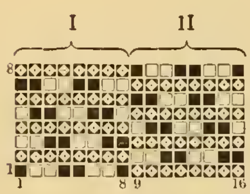


Fig. 719.

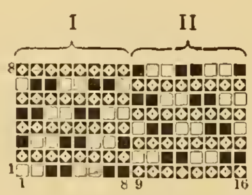


Fig. 720.

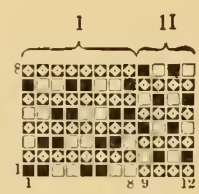


Fig. 721.

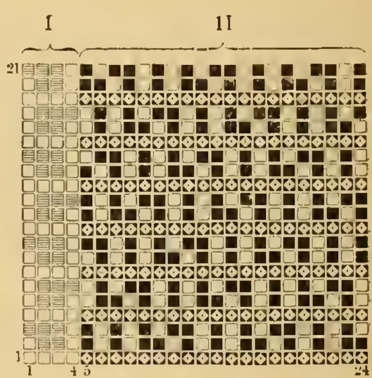


Fig. 722.

The direction for running the twill in both ribs in weave Fig. 719 is the same, but which is differently arranged in weave Fig. 720.

Fig. 720 has a similar repeat and the same weave (^{2}——$_{2}$ 4-harness twill) for face. The difference is in the direction of the twill in the face-weave, which has a different direction arranged for each rib.

Weave Fig. 721 illustrates a further step in figuring rib-weaves. In this figure rib I is interlaced on its face-weave by the ^{2}——$_{2}$ 4-harness twill, and rib II with the common plain. Repeat of weave: 12 warp-threads and 8 picks; rib I calls for the first eight warp-threads; rib II requires warp-threads 9, 10, 11 and 12.

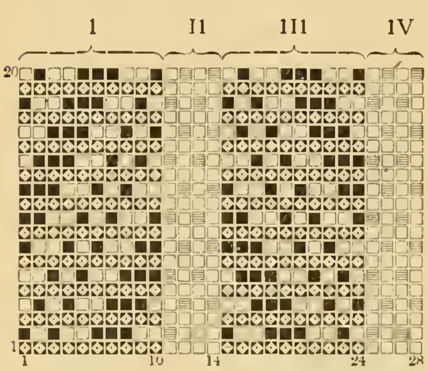


Fig. 723.

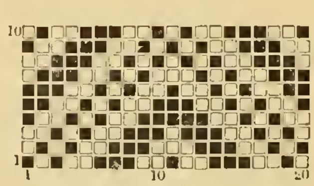


Fig. 724.

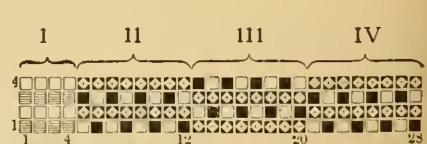


Fig. 725.

Weave Fig. 722 illustrates still another step in the figuring of rib-weaves, observing for the general arrangement 2 face picks, to alternate with one rib-pick. Repeat of weave: 24 warp-threads and 21 picks; rib I is produced by every third pick with the first 4 warp-threads, and rib II by warp-threads 5 to 24, with two successive picks out of three picks in repeat of arrangement, and interlacing as face-weave with the regular 7-harness corkscrew.

Fig. 723. Repeat of weave: 28 warp-threads and 20 picks.

This weave illustrates the application of a pointed twill for face-weave of every other rib, I, III, etc. Every even numbered rib, II, IV, etc., is produced by 4 warp-threads; one pick floating on the face over all four warp-threads (rib-pick in the adjacent ribs) to exchange with one pick interlacing on common plain.

Fig. 724 illustrates the face-weave for Fig. 723, as used for rib I and III. Repeat: 20 warp-threads and 10 picks, and is the pointed twill derived out of the $\frac{1}{1}\frac{1}{2}\frac{3}{2}$ 10-harness, uneven-sided twill.

Weave Fig. 725 illustrates a rib-weave, constructed in four changes. Repeat: 28 warp-threads and 4 picks.

The next sub-division of rib weaves embraces the diagonals. These can be further classified into two divisions. Those designed with an extra rib-pick and consequently an extra face-pick

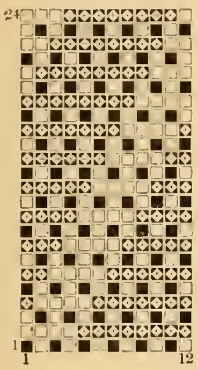


Fig. 726.

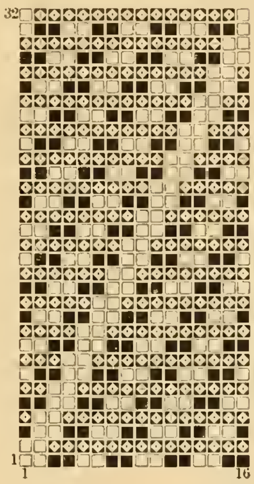


Fig. 727.

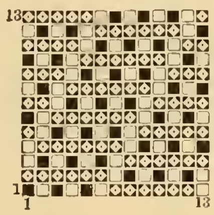


Fig. 728.

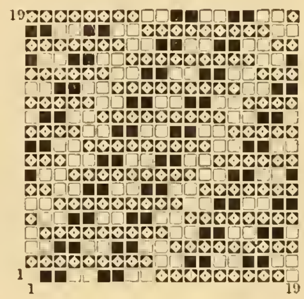


Fig. 729.

(see Figs. 726 and 727), and the diagonal rib-weaves in which every pick is used partways for "rib-pick," and partways for face-pick. In this manner weaves Figs. 728 and 729 are constructed.

Weave Fig. 726 has for its repeat 12 warp-threads and 24 picks. The face-picks interlace in common plain, while the rib-picks float under 8 and above 4 warp-threads.

Weave Fig. 727 requires for its repeat 16 warp-threads and 32 picks. The face-picks have for their weave the $\frac{2}{2}$ 4-harness twill, while the rib-picks in their repeat in 16 warp-threads float under 14 and over 2 threads.

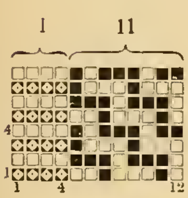


Fig. 730.

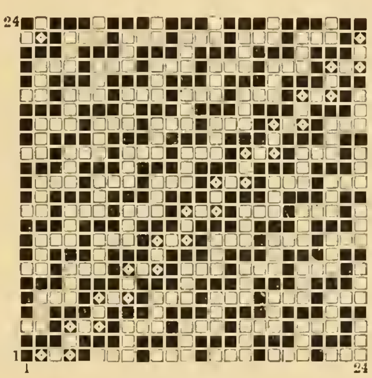


Fig. 731.

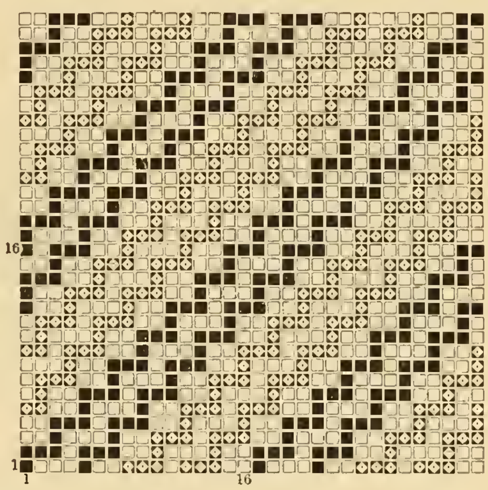


Fig. 732.

Weave Fig. 728, as previously mentioned, is a rib-weave in which every pick is used partways for "rib-pick," and the remaining part forming, by interlacing with the warp, the face-weave. Repeat: 13 warp-threads and 13 picks. Width of rib-float 6 warp-threads, exchanging with 7 warp-threads interlaced on plain weave.

In weave Fig. 729 the same principle, that of using each pick for rib-float and face-pick, is observed. For face-weave a common-twill is used. Repeat: 19 warp-threads and 19 picks. Rib-float is 9 threads, and interlaces in warp for face $_{2}\frac{2}{2}\frac{2}{2} = 10$ threads.

Another method of producing rib-weaves is to combine regular double cloth at certain places with a single cloth. In such cases the fabric when forming double cloth will not be stitched together, as, for example, weave Fig. 730. Warp-threads 1, 2, 3 and 4 form a common plain rib-weave or single cloth, while warp-threads 5 to 12 interlace (without binding) with the filling on the regular " double plain." Repeat of weave: 12 warp-threads and 4 picks.

These rib-effects in double cloth can also be produced entirely by the binding of both single-cloth fabrics. It may be arranged to form ribs in the direction of the warp and effects in a diagonal direction as shown in Fig. 731. Repeat: 24 warp-threads and 24 picks. ■ represents the weave for regular double-plain and ◘ shows the stitching of both fabrics in a diagonal direction for the required rib.

Another step for producing rib-effects in double cloth is taken by exchanging the face-cloth with the back, and the back with the face. This method of exchanging may be arranged to run warp-ways (vertical) or in a diagonal direction. For illustrating this method Fig. 732 has been designed. Repeat: 16 warp-threads and 16 picks.

Fabrics produced by means of weaves designed on the regular double-cloth system, such as weaves Figs. 730, 731 and 732 and other similar weaves, do not have the rib-effect appear so prominent as in the case of the preceding weaves, all of which contain the peculiar pick known as *rib-pick*, *rib-float*, etc., and which *assists*, for the reasons given, to such a great extent *in making the rib-effect prominent.*

THREE-PLY FABRICS.

It will be readily understood by any one that has carefully studied the structure of two-ply fabrics that by the same method and principles employed in combining two single cloths into one fabric, known as two-ply or double cloth, three such single-cloth fabrics can also be combined into one fabric.

In the construction of a 3-ply fabric a regular set of warps and filling for each of the three single cloths is required, thus dealing with three systems of warp and three systems of filling in designing. To impart a more perfect understanding, the construction of a 3-ply fabric from its beginning to the finished weave is shown, and for this purpose three single-cloth fabrics interlaced on the plain weave are selected.

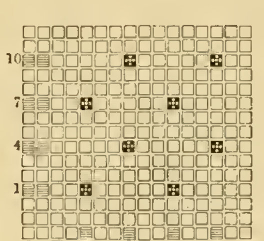


FIG. 733.

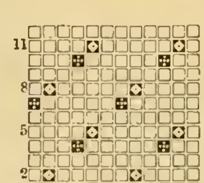


FIG. 734.

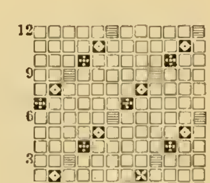


FIG. 735.

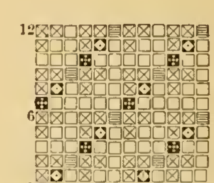


FIG. 736.

Fig. 733 illustrates the first set of the plain weave, or the weave for single cloth number one (⊞ type). Warp and filling-threads used are numbered on the left side and the bottom of the design, and are indicated by ▤ type. "One thread taken and two missed" in each system for the other two single cloths.

Fig. 734 illustrates by ◘ on warp-threads 2, 5, 8, 11 and on the corresponding picks, the interlacing of the single cloth number two (plain weave).

In Fig. 735 the interlacing of the third or last single cloth is shown on warp-threads 3, 6, 9, 12 and the same numbered picks (▤ the type used).

Next, raise for the picks of the lower single cloth (in the 3-ply structure) each warp-thread of the two upper cloths (face and interior cloths); also, raise the warp-threads of the face cloth on the interior picks. This method of operation is illustrated (successively from Fig. 735) in weave Fig. 736 by ⊠ type.

In this is shown :—

Pick 1, first pick of face cloth.
" 2, " " interior cloth (face raised).
" 3, " " back cloth (face and interior raised).
" 4, second " face cloth.
" 5, " " interior cloth (face raised).
" 6, " " backed cloth (face and interior raised).

And thus the repeat: 6 warp-threads and 6 picks, allows 2 warp-threads and 2 picks for the structure of each fabric. Weave Fig. 736 thus produces three distinct single cloths resting in the

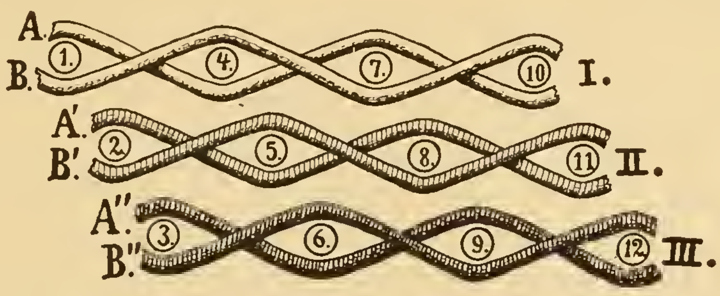


Fig. 737.

loom after being woven one above the other, as shown in the sectional cut in diagram, Fig. 737. The next process is the combining of these three single cloths into one fabric, which is technically known as the "stitching." To effect this in a proper manner combine the backing-cloth to the interior cloth, and this in turn to its face.

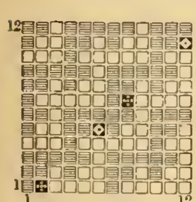


Fig. 738.

In weave Fig. 738 this method of "stitching" is clearly indicated. In this figure the ▤ type illustrates the three single-cloth fabrics, equal to the weave illustrated in Fig. 736 by four different characters of type. In Fig. 738 ■ illustrates the stitching of the interior cloth to the face-cloth, and the ▫ the stitching of the back-cloth to the interior cloth.

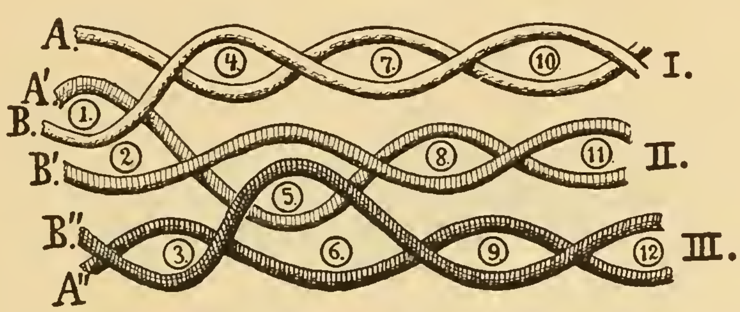


Fig. 739.

Diagram Fig. 739 illustrates the section of a 3-ply fabric interlaced by means of the weave previously shown (Fig. 738).

FOUR AND FIVE-PLY FABRICS.

Sometimes it is desired to have produced fabrics constructed out of more than three single cloths.

Weave Fig. 740 clearly illustrates the construction of a 4-ply fabric.

The ▤ type represents the interlacing of the four single cloths.

■ on picks 1 and 9 illustrates the stitching of the second cloth to the face (or first) cloth.

⊠ on picks 2 and 10 represents the stitching of the third cloth to the second.

▫ on picks 7 and 15 illustrates the stitching of the back cloth to third cloth, and which completes the stitchings of the four single-cloth fabrics into one, and technically classified as "four-ply."

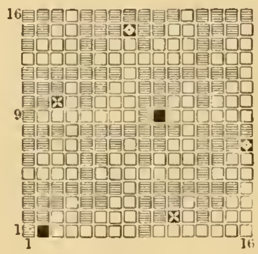


Fig. 740

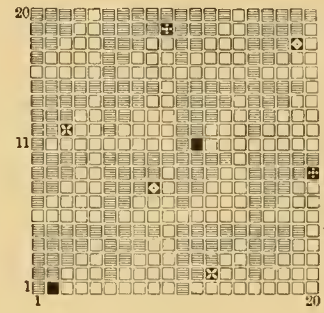


Fig. 741.

Weave Fig. 741 shows the construction of a 5-ply fabric.

⊟ type represents the interlacing of the five single cloths.

■ type on picks 1 and 11 illustrates the stitching of cloths 1 and 2.

⊠ type on picks 2 and 12 illustrates the stitching of cloths 2 and 3.

▫ type on picks 8 and 18 illustrates the stitching of cloths 3 and 4.

⊞ type on picks 9 and 19 illustrates the stitching of cloths 4 and 5.

And thus closes the complete stitching of the four single-cloth fabrics into one, technically known as "five-ply."

Pile Fabrics.

Textiles classified as "pile" fabrics, form a separate sub-division of woven articles, and are characterized by the soft covering which generally overspreads and conceals, to a great extent, the interlacing of the warp and the filling. In this division of textiles, are to be found some of the grandest and most complicated products of the loom. In every pile fabric one series of threads is employed for producing the ground of the fabric, while a second forms the pile, so that two distinct systems of warp or of filling are always necessary in the manufacture of these fabrics.

Technically, they are divided into pile fabrics in which the pile is produced by an extra filling, and pile fabrics in which the pile is produced by a separate warp in addition to the ground warp. The greatest variety of effects can be produced in the latter sub-division, and fabrics produced on this principle of weaving, find a very extensive use.

Pile Fabrics Produced by Filling.

Velveteens, Fustians, Corduroys.

These fabrics require for their construction one kind of warp; also, in most fabrics, one kind of filling. If one kind of filling is used the same is consequently employed for the "pile" picks and the "ground" or "foundation" picks of the pattern. If two kinds of filling are used, one kind is employed for the pile and the second kind produces the foundation-cloth. In preparing the design, the arrangement for the ground and pile picks, is either alternately one pick pile, one pick ground, or, two picks pile, one pick ground, or, three picks pile, one pick ground, four picks pile, one pick ground, etc. The arrangement indicated as the second method is the one most generally used. For the ground structure of the fabric, "the plain-weave," or, "the double plain, warp-ways," or, "the 3-harness twill," or, "4-harness even-sided twill," are the ones most frequently used. In any of these cases the filling for the pile is floating over 3, 5, 7 or more warp-threads.

The floats of the pile are afterwards cut open with a knife constructed especially for it. This method of cutting the pile for the fabrics is old, and dates back to the beginning of the fifteenth century.

Cutting the Pile by Hand.

This procedure is as follows: The fabric is stretched on the cutting table, which has (in most instances) a length of from 55 to 70 inches, and is fastened to it by means of clamps. Next, the cutter takes his knife for cutting the pile, which consists of a long steel bar formed into a very sharp knife at its end, and provided with a guide, consisting of a narrow piece of sheet-iron doubled and forming a groove, fitting on the knife; the part of this piece of sheet-iron extending from the knife, is formed into a needle, of a length which is regulated by the length of the pile to be cut. The cutter inserts the needle into the row of floats which is nearest to the selvage, and pushes the knife (in direction of the warp) through the entire floats in the one direction; the next row of floats is treated in the same manner, and this is continued until all the rows are cut. In the lower grades of these fabrics, only every other row of floats is cut, and consequently the thickness of the pile is reduced in proportion. Again, stripes of cut and uncut pile (regulated as to dimensions in width entirely at will) are produced.

After cutting open the pile over the surface of the table, the clamps are opened and the next length (of 55 up to 70 inches) is fastened. This process is repeated until the entire piece has its pile cut. Every length of the table generally calls, in the lower qualities, for 500 to 600 runs, while the better grades require from 800 to 1200 runs in a single width of those fabrics. This cutting by hand is naturally a very slow and expensive job. (Flour-paste is often applied to the back of the fabric, so as to make the cutting of the pile easier and safer.)

Of late years, machines have been invented to cut this pile and have proved successful to a certain extent.

After cutting the pile and subsequently mending any imperfections, either produced during the process of weaving or cutting, the fabric is turned over for the dyeing and finishing.

Designs for Weaving these Fabrics.

As mentioned already, one warp is used both for interlacing the ground and binding the pile-filling. The ground-weave is generally either or, or, or, etc., while the pile-filling is floating 3, 5, 7 or more ends.

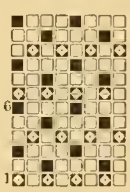


Fig. 742.

Fig. 743.

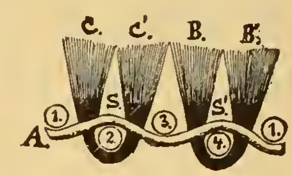


Fig. 744.

Fig. 742 represents a common weave used for these fabrics, and constructed with a texture of 4 warp-threads, 6 picks in one repeat of the pattern. ■ are the pile-picks, □ the ground-picks. Pile, 1 up, 3 down. Ground, "plain," two picks pile to alternate with one pick ground.

Fig. 743 represents the sectional cut of the woven fabric before the pile is cut.

Fig. 744 represents the corresponding section with the pile cut. The letters and numbers in both designs are identical.

Pick A is the ground pick. 1 up, 1 down, to be exchanged in pick 4 (not represented in the drawing) by 1 down, 1 up. Picks *B* and *C* are the pile picks, which are duplicated in every repeat of the weave. Arrow *S* in Fig. 743, represents the place for the cutting of the pile for pick *B*. *S*, in Fig. 744, represents the pile as cut. Arrow S^1, in Fig 743, marks the place and direction for cutting the pile for pick *C*. S^1, in Fig. 744, represents the pile as cut. In Figs. 743 and 744 the ground pick is shown outlined, while Fig. 743 has the one pile pick *B* marked black, and the other pick *C* illustrated as shaded. Fig. 744 illustrates both pile picks, and equally represented in black.

This change in Fig. 743 has been made to simplify the construction of the fabric and for the benefit of the novice in designing.

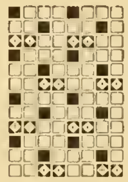


Fig. 745.

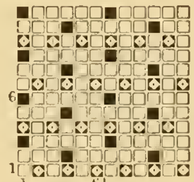


Fig. 746.

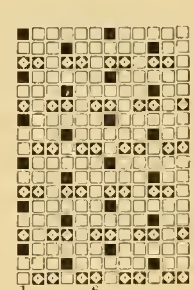


Fig. 747.

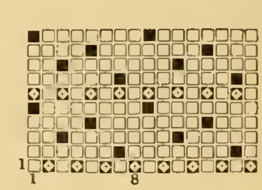


Fig. 748.

Fig. 745.—4 warp-threads, 6 picks in 1 repeat. ■ equal pile-picks. □ equal ground-picks. Pile is produced on 1 up, 3 down. Ground is produced on the common 4-harness rib-weave 2——2.

Fig. 746 represents a weave executed on 6-harness and 6 picks repeat; using for pile-filling (■) 1 up, and 5 down, while the ground-cloth is formed on the plain (□).

Fig. 747 is designed for 6-harness, with 9 picks in one repeat; ■ for pile-filling, □ for ground-filling. Pile, 1 up, 5 down. Ground weave, 3-harness twill, warp up.

Fig. 748 represents a draft for a velveteen fabric, having 4 picks of pile-filling to 1 ground-pick; the pile-filling floating over 7 warp-threads. The ground is interlaced on plain.

A careful examination of this draft will show the possibility of obtaining, by means of the latter, a fabric which will take up the filling easily and yet hold the pile very strongly to the ground-fabric; a point which is of great advantage in producing a firm and perfect fabric; a velvet resisting the wear these fabrics are subjected to so frequently. This draft is designed for a high number of picks to one inch; therefore, if the weight should have to be lowered on account of a considerably less number of picks, this weave must be changed accordingly, so as to bind differently. For example, take picks 7, 8, 9, 10, and move the raisers one thread toward the right hand. If a sufficient number of picks are not in a fabric to warrant the binding of the pile solidly

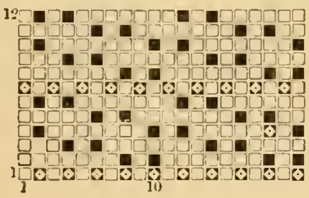


Fig. 749.

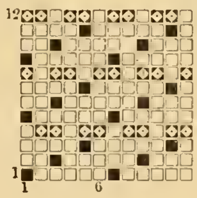


Fig. 750.

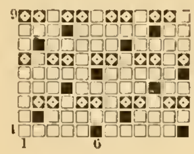


Fig. 751.

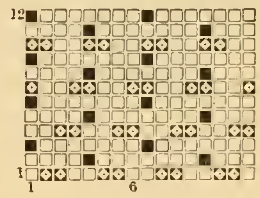


Fig. 752.

to the ground-cloth, by means of binding the former to the latter with one end, two ends up and separated by one thread down, must be used. In this manner weave Fig. 749 is executed, having five plush-picks to each ground-pick. Repeat: 10 warp-threads, and 12 picks. The float of the pile is over 7 threads, and each pile-pick is interlaced to the ground fabric by 1 up, 1 down, 1 up. All the pile-picks interweave under the same warp-threads (use every alternate warp-thread), while one of the two ground-picks intersects over the latter. This arrangement in the design allows the picks to go easy in the fabric and naturally adapts itself for high filling textures.

The proportion of the pile-picks to the ground-picks is always regulated by the required closeness of the pile.

Fig. 750 shows the design for a 3-harness ($\frac{2}{}\text{——}\frac{}{1}$) twill-ground in connection with 3 pile-picks to 1 ground-pick. The design repeats with 6 warp-threads and 12 picks.

Fig. 751 has 2 picks pile, 1 pick ground; the design repeating with 6 warp-threads and 9 picks. Designs Figs. 748, 749, 750 and 751 have pile-picks indicated by ■ and ground-picks indicated by ◘.

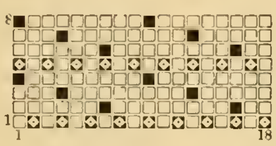


Fig. 753.

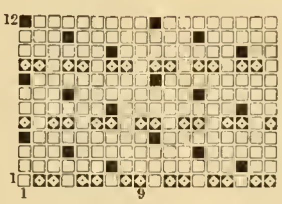


Fig. 754.

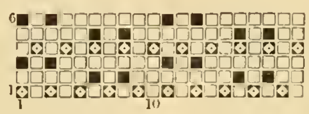


Fig. 755.

Fig. 752 represents the float $\frac{1}{}\text{——}\frac{}{7}$ for the pile, (■) interlaced in a ground-fabric woven on the 4-harness even-sided twill (◘). The arrangement of the pile towards the ground is 2 to 1.

Fig. 753 illustrates the plain ground in connection with the pile-floating, $\frac{1}{}\text{——}\frac{}{8}$. 3 picks pile to 1 pick ground; ■ for pile, ◘ for ground, in design. Repeat of weave: 18 warp-threads, 8 picks.

Fig. 754 shows one of the most frequently used designs on a repeat of 9 warp-threads and 12 picks. 3 pile-picks to 1 ground. ■ for pile, ◘ for ground. Float of the pile-filling $\frac{1}{}\text{——}\frac{}{8}$.

Fig. 755 illustrates the plain ground with the pile $\frac{1}{}\text{—}\frac{}{1}\text{—}\frac{1}{}\text{—}\frac{}{7}$. 2 pile-picks to alternate with 1 ground-pick. Repeat of design: 10 threads in warp and 6 picks. ■ for pile, ◘ for ground.

Having given a complete idea of the construction of plain-faced fabrics, our attention is next directed to corduroys.

Corduroys.

These fabrics have stripes running the length of the stuff, but may also have them running in a diagonal direction. Again, they may form figures of any description. If forming the regular cords, they may also be made to vary in widths.

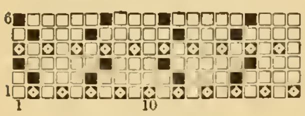


Fig. 756.

Weave Fig. 756. 10-harness and 6 picks repeat of pattern. Ground-fabric is a plain-weave, pile-float, $\frac{1}{5}\frac{1}{3}$. 2 pile-picks to 1 ground-pick. ▪ for pile, ▫ for ground.

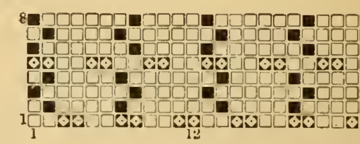


Fig. 757.

Weave Fig. 757. 12-harness and 8 picks repeat of pattern. Ground-fabric, a double plain-weave, warp-ways, pile-float, $\frac{1}{6}\frac{1}{4}$. 3 picks pile to 1 pick ground. ▪ for pile, ▫ for ground.

Chinchillas—Whitneys. (Plain and figured effects.)

These fabrics are produced upon weaves similar to those shown in Figs. 570 to 572. The cutting of the pile filling is done automatically during the finishing process by the "gig," and the pile thus cut is raised by the "whipper." In the construction of these weaves, as well as in arranging the texture, little importance is given to a compact, solid interlacing of warp and filling, especially as the condition of a soft and spongy nature is always required in the finished fabric. In some of these fabrics only two kinds of filling are used, the ground and the pile filling, while others are made with three kinds of filling—the ground, the pile and the interior filling. For fabrics of a plain character (as to face) use weaves such as the 4-harness broken-twill, the 5-harness satin, etc. Filling for face, for the interlacing of the pile or face filling, and the same weave, arranged warp for face, for the ground filling. Such weaves have been previously explained and illustrated in Figs. 570, 571 and 572, page 109.

Regular double-cloth weaves are also used, arranged: 1 end face, 1 end back, 2 ends repeat in warp; 1 pick face, 1 pick back, 1 pick face, 1 pick interior, 4 picks in the repeat. For face-weave the 4-harness broken-twill is generally used (filling up). For back-weave the $\frac{2}{2}$ or $\frac{3}{1}$ twill. On the interior pick all the face-warp is raised, leaving the entire back-warp in the lower shed, so that this filling will rest the same as the wadding in the piqué fabric—between the face and back cloth of the fabric. The object of the interior filling is to increase the thickness of the fabric, and to cheapen the cost of manufacture by using a low-grade stock for it, which is neither visible on the face nor the back of the fabric.

As previously mentioned, fabrics of this kind must have a soft spongy nature when finished; so care must be exercised in not weaving them too wide in the loom, as but very little fulling will be required. For the stock for the face or pile filling, select a fine but short staple. After fulling and scouring, or only scouring, the fabric is gigged. The teasels cut the soft pile filling in the centre between the points of interlacing of the latter with the warp, and after running the fabric over the "whipper" before it passes to the dryer, the whipping process (beating) raises each and every single float of filling (fastened by one or more ends of warp to the fabric) and produces a velvet surface. After running the fabric in this condition over the shears, for the purpose of producing an even height of pile, it is put upon the chinchilla machine to have its velvet face rubbed, forming chinchilla rows in the direction of either the warp or the filling, or in a diagonal direction; or forming round knobs known as "Ratinè." The size of the chinchilla effects or the ratine effect is regulated by the height of the pile, and this by the shearing process. (Two- or three-ply spun face-filling is of more advantage to use than the equivalent size in one-thread compound.)

Fancy or Figured Chinchillas.

These fabrics are produced by arranging the floats of the pile-filling so as to form figures (designs) in the way that the above mentioned pile-filling is fastened to the ground cloth, after having its floats cut.

To illustrate this subject designs Figs. 758, 759, 760, 761, 762, 763, 764, and 765 are given.

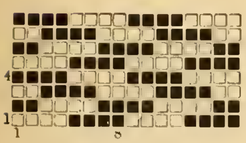


Fig. 758.

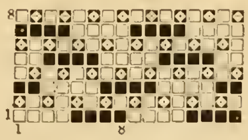


Fig. 759.

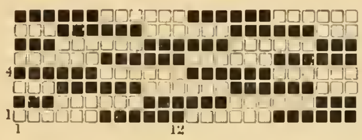


Fig. 760.

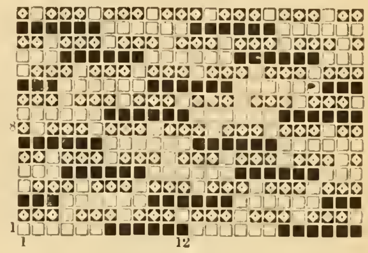


Fig. 761.

Fig. 758 illustrates the face-weave for Fig. 759, the complete weave.

Repeat: 8-harness and 8-picks.

▪ are pile-picks, ▫ are ground-picks.

Fig. 760 illustrates the face-weave for Fig. 761, the complete weave.

Repeat: 12-harness and 8 picks.

▪ are pile-picks, ▫ are ground-picks.

Fig. 762. Repeat: 8 warp-threads and 8 picks.

Fig. 763. Repeat: 12 warp-threads and 36 picks.

Fig. 764. Repeat: 12 warp-threads and 8 picks.

Figs. 762, 763 and 764 are face-weaves for fancy chinchillas, to be arranged either similar to those given in Figs. 758 to 761 or for regular double cloth, using face and back-warp with pile-

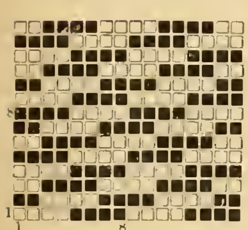


Fig. 762.

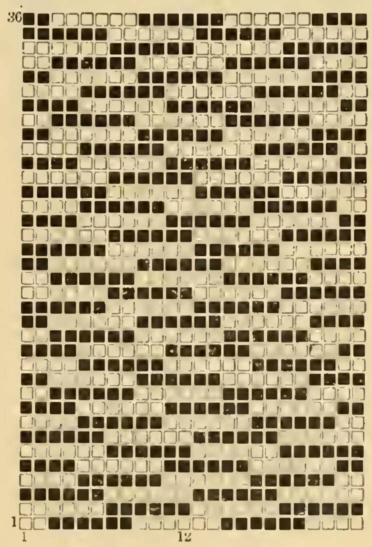


Fig. 763.

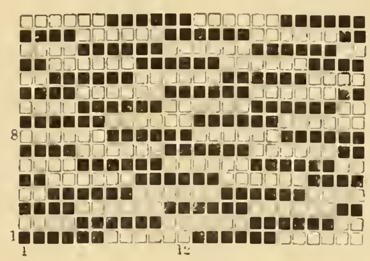


Fig. 764.

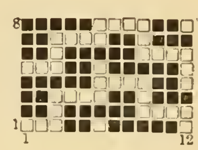


Fig. 765.

filling interior and backing. Fig. 765 illustrates a specimen of the chinchilla weave, specially adapted for producing chinchilla rows lengthways in the fabric.

CHENILLE.

Chenille is a fringed thread and is used either for filling in such fabrics as curtains and rugs, or it is used in its first woven state for ornaments such as trimmings, fringes, etc., for ladies' wear as well as for decorating purposes. (In fringe-weaving the chenille part of the fabric is sometimes produced at the same time that the heading of the fabric is woven. We will later on describe this separate method.)

When chenille is used as filling, its fibres extend forward in every direction through the perforations of the fabric, producing a fur-like surface on the goods it is applied to. As a general rule for these fabrics, the chenille forms the main part of the fabric. The remaining part, if warp, or warp and filling, is only used for holding the fabric in its position. There are two methods commonly used in weaving this chenille.

1st. Using 4 warp-threads on common plain weave. 2d. Using 2 or 3 warp-threads on the gauze weave. A short sketch of each method is given.

Chenille Produced by Using 4 Warp-threads on Plain Weave.

Procure a set of harness using a plain weave (2, 4, 6 or more shafts). In this draw the warp the same as in regular cloth. By drawing the warp in the reed always put the four warp ends, which have to work together, in one dent, leaving as many dents empty as required, according to the size of the chenille. The filling (which is introduced in the ordinary manner) is bound in plain at the places where the four warp-threads in one dent are situated (see I, II, III in Fig. 766) and floated at the distances where no warp-threads are. After weaving the fabric in this manner it is cut in the direction of the arrows S and S^1.

Two methods are employed for cutting chenille. It is done either on the loom during the weaving operation, or after the fabric leaves the loom.

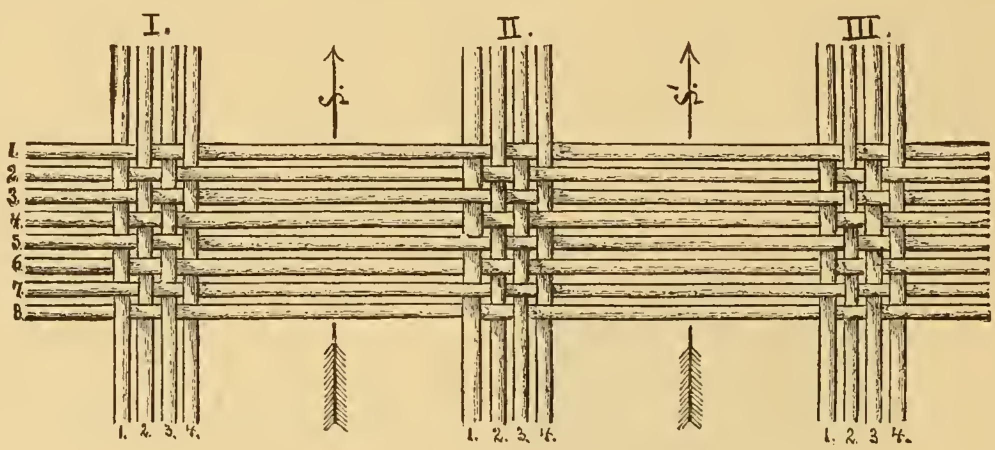


FIG. 766.

Every set of 4 warp-threads forms one strip of chenille, hence as many sets as are used over the width of the fabric, so many strips are obtained. In figure fabrics where each strip of chenille is required to be of a different arrangement of colors for forming the design, the number of sets used in weaving the chenille indicates the number of fabrics to be set afterwards in the following process. For example: in weaving chenille for dados for turcoman curtains, suppose 140 sets of strips are woven at the weaving of the chenille, and every pick of the dado is to have a different arrangement of colors, the result will give us 70 pairs of curtains to be set. After cutting the chenille into strips they are twisted, every 4 threads of warp being thus formed into one, with the filling-threads extending from it in every direction, and giving it the appearance of a fringed thread. This twisting tends to hold the interwoven filling firmly in the warp-threads, and hence, adds strength to the fabric.

Chenille Produced by Using 3 Warp-threads.

The process of manufacture here is the same as in chenille made out of 4 warp-threads on the common plain weave. The only difference consists in employing but 3 warp-threads for the centre of every part of the chenille strips, and interweaving the filling in gauze instead of plain. This process, which certainly will be found more expensive than the first, will in return, give a great deal more strength to the fabric by holding the filling yet more firmly in the warp, and making the cutting easier and safer. The process of twisting the chenille strips after cutting, as observed in the former fabric, will be the same in this case. (Chenille produced with 2 warp-threads is explained later in a special chapter on Gauze Weaving.)

Arrangement of Design for Weaving Figured Chenille.

After the design is finished on the squared paper, it is cut into strips in the direction of the filling, as every line has to be woven separately for the chenille strips. To explain this process, Figs. 767 and 768 are designed.

Fig. 767 illustrates the complete design (border in four colors).

Fig. 768 represents one-half repeat of the design, cut into strips in the direction of the filling.

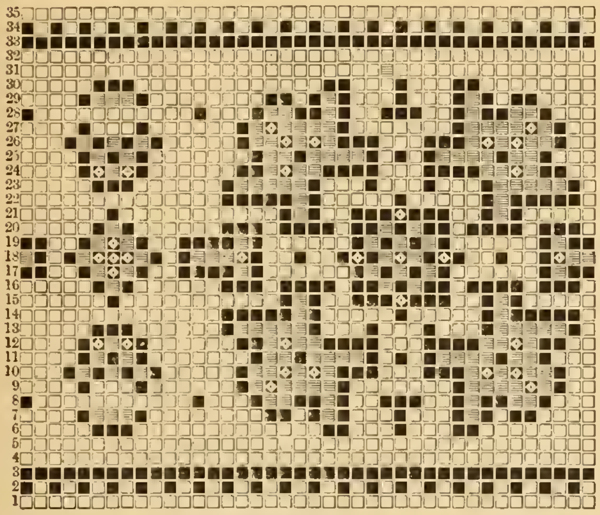


Fig. 767.

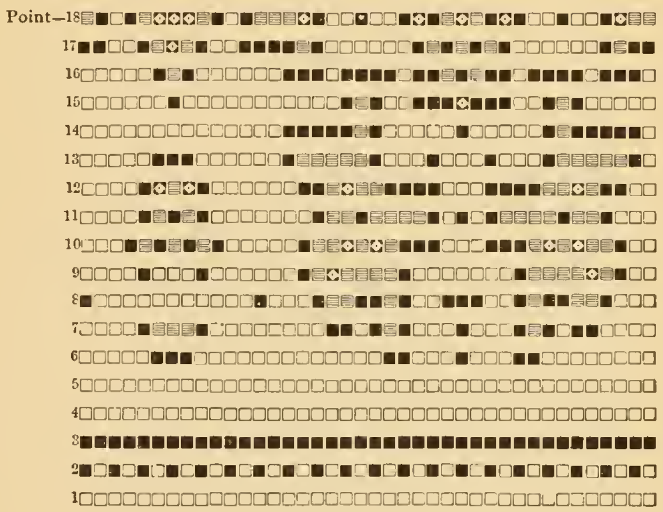


Fig. 768.

In examining Fig. 767 it is found that 35 picks are required for one repeat. The design itself represents a "point figure," picks 1 to 18 and back again. Indicating the colors by type as follows: □ for straw color; ▤ for red; ◘ for maroon; ■ for blue-green, we have:

Strip 1.—All straw color.
" 2.—One pick straw, one pick blue-green, 20 times for one repeat.
" 3.—All blue-green.
" 4 and 5.—All straw color.
" 6.— 5 picks, straw.
3 " blue-green.
13 " straw.
2 " blue-green.
3 " straw.
1 " blue-green.
3 " straw.
2 " blue-green.
8 " straw.

—

Strip 7.—4 picks, straw.
1 " blue-green.
3 " red.
1 " blue-green.
8 " straw.
2 " blue-green.
1 " straw.

7 cont'd.—1 pick, blue-green.
1 " red.
1 " blue-green.
3 " straw.
1 " blue-green.
3 " straw.
1 " blue-green.
1 " red.
1 " blue-green.
1 " straw.
2 " blue-green.
4 " straw.

—

Strip 8.— 1 pick, blue-green.
11 " straw.
1 " blue-green.
3 " straw.

8 cont'd.—1 pick, blue-green.
2 " red.
2 " blue-green.
1 " red.
1 " blue-green.
2 " straw.
3 " blue-green.
2 " straw.
1 " blue-green.
1 " red.
2 " blue-green.
2 " red.
1 " blue-green.
3 " straw.

—

Strip 9.—4 picks, straw.
1 " blue-green.
3 " straw.
1 " blue-green.
6 " straw.
1 " blue-green.
1 " red.
1 " maroon.
4 " red.
1 " blue-green.
7 " straw.
1 " blue-green.
4 " red.
1 " maroon.
1 " red.
1 " blue-green.
2 " straw.

—

Strip 10.—3 picks, straw.
1 " blue-green.
1 " red.
1 " blue-green.
1 " red.
1 " blue-green.
1 " red.
1 " blue-green.
5 " straw.
1 " blue-green.
2 " red.
1 " maroon.
1 " red.
1 " maroon.
1 " red.
3 " blue-green.

10 cont'd.—3 picks, straw.
3 " blue-green.
1 " red.
1 " maroon.
1 " red.
1 " maroon.
2 " red.
1 " blue-green.
2 " straw.

—

Strip 11.—4 picks, straw.
1 " blue-green.
1 " red.
1 " blue-green.
1 " red.
1 " blue-green.
7 " straw.
1 " blue-green.
2 " red.
1 " blue-green.
4 " red.
1 " blue-green.
1 " straw.
1 " blue-green.
1 " straw.
1 " blue-green.
4 " red.
1 " blue-green.
2 " red.
1 " blue-green.
3 " straw.

—

Strip 12.—4 picks, straw.
1 " blue-green.
1 " maroon.
1 " red.
1 " maroon.
1 " blue-green.
6 " straw.
2 " blue-green.
1 " red.
1 " maroon.
2 " red.
4 " blue-green.
3 " straw.
4 " blue-green.
2 " red.
1 " maroon.
1 " red.

12 cont'd.—2 picks, blue-green.
2 " straw.

—

Strip 13.—5 picks, straw.
3 " blue-green.
6 " straw.
1 " blue-green.
5 " red.
1 " blue-green.
3 " straw.
1 " blue-green.
3 " straw.
1 " blue-green.
3 " straw.
1 " blue-green.
5 " red.
1 " blue-green.
1 " straw.

—

Strip 14.—14 picks, straw.
5 " blue-green.
1 " red.
1 " blue-green.
5 " straw.
1 " blue-green.
5 " straw.
1 " blue-green.
1 " red.
5 " blue-green.
1 " straw.

—

Strip 15.—6 picks, straw.
1 " blue-green.
11 " straw.
1 " blue-green.
1 " red.
1 " blue-green.
2 " straw.
3 " blue-green.
1 " maroon.
3 " blue-green.
2 " straw.
1 " blue-green.
1 " red.
1 " blue-green.
5 " straw.

—

Strip 16.—5 picks, straw.
1 " blue-green.
1 " red.

16 cont'd.—1 pick, blue-green.
6 " straw.
3 " blue-green.
1 " straw.
4 " blue-green.
1 " straw.
2 " blue-green.
1 " red.
1 " blue-green.
1 " red.
2 " blue-green.
1 " straw.
4 " blue-green.
1 " straw.
3 " blue-green.
1 " straw.

—

Strip 17.—2 picks, blue-green.
2 " straw.
1 " blue-green.
1 " red.
1 " maroon.
1 " red.
1 " blue-green.
2 " straw.
4 " blue-green.
1 " red.
1 " blue-green.
6 " straw.
1 " blue-green.
1 " red.
1 " blue-green.
1 " red.
1 " blue-green.
1 " red.
1 " blue-green.
6 " straw.
1 " blue-green.
1 " red.
2 " blue-green.

—

Strip 18.—1 pick, red.
1 " blue-green.
1 " straw.
1 " blue-green.
1 " red.
3 " maroon.
1 " red.
1 " blue-green.

18 cont'd.—1	pick,	straw.
1	"	blue-green.
3	"	red.
1	"	maroon.
1	"	blue-green.
2	"	straw.
1	"	blue-green.
2	"	straw.
1	"	blue-green.
1	"	maroon.
1	"	blue-green.
1	"	red.

18 cont'd.—1	pick,	maroon.
1	"	red
1	"	blue-green.
1	"	maroon.
1	"	blue-green.
2	"	straw.
1	"	blue-green.
2	"	straw.
1	"	blue-green.
1	"	maroon.
2	"	red.
—		

Pick 19 will equal pick 17. Pick 20 will equal pick 16, and so on until pick 35 is reached, which equals pick 1.

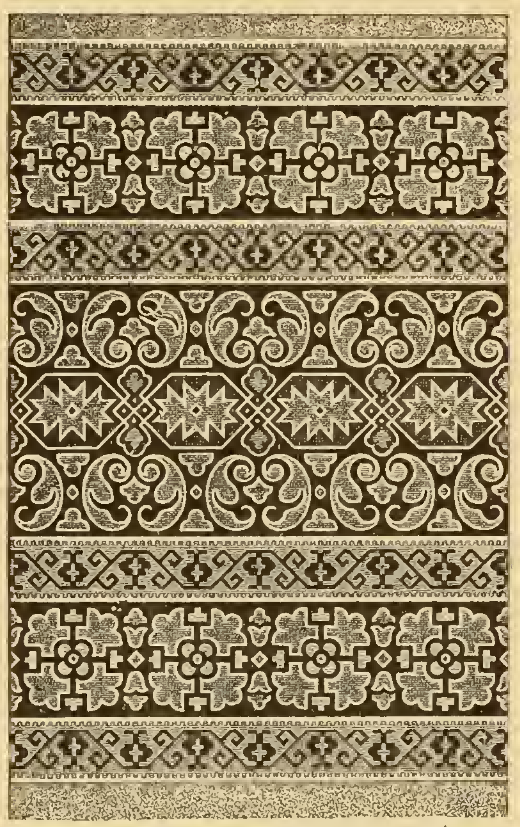


Fig. 769.—Design for Chenille Curtain. (Border.)

Suppose we have 20 picks to 1 inch in the chenille, the repeat of the figure (40 picks) will be 2 inches, or 22 repeats in a curtain 44 inches wide.

According to the width of the loom on which we have to produce the chenille filling and the size of the chenille to be made we find the number of duplicate strips produced the same time.

Suppose we have a loom weaving one yard wide in reed, and want a chenille of $\frac{1}{4}$ inch diameter (on loom). We ascertain the number of strips of each kind of color-arrangement produced at once, as follows:

$36 \times 4 = 144$ strips chenille of the same color-arrangement, produced at the same time. This equals 72 duplicate strips for 72 pairs of curtains.

If this border should have to be used twice in each curtain (4 strips in the complete pair) we must calculate for 36 pairs of curtains, etc.

Another arrangement for weaving chenille (lower grade) is illustrated and explained in the chapter on cross weaving.

Two methods of separating or cutting the web into the required strips, are in use. That which separates it automatically in the loom during the process of weaving, and that, the most generally used, which separates the web after it leaves the loom by means of the

Chenille Cutting Machine.

For illustration of this subject the machine, patented by William McIlwain, has been selected.

Fig. 770 is a top or plan view of it. Fig. 771 is a vertical section in line *x x*, Fig. 770. (Similar letters of reference indicate corresponding parts in both figures.)

A represents the frame of the machine, on which are mounted rollers *B C D*, which feed the chenille fabric into the machine, the rollers *B D* receiving motion in the same direction.

G represents a transversely-extending comb, which is secured to the frame of the machine at the end thereof opposite to the roller *B*, and H represents a rotary cutter, whose shaft, mounted on the frame *A*, receives motion from the pulley *a*. The cutter *H* is formed of a series of circular blades fitted between teeth of the comb *G*, and washers alternating with the blades, the washers serving to adjust the distance between the blades, and in connection with a nut and collar to clamp the blades in position. The comb is vertically adjustable and has above it a pressure bar, *G''*, properly secured to the frame *A*, or a projection thereof, the object being to force the fabric against the comb and hold it firmly and flat during the cutting operation. (Pressure-bar G'' is

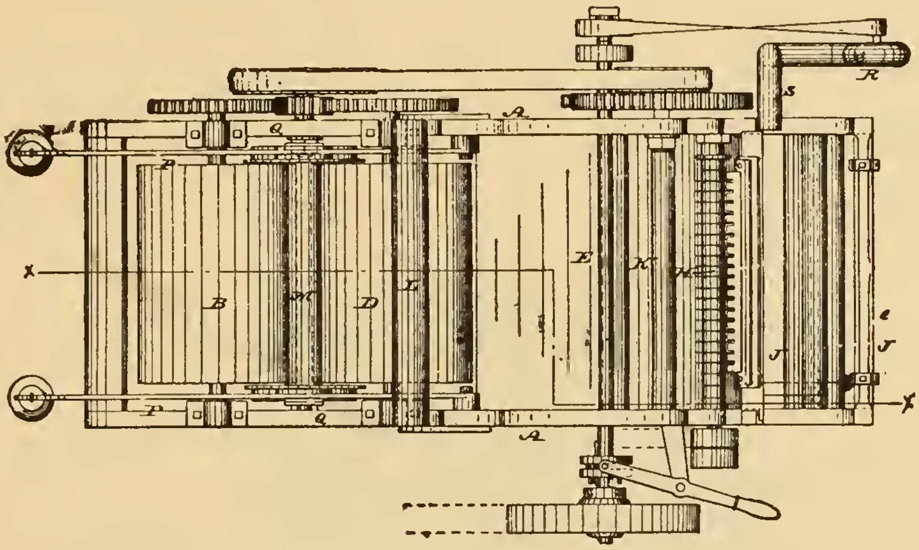


FIG. 770.

removed in Fig. 770.) Mounted on the frame, or the attachments thereof, on opposite sides of the cutter, are tension-regulating rollers *J K*. Secured to the frame, and at the rear end, are transversely extending beams *d e*, around which the fabric to be cut is passed from the roller *D* to the rollers *J*.

L represents a roller at the top of the frame *A*, and *M* represents a roller on which the cut chenille is wound. Roller *M* rests on the rollers *B D*, and has its frictional contact with the

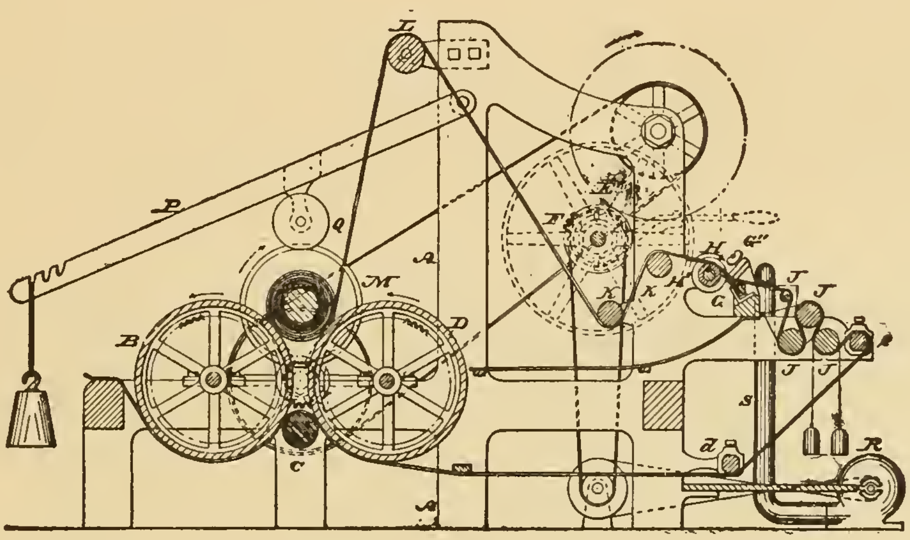


FIG. 771.

roller adjusted by means of weighted levers *P*, which are pivoted to the frame *A*, and carry rollers *Q*, which are in contact with the peripheries of the heads of roller M.

Supported on the base of the machine, or on the floor of the apartment, is a fan or blower, *R*, the pipe *S* whereof leads upwardly and transversely, and opens just in advance of the cutter *H*, so as to direct a current of air over the fabric and remove fine particles of the same and dust therefrom. The chenille fabric to be cut into strips is passed under the roller *B* over the roller *C*, under the roller *D*, under the beam *d*, under and around the beam *e*, under and over the several rollers *J*, and then between the comb *G* and bearing-plate G'', where the cutter H acts on the fabric, thus severing it into chenille strips, the chenille strips then passing over and under the rollers *K* and over the roller *L* to the roller *M*, on which they are wound. The roller *M* is then removed, and the several lengths of chenille thereon are re-wound or re-rolled on other rollers or spools, and subjected to further operations.

CHENILLE AS PRODUCED IN THE MANUFACTURE OF FRINGES.

In fringes and similar upholstery fabrics the chenille is produced through the warp, the filling taking the place of the inside binders. For a practical explanation of this point we refer

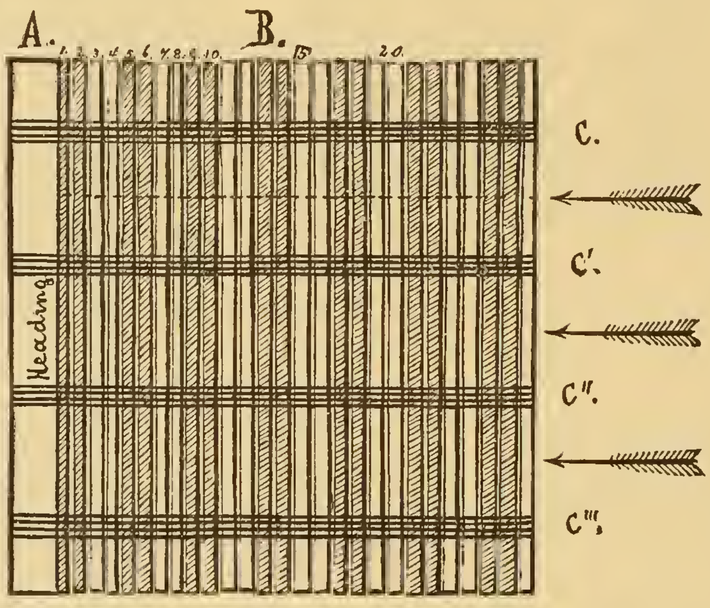


Fig. 772.

to Fig. 772. In this illustration we represent under *A* the heading, under *B* the worsted, wool cotton or silk warp for producing the chenille. *C, C', C'', C'''*, etc., represent the fine cotton binders interweaving in the heading and chenille part of the fabric (forming the centre of the chenille after cutting). The arrows at the right hand indicate the places where the chenille has to be cut towards the heading as indicated by the dotted line between *C* and *C'*.

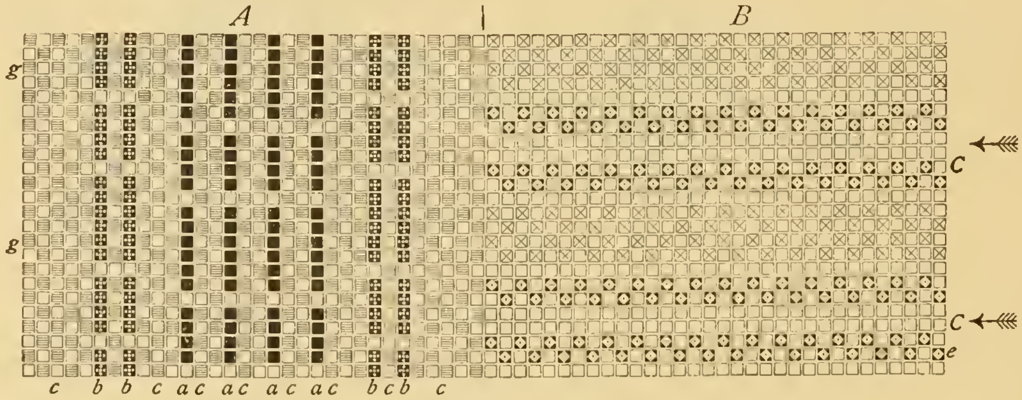


Fig. 773.

Fig. 773 represents the weave for a chenille fringe. *A* is the heading of the fabric and *B* the chenille part. The width of heading in fabric to be ¾ inch; the width of chenille fringe to be from 1 to 3 inches. Three ends of 2-ply loose twisted zephyrs to be used for one end in the chenille fringe. Two ends of 2-ply 50s cotton used in ground of heading for one end. Two ends of 2-ply zephyr used for one end in figure of heading.

Specimen Dressing of Heading for Present Example:

10	ends of	2-ply 50s lt. blue cotton	for	5	ends (heddles).
1	"	Gold tinsel	"	1	end.
2	"	2-ply 50s lt. blue cotton	"	1	"
1	"	Gold tinsel	"	1	"
6	"	2-ply 50s lt. blue cotton	"	3	"
2	"	2-ply lt. blue zephyrs	"	1	" } 3 times over = 9
4	"	2-ply 50s lt. blue cotton	"	1	" }
2	"	2-ply lt. blue zephyrs	"	1	"
6	"	2-ply lt. blue cotton	"	3	"
1	"	Gold tinsel	"	1	"
2	"	2-ply lt. blue cotton	"	1	"
1	"	Gold tinsel	"	1	"
10	"	2-ply lt. blue cotton	"	5	"
—				—	
60 ends.			for	32	heddles.

Dressing for Fringe. (Chenille part.)

9	ends	Zephyrs.	Blue	shade No.	1	for	3	heddles.
9	"	"	"	"	2	"	3	"
12	"	"	"	"	3	"	4	"
12	"	"	"	"	4	"	4	"
9	"	"	"	"	1	"	3	"
9	"	"	"	"	2	"	3	"
12	"	"	"	"	3	"	4	"
12	"	"	"	"	4	"	4	"
12	"	"	Yellow			"	4	"
—							—	
96 ends Zephyrs						for	32	heddles.

The ◘ type in the chenille part of the weave indicates the weave for the cotton cord required to be interwoven for the filling. Hence every filling line in the design containing this type will require 2 separate picks: 1 pick for the heading; ⊟, ■, and ▤ up, □ and ◘ down; 1 pick for the chenille; ◘ up, ⊟, ■, ▤ and □ down.

The process of weaving is clearly indicated in the drawing Fig. 774.

In weave, Fig. 773, and fabric sketch, Fig. 774, the letters used for indicating the different systems of threads correspond.

c stands for 2 ends of 2-ply 50s light blue cotton (heading).

b stands for 1 end of gold tinsel (heading).

a stands for 2 ends of 2-ply light blue zephyrs (heading) as used in the different arrangement of colors mentioned before. The arrows in both (weave and sketch) are also on corresponding places.

Fig. 775 represents the finished fabric sample. For the filling for heading, 4 ends of 2-ply light blue worsted are used. For filling for the centre of chenille strip and interweaving in the heading, use 2-ply 60s black cotton.

Weaves Fig. 776 and 777 are two additional specimen designs for chenille fringe.

After the chenille fringe is woven and the heavy cord extracted, the fringe is submitted to a steaming, which process will put the twist into it as required, for a double purpose. *A* for general appearance. *B* for strength, so as to resist a pulling out of threads in the chenille part.

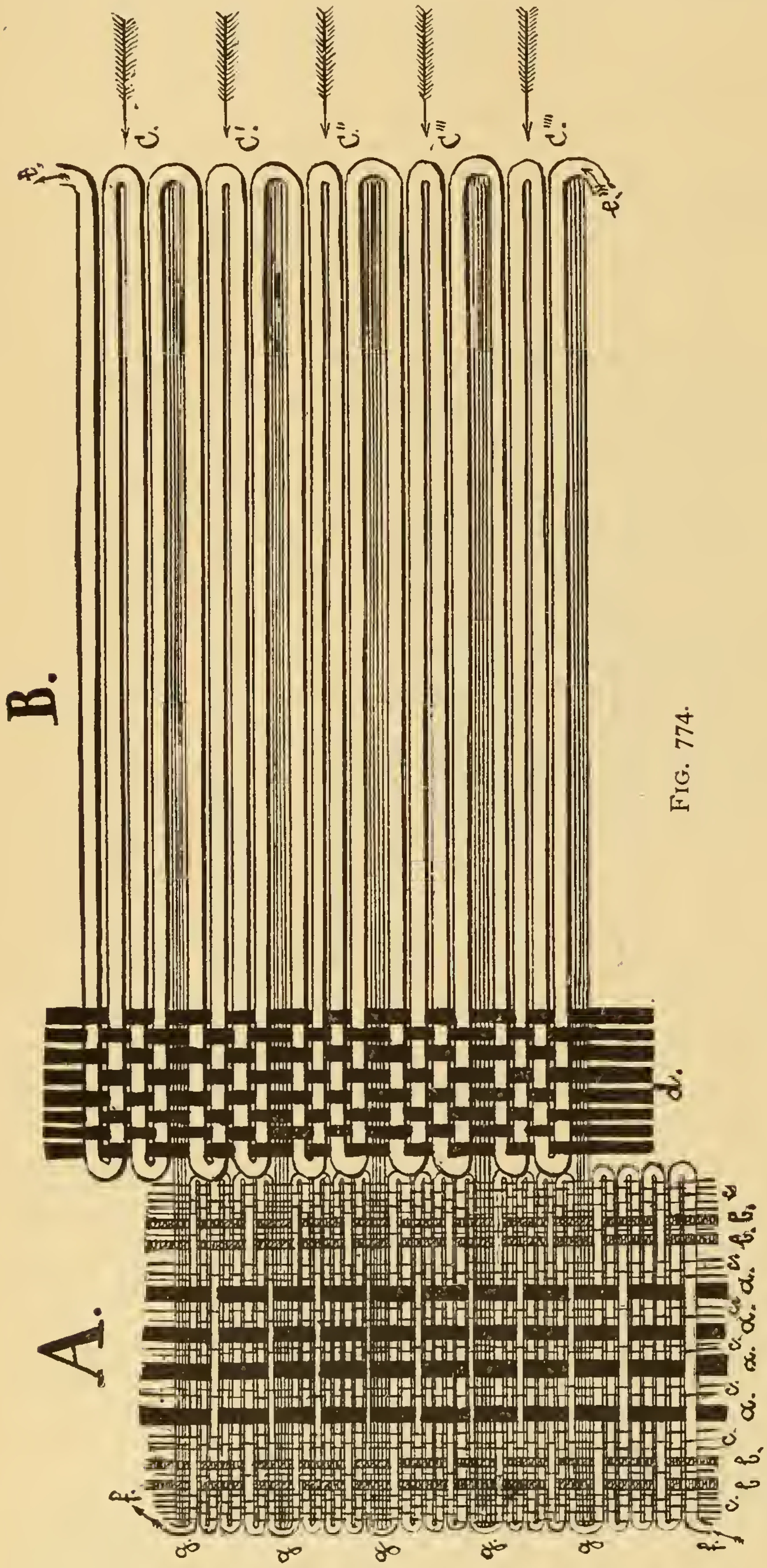


Fig. 774.

Lately this method of producing chenille fringe (in certain fancy effects) has been patented for weaving a double set of fabrics at the same time, thus separately weaving two fillings with two sets of heading warps, at intervals, alternately interweaving the above mentioned fillings with a set of body-warps, and interlacing a temporary filling with these body-warps in alternation with said heading-fillings, and then cutting the body of the fabric so produced between the insertions of heading-fillings and removing the temporary filling.

In diagram Fig. 778 is illustrated such a fabric, having the temporary filling both interlaced and liberated. The body of the fabric is cut and two distinct fringes are produced, each fringe having a series of spaces, and each space of one fringe being slightly wider than the width of two pendants; the spaces and pendants alternating in the fringe.

A represents two fringes consisting of the heads *a a* and pendants *b b*. The spaces *c c* between each two pairs being slightly wider than the width of a pair. The fabric of which the fringes are formed consists of a body, *B*, and two heads, *a a*.

In weaving the fringe fabric a cord *d* is thrown into the body at intervals as temporary weft, after the previously explained method of forming "single set" chenille-fringe fabrics. Two shuttles are employed for the heads *a a*, one for each head. The threads *e* from the two shuttles for the heads are separately woven with the warps *a′ a′*, employed for these heads, thus producing two heads, and threads *e* are alternately and at intervals shot past the heads into and across the body, and woven with the warps *d′* thereof, so as to bind the portions of the body, which afterward constitute the axes or cores of the pendants of the fringe, it being noticed that the two woven heads are alternately connected with the body by such threads *e* as are shot into the body at intervals. The cord *d* is woven only with the warps *d* of the body, and is introduced therein alternately with the filling *e*, as shown. When the fabric is finished, the body is cut through between the cords *d*, midway between the fillings *e*, as usual in making chenille fringe, thus

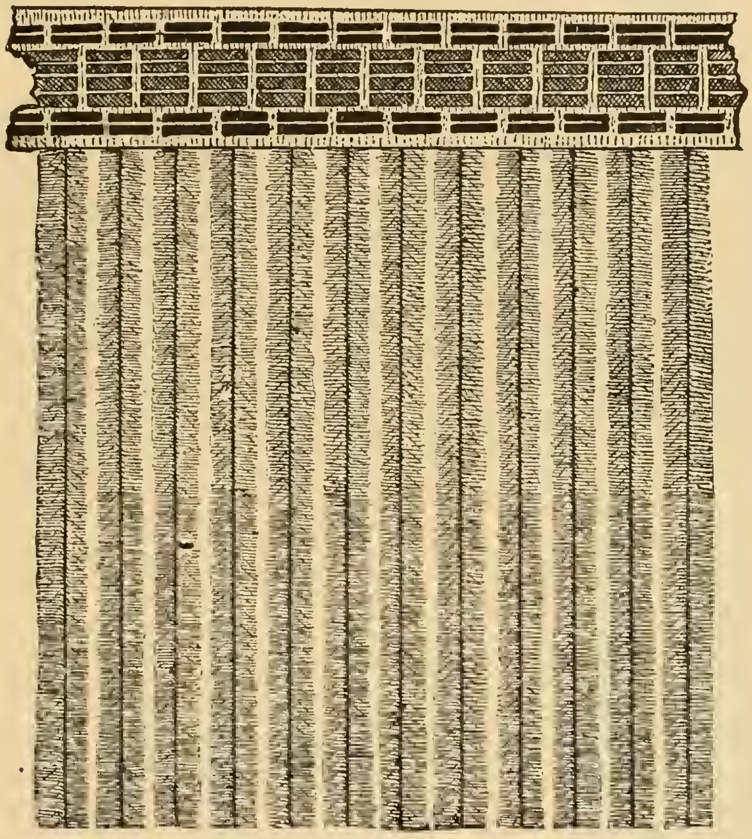


Fig. 775.

severing the pendants, and the temporary filling is removed. It will be seen that by so doing said pendants are separated into two series, one series being connected with one head and the other series with the other head, and the pendants of one series having left among them spaces corresponding with the pendants of the other series. These spaces may be equal

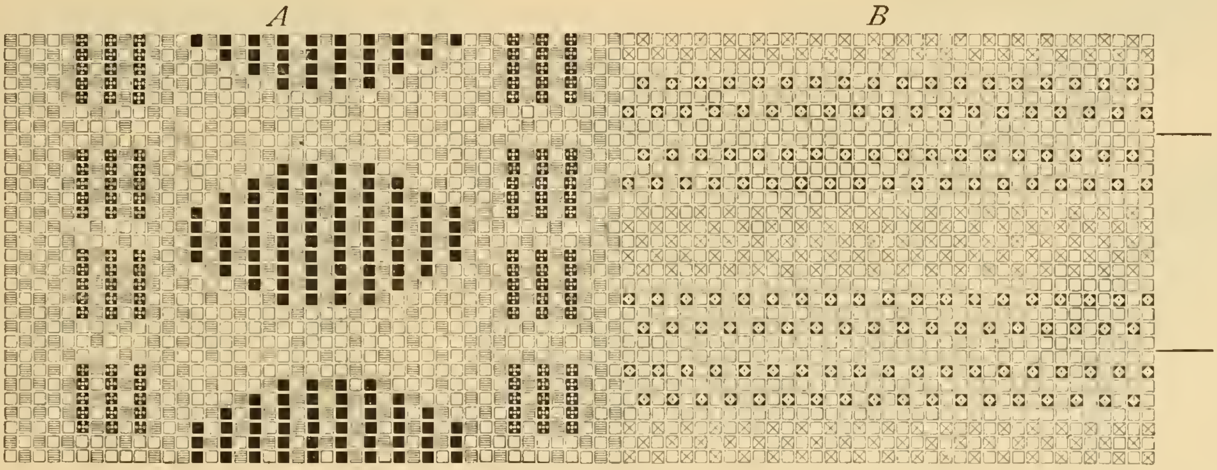


Fig. 776.

to one, two, or more pendants, according as the set of threads *e* are thrown across the body from the two heads.

Another method of weaving a double set of chenille fringes at once, and with their pendants attached, is illustrated in Figs. 779 and 780. This method of operation (patented by S. Steinecke) consists in interweaving two separate sets of heading-warps and one series of ordinary body-warps with a single filling or series of picks, and also a series of temporary picks of another heavier size filling, which is removed in like manner to that of the temporary filling inserted in fabrics previously illustrated.

Fig. 779 represents a plan of the construction of the fabric, showing the pendants in pairs on the opposite headings, some of the fabric being cut so as to form the pendants (as they appear when finished) in pairs on the lower part of the diagram.

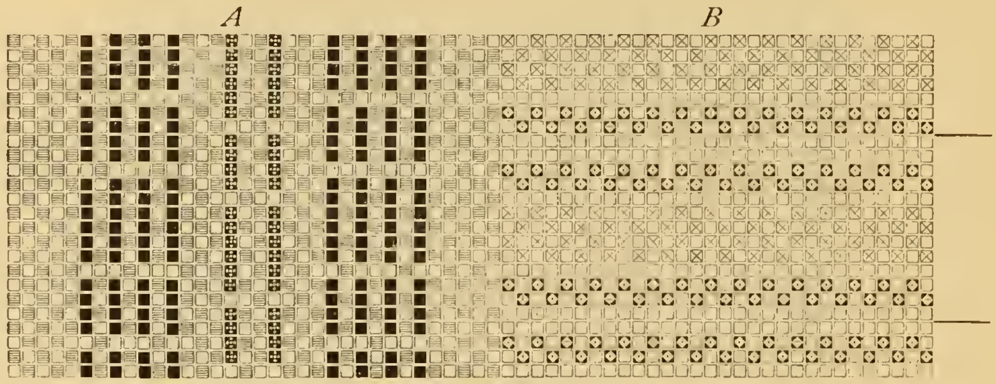


Fig. 777.

Diagram Fig. 780 shows the method of interlacing binder filling which forms the cores of the pendants.

A A represent two sets of heading-warps at the sides of the usual body-warps, *B* for forming the pile-threads of the chenille. The warps *A* and *B* are interwoven with the filling *C*, which may consist of a single thread or series of threads, all in the same shuttle.

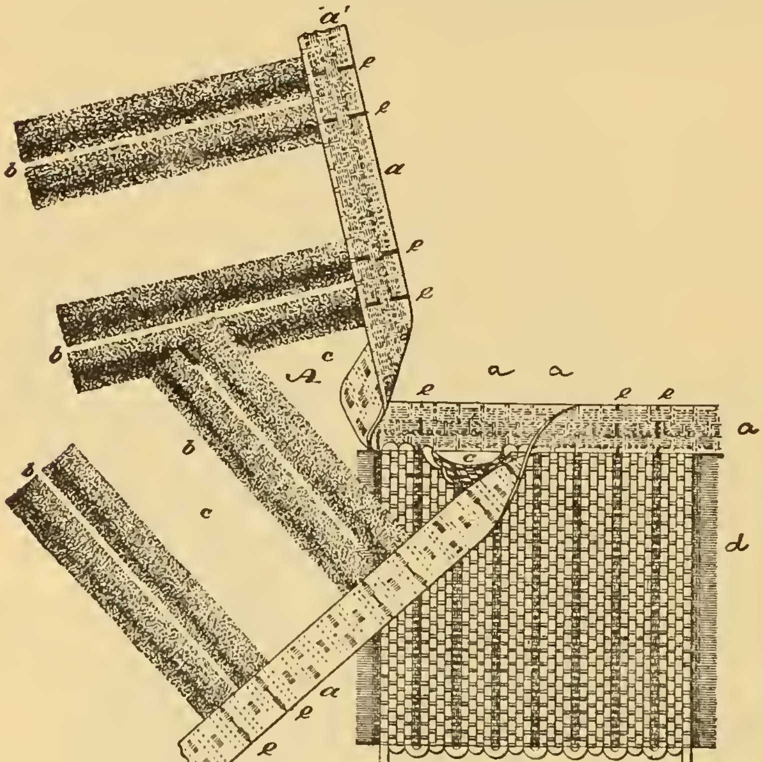


Fig. 778.

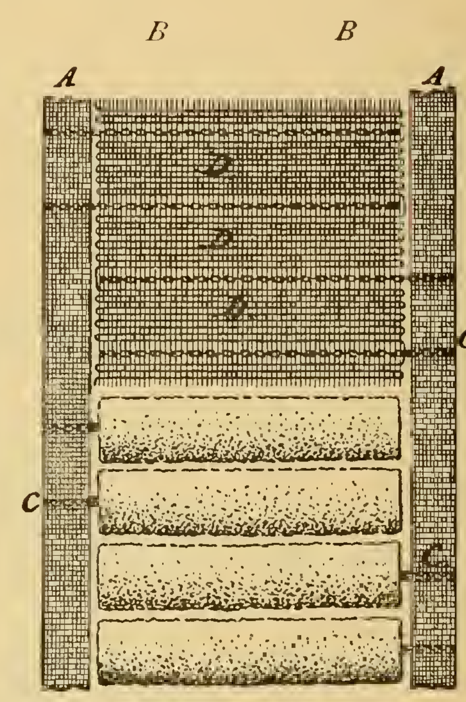


Fig. 779.

The filling is interlaced in the following manner: The filling is interwoven with the left-hand heading-warps *A*, then, with the body-warps *B*, up to the inner edge of the right-hand heading-warp *A* but not with the said right-hand heading-warp *A*; then the intermediate or filling weft, *D*, which is to be removed later on, is interwoven with the body-warps *B*, but not with the headings. After three, four, or more courses of the intermediate weft, *D*, have been formed, the weft-thread *C* is again interwoven with the body-warps B and one of the heading-warps; but in this case the weft C is interwoven with the right-hand heading-warp A, and with the body-warps up to the inner edge of the left-hand heading-warp A, but not with said left-hand heading-warp A, and so on alternately, so that, as shown in Fig. 779, the weft-thread C is interwoven at regular intervals with the body-warps, and is alternately interwoven with the left and right-hand heading-warps A. The warps B are then cut parallel with the wefts C, midway between them, and the temporary wefts D are removed, and thereby two chenille fringes are formed, one on each heading A, the pendants being connected alternately with the opposite headings, as shown.

As shown in Fig. 779, the filling can be interwoven in such a manner that in pairs they are alternately connected with the opposite headings, or the first, second and third picks may be interwoven with the right-hand heading, and the next, first, second and third picks to the opposite heading, and so on. In all cases the permanent filling will ordinarily be interwoven with the heading-warps, as shown in Fig. 780, in which case the filling must be severed at the points a at both headings. The filling interwoven with the headings, and extending across the warps, form the cores of the chenille pendants.

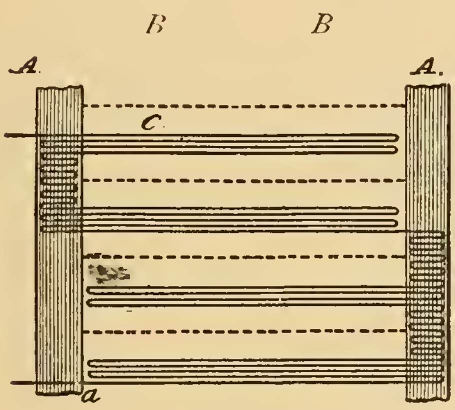


FIG. 780.

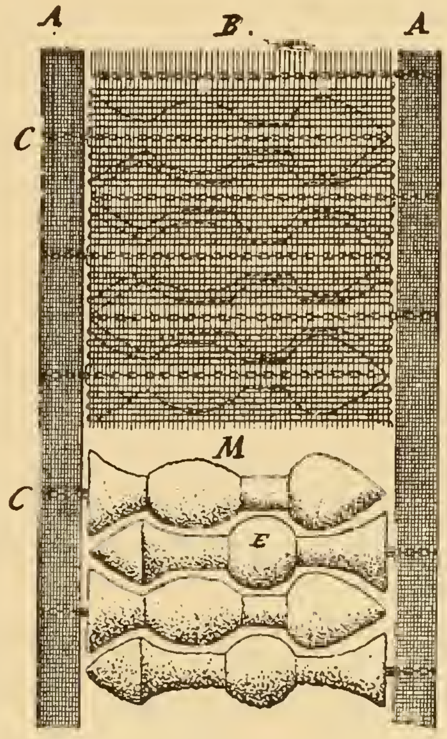


FIG. 781.

In Fig. 781, the previously explained method of weaving a double set of chenille fringes with their pendants attached, is shown as applied to the production of pendants which are shaped so as to have a varying-diameter.

A A are the heading-warps; B, the body-warps between the two sets of heading-warps.

C C filling interwoven with the heading and body warps and forming cores or centres of the pendants E. The core C of each pendant of the weft is interwoven with one heading warp only, and, as shown in the drawing, the cores of the chenille pendants are interwoven alternately with the opposite headings.

If desired, one, two, or three cores may be interwoven with one heading, and the next one, two, or three cores with the opposite heading, and the cores may be grouped on the opposite headings in any suitable manner.

Temporary filling M is interwoven with the body-warps between the picks C to form the chenille fabric. Then the body-warps are cut with suitable dies, knives or scissors, between the permanent picks to produce shaped pendants—that is, pendants in which the diameters of the pile-threads vary at different points through their entire length.

PILE FABRICS IN WHICH THE PILE IS PRODUCED BY A SEPARATE WARP IN ADDITION TO THE GROUND WARP.

As indicated, two kinds of warps are necessary to the production of these fabrics. One warp, the "ground-warp," with the filling, produces the ground or body of the fabric, while a second warp, known as the "pile-warp," produces the face.

In any pile fabric, from the common velvet to the most complicated Astrakan cloth, Brussels, Wilton or tapestry carpet, the method of entwining the ground structure is of a very simple character (either common plain, basket, or a twill of short repeat), while the interlacing of the pile-warp into the ground cloth is of a more complicated nature. In all warp-pile fabrics two methods of producing the pile are essential. Either the pile is left uncut, which is technically known as the "Terry" pile, or the pile is cut, known technically as the "velvet" pile. In addition to these two ground principles for producing the warp-pile, an endless variety of effects and combinations are produced by using various color combinations for each kind, again varying the height of the pile, combining cut and uncut (velvet and Terry effect) pile for forming additional designs in one fabric, etc., etc.

Ground-warp and pile-warp are independent in their operation on the loom, therefore each must be wound on a separate beam, as a different tension and "let-off" is required for each.

In fabrics of a fancy character one beam for the pile-warp will not be sufficient, and the number must be increased for some fabrics to a great extent, in fact in such fabrics as Brussels or Wilton carpets it must be increased to one miniature beam for each individual pile warp-thread.

Structure of Warp Pile Fabrics.

Warp-pile fabrics are constructed by raising the pile-warps from the ground cloth over a wire and then interlacing the same into the cloth again. The entire pile-warp may be raised over the wire on a pick, or part of it only. In every case we must be careful to arrange the binding so as to secure the pile proper to the ground cloth. In case we want to raise only a part of the pile-warp at one pick we must, in addition to the binding, arrange the distribution according to the effect required.

Terry and Velvet Pile.

In all warp-pile fabrics the same kind of warp yarn may be employed to produce the pile for either the Terry or the velvet effect; but it will be necessary to use different wires if the fabric is to be woven on a power loom. The Terry pile is produced by using a plain wire, as illustrated in Fig. 782, which, when drawn out, leaves the loop intact.

Fig. 783.

Fig. 782.

If "velvet pile" is desired we must use wires of a style similar to that illustrated in Fig. 783, being a wire which has a knife attached to its extreme end. This cuts its way through the pile as the wire is pulled out.

In weaving pile fabrics on a hand loom, frequently one kind of wire is used for producing both Terry and velvet effects of an equal size. This wire is provided with a groove for inserting the knife of the "trevette" when a velvet face is required. Fig. 784 illustrates the section cut of such a wire (see *S*). The knife of the trevette is shown at *A*. *B* represents a warp-thread as cut and secured to the body or ground of the cloth by means of picks 1 and 2, which in the present example represent the two connecting picks to the pick for inserting the wire. If no cutting is required (Terry) the wire is pulled out. Thus it will be seen that the production of velvet or Terry effects in the fabric is effected by cutting, or not cutting, certain pile picks, the change to either effect being entirely at the will of the weaver. The trevette is a frame having a knife fixed in it for cutting the pile, and is illustrated in Fig. 785 by a front view and in Fig. 786 by a side view. Letters used for indicating the different parts in both designs are used correspondingly.

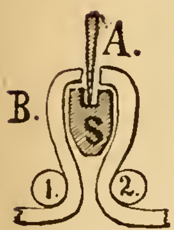


Fig. 784.

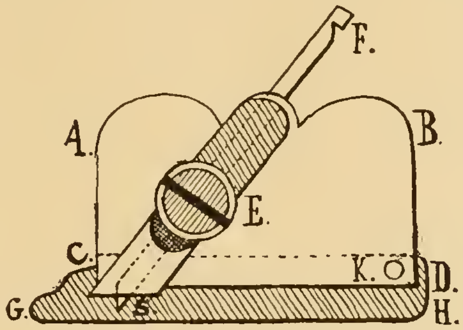


Fig. 785.

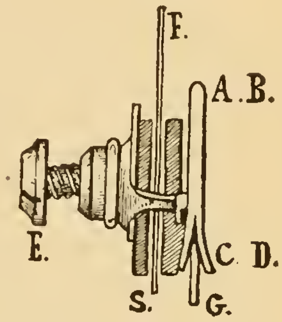


Fig. 786.

The weaver inserts the trevette on the wire to be liberated at the left side of the fabric and runs it quickly over the entire width of the wire.

Explanations and Illustrations of the Method of Operation in Producing Warp Pile Fabrics.

As previously mentioned, in warp pile fabrics we require two kinds of warp, one for the ground cloth and one for the pile. Each kind of warp is drawn in on its own set of harness, arranging in most every instance the pile warp nearest to the reed.

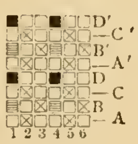


Fig. 787.

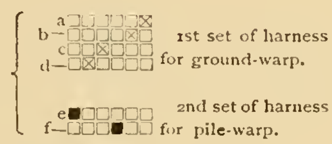


Fig. 788.

In Fig. 787 we illustrate a weave for a pile fabric. Repeat: 3 warp-threads, 4 picks. Arrangement of warp: 2 threads ground (2, 3, 5 and 6), 1 thread pile (1 and 4) = 3 threads in repeat. Filling: 1 ground pick heavy (*A*), 2 ground picks finer (*B* and *C*), 1 pick for inserting wire (*D*), = 4 picks in repeat.

Fig. 788 represents the drawing-in draft arranged, 4-harness in first set for ground warp and 2-harness in the second set for pile warp. Harness: *a*, *b*, *c* and *d* for ground; harness: *e* and *f* for pile.

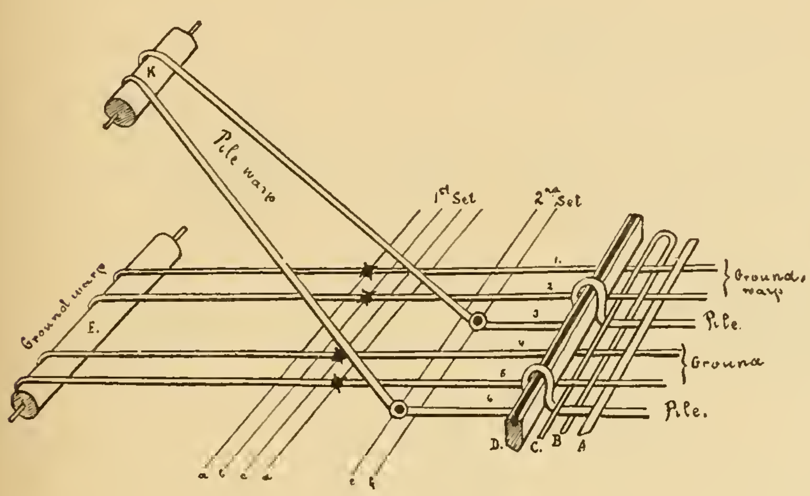


Fig. 789.

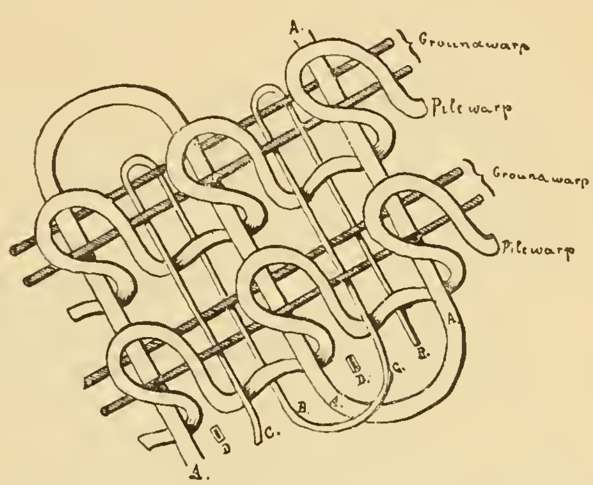


Fig. 790.

Fig. 789 illustrates the method of operation on the loom. Every letter or number used in this diagram corresponds with those used in Figs. 787 and 788, and thus will readily explain itself.

Fig. 790 represents a reproduction in perspective of the fabric as produced with weave Fig. 787. Letters used in this drawing also correspond with those used in Figs. 787, 788 and 789.

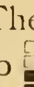
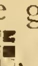
In drawing Fig. 789, representing the method of operation for forming pile fabrics, only one wire is shown interwoven. The same will illustrate a principle most frequently observed, *i. e.*, to have the pile warp in the lower shed, both in the pick preceding the wire as well as the one following. This method has a strong tendency to drive the wires into position as well as to keep them there. In some fabrics this method is changed with respect to the pick preceding the wire, but in whatever warp pile fabric to be constructed by means of wires, the pick following the insertion of the wire must have all pile warp-threads, raised as before over the wire, down.

We will now give a short sketch of the method of operation on the hand loom when weaving warp pile fabrics, thus illustrating also a like principle for weaving the same fabrics on the power loom. After the weaver has interlaced the required number of ground picks between the threads of the combined warps, a shed is formed either by raising the entire pile warp-threads in the upper part of the shed and forming the lower part of the shed by means of the ground warp, or by raising only a part of the pile warp in this pick, forming the lower part of the shed by the entire ground warp and also the remaining part of the pile warp. This shed remains formed until the wire has been passed through, extending on each end several inches wider than the selvage threads. Towards this wire so inserted the reed is brought with considerable force, and pushes the wire close towards the previously interwoven ground picks. The shape of these wires is of such a form that, by arranging the latter so that the reed when pressing towards the interlaced part of the fabric comes in contact with the grooved edge, the wire is caused to stand on its lower edge. In this upright position it is maintained by pressing the reed towards the wire until a new shed (ground pick) is formed, in which the filling for the ground cloth is inserted by means of a common shuttle as is done in the ground pick preceding the insertion of the "wire."

By this method of fastening the pile warp over its respective wire to the ground cloth, the latter is also securely fastened to it, and, if an uncut pile effect is desired, requires some effort to liberate it. After inserting the required number of ground picks the process of inserting the wires is repeated, several wires always being retained in the fabric to keep the pile-threads from pulling out of the texture, which would destroy the face. From 6 to 12 wires, according to the material and the method of interlacing the ground cloth, as also the closeness or "height" of texture, are required to remain in the fabric to prevent any possible trouble, as pointed out. The last wire liberated is always the next to be inserted.

We will now proceed to explain and illustrate a few of the most prominent warp pile fabrics.

Velvet and Plush Fabrics.

These fabrics are constructed with two kinds of warps. The ground-warp consists either of silk or cotton, and interlaces with the filling on plain , rib , , basket , or a 3, 4, 5, 6 harness twill; whereas the pile-warp being of silk, forms the face, through interlacing with the ground-cloth after, or before and after, raising for the wire.

The ground-warp is woven with a tight tension, while the pile-warp is arranged to "take up" easily. The name of the fabric indicates the "cut" character for the pile. As previously mentioned, two beams are necessary, the beam for carrying the ground-warp, and the beam for carrying the pile-warp. The pile-beam must be situated in a higher position (in the rear of the loom) than the beam carrying the ground-warp, so that the pile-threads will run in an oblique direction towards the harness. The proportion of pile and ground-warp as well as the height of texture, and threads per dent, vary for the different qualities.

Arrangements most frequently used are:

2 ends ground to alternate with 1 end pile. or, 2 ends ground to alternate with 2 ends pile.

Or, 2 ends ground, 1 end pile, 1 end ground, 1 end pile, = 5 ends in repeat. Or, 1 ground, 1 pile, 1 ground, 2 pile, = 5 ends in repeat. Or, 1 ground, 2 pile, 2 ground, 2 pile, = 7 ends in repeat. Or, 2 ground, 1 pile, 2 ground, 2 pile = 7 ends in repeat, etc., etc.

The ground-warp and pile-warp are each put on a separate set of harness, generally using 4 successive harnesses for drawing in the ground-warp, and 2 harnesses for the pile-warp. For example:

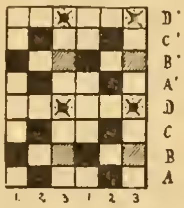


Fig. 791.

Fig. 791 represents a common velvet weave in which 2 ground warp-threads alternate with 1 end pile-warp. Filling: 3 picks, ground (*A. B. C.*) to alternate with 1 wire (*D*).

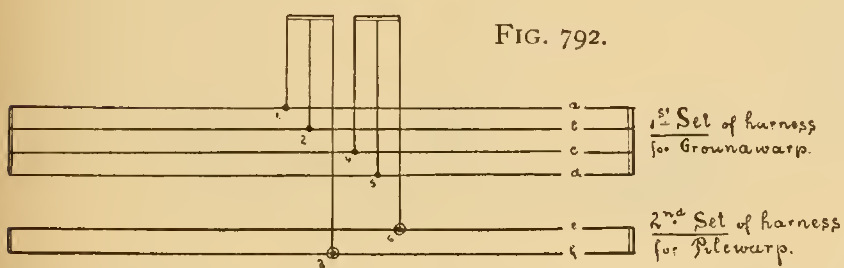


Fig. 792.

Fig. 792 illustrates the drawing-in draft with two sets of harness. Harness *a*, *b*, *c*, *d* for the ground-warp (4), harness *e* and *f* for the pile warp (2).

Technically the velvet fabrics are classified as "two-picks velvet," "three-picks velvet," etc., which means that in the two-picks velvet we use two ground-picks between each insertion of the wire, and in the three-picks velvet three successive ground picks, and so on.

In Fig. 793 we illustrate one of the plainest of the velvet weaves and representing what is technically classified as "the common two-picks velvet" weave.

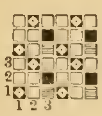


Fig. 793.

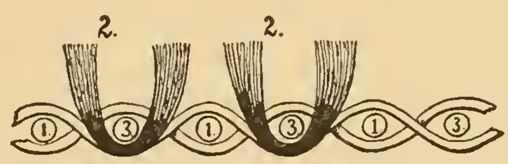


Fig. 794.

Fig. 794 represents the sectional cut of this weave. An examination of this weave will illustrate the following arrangement for each pick:

Pick 1 raises ground warp-thread 1 and the pile.
" 2 " only the pile (wire).
" 3 " " ground warp-thread 2.

Repeat: 3 warp-threads and 3 picks.

Warp: 2 ground-threads to alternate with one pile-thread (this pile can also be a two-fold or a three-fold thread).

Filling: 2 ground-picks to alternate with one pick for inserting wire.

Fig. 795.

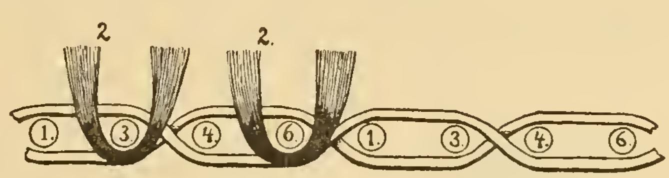


Fig. 796.

In Fig. 795 we illustrate a velvet weave frequently used, which has for the interlacing of the ground cloth the common rib-weave (2 harness and 4 picks).

In this weave we find the ground-picks preceding the pick for inserting the wire, as well as the ground-pick following the latter, call for the raising of the same ground warp-threads (two picks in a shed in the common rib-weave).

Fig. 796 illustrates the section of a fabric interlaced on weave Fig. 795. An examination of each pick will show the following results:

Pick 1 raises ground warp-thread number 1 and the pile.
" 2 " only the pile (for inserting the wire).
" 3 " only ground warp-thread number 1.
" 4 " ground warp-thread number 2 and the pile.
" 5 " only the pile (for inserting the wire).
" 6 " only the ground warp-thread number 2.

Repeat: 3 warp-threads and 6 picks.

Warp: 2 ground-threads to alternate with 1 pile-thread (which can also be a two-fold or three-fold thread).

Filling: 2 ground-picks to alternate with one pick for inserting wire.

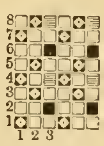


FIG. 797.

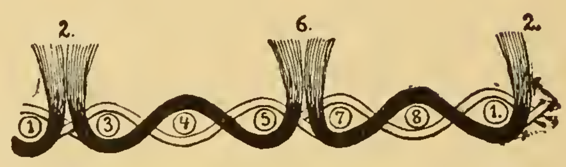


FIG. 798.

In Fig. 797 we illustrate the common "3-picks velvet" weave, which has for its interlacing of the ground-cloth the common plain weave.

Repeat: 3 warp-threads and 8 picks.

Warp: 2 ground-threads to alternate with 1 pile-thread (which can also be a two-fold or three-fold thread).

Filling: 3 ground-picks to alternate with one pick for inserting the wire.

An examination of each successive pick will show the following results:

Pick 1 raises ground warp-thread No. 1. (Ground-pick 1.)
" 2 " pile-warp for inserting wire.
" 3 " ground warp-thread No. 2. (Ground-pick 2.)
" 4 " ground warp-thread No. 1 and pile-warp. (Ground-pick 3.)
" 5 " ground warp-thread No. 2. (Ground-pick 4.)
" 6 " pile-warp for inserting wire.
" 7 " ground warp-thread No. 1. (Ground-pick 5.)
" 8 " ground warp-thread No. 2 and pile-warp. (Ground-pick 6.)

The section cut of this weave, which is represented in diagram Fig. 798, readily explains the advantages of this weave over the preceding ones, in that it more securely fastens the pile to the ground-cloth, every pile warp-thread being interlaced by $\frac{1}{1 \quad 1}$ before it is raised for inserting the wire. Therefore fabrics produced with this weave will be more durable than fabrics interlaced as shown in sections 794 and 796; of course, by using the texture and size of yarn alike in all three examples, the fabric as produced with weave Fig. 797 will be less dense, in appearance of the face, than the others.

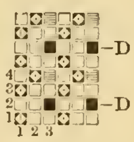


FIG. 799.

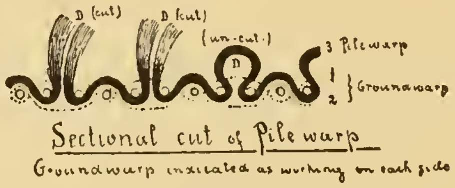


FIG. 800.

In weave Fig. 799 we represent another "3-pick velvet" weave. Diagram Fig. 800 represents the section of a fabric interlaced with weave Fig. 799. Letters for indicating the different threads in weave and section are used correspondingly. Two loops formed by the insertion of the wires are shown as cut, whereas one is represented as uncut.

An examination of the weave will show the following results:

Repeat: 3 warp-threads and 4 picks.

Arrangement of Warp: 2 ends ground to alternate with 1 end pile.

Filling: 3 picks ground to alternate with 1 pick forming the shed for inserting the wire. Picks marked 1, 3, 4, are ground picks. Pick 2 (= *D*) is the pick for inserting the wire. If using a twill weave for interlacing the ground-cloth in a velvet fabric, we generally use not less than 3 successive ground picks to alternate with one pick for the wire. Less ground picks would result in a texture not sufficiently strong to resist the pulling out of the pile by the wear the fabric is put to.

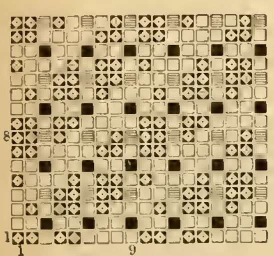


FIG. 801.

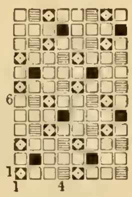


FIG. 802.

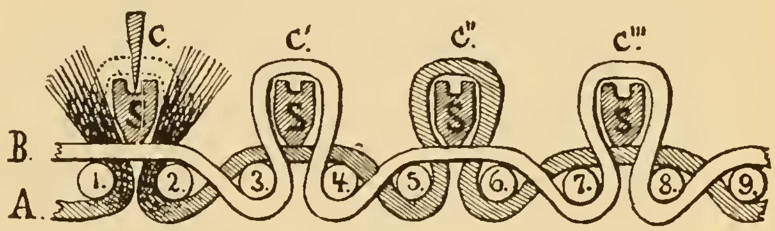


FIG. 803.

In Fig. 801 we illustrate the design for a pile fabric having the $\frac{4}{\quad 2}$ 6-harness twill for weave of the ground structure.

Repeat: 9 warp-threads and 8 picks.

Arrangement of warp: 2 ground threads, 1 pile thread = 3 threads repeat.

Filling: 3 ground picks to alternate with 1 pile pick.

The method of interlacing the pile warp to the ground cloth is, in the present example, equal to the one illustrated in Fig. 800.

In place of one pile thread we can also use a two-fold or three-fold thread.

In the manufacture of velvets and plushes, in which no dense pile is required on the face, as also in fabrics in which the material used is rough or too close set, and so liable to "choke" between the raising and lowering of the entire pile warp or *vice versa* the entire ground warp, we raise on every successive pile pick only each alternate pile warp-thread. The proportion of pile warp and ground warp in these fabrics is generally equal; one ground warp-thread to alternate with one thread of pile warp.

In this manner design Fig. 802 is executed.

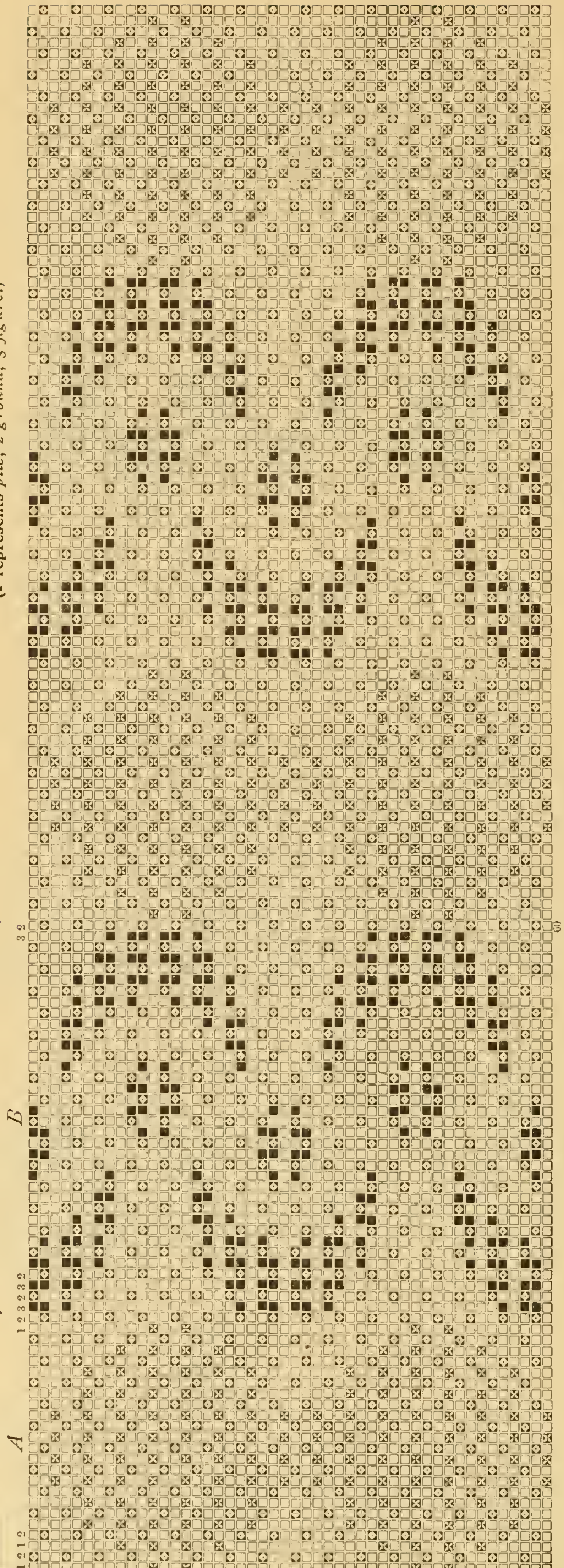
Repeat: 4 warp-threads and 6 picks (4 ground picks, 2 picks for wires).

Filling: 2 picks ground to alternate with 1 pick for inserting the wire.

Diagram Fig. 803 represents a sectional view of the method of interlacing both pile warp-threads in the ground cloth in weave Fig. 802. One pile warp-thread, indicated as *A*, is shown shaded and situated behind pile-thread *B*, which is shown in clear outlines. *S* represents the section of a wire as used in hand looms, but which will also demonstrate the section of a wire as used in power looms. *C* represents the section of the knife in the trevette. The first loop is shown as cut, whereas the other three are represented as uncut.

FIGURED VELVET.

In these pile fabrics more figuring is possible than in any other kind of textile fabrics. One of the first requisites for figuring these fabrics is the use of different colors for forming designs. Then, again, we can figure successfully by using uncut pile with the regular cut pile, as also by using the common weaving to form figures with the pile weaving. We can also produce new additional designs by means of high and low pile. All these latter methods for forming additional figures will result in the necessity of using a great many beams, and in some fancy figures



Pile Effect. 2 Systems Warp, 1 System Filling.

(1 represents *pile*, 2 *ground*, 3 *figure*.)

Fig. 804.

produced by harness work as well as all figuring done by means of the Jacquard machine, the number of beams will increase according to figured character of design until a separate small beam "pile-warp spool" for each individual pile warp-thread must be used. In using this arrangement of spools it is advisable to adjust a hack (divider) in rear of the loom, so as to readily find the place of breaking of any thread in the loom during weaving.

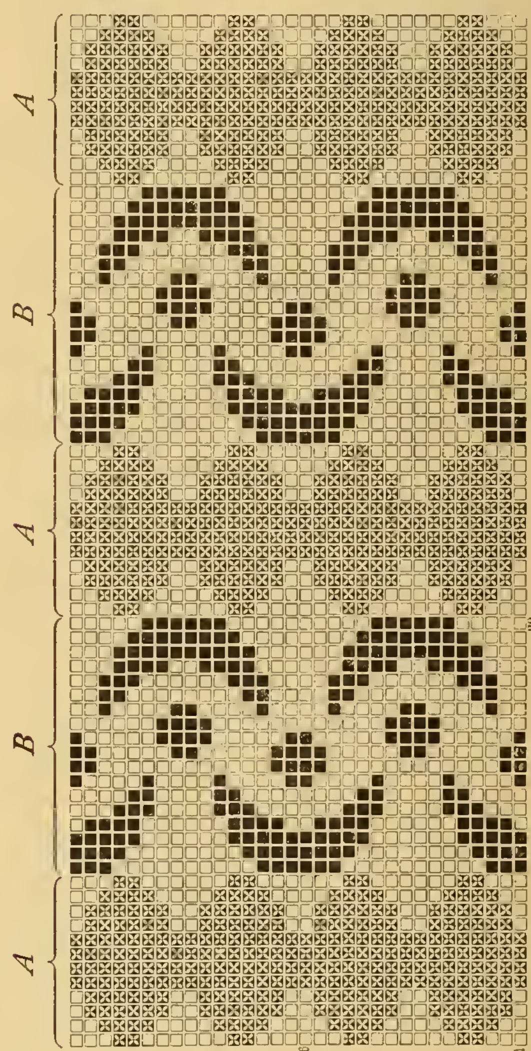


Fig. 804*b*.

Fig. 804. Combination of figured pile-effects and figure-effects, produced upon two systems of warp and one system of filling.

Arrangement of dressing:

A, 1 end pile, 1 end ground, } 12 times = 24 ends.

B, 1 end figure, 1 end ground, } 18 times = 36 ends.

Repeat 60 ends.

Lowest number of harness possible for drawing in, is 24-harness.

Filling: 1 wire (pile), 2 ground.

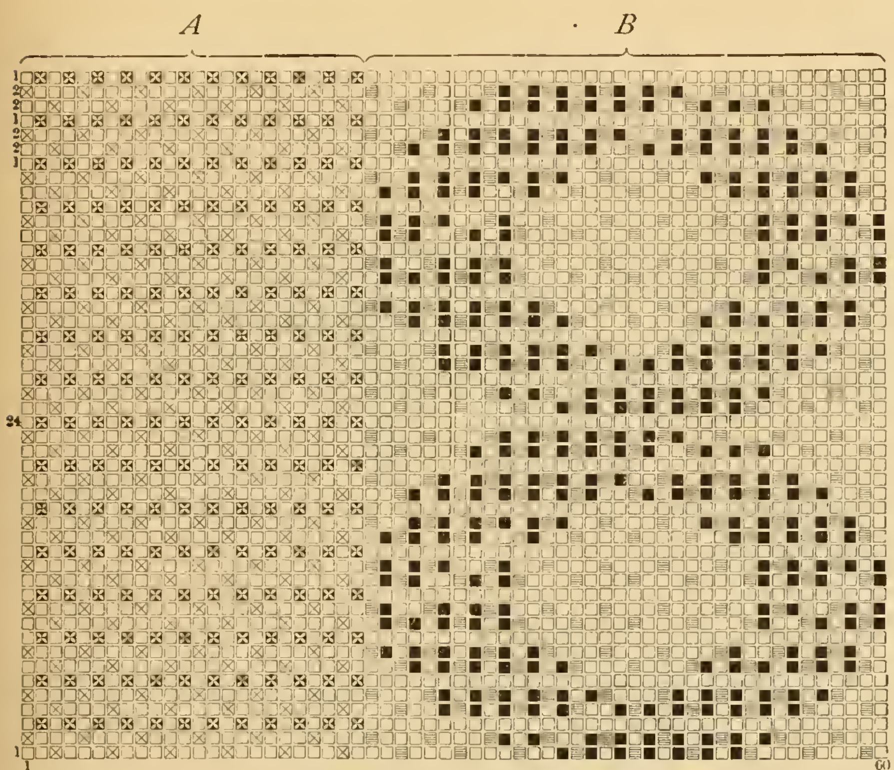
Fig. 804*b*. Motive for weave 804.

⊠ pile effect. ▪ effect produced on ordinary weaving with extra warp.

In both designs (the motive and the weave) three repeats of the pile part and two repeats of the part figured by extra warp (ordinary woven) are illustrated.

Fig. 805. Repeat: 60 warp-threads, 24 picks. Can be reduced, if required, to 21 or 23-harness.

Fig. 805*b*. Motive for preceding weave.



(1 represents *pile*, 2 *ground*, *filling*.)

FIG. 805.

A. Pile Effect. Dressing: 1 end pile, 1 end ground, 12 times, = 24 ends.

B. Figure Effect. Produced upon 2 systems of warp, 1 system of filling. Dressing: 1 end figure, 1 end ground, 18 times, = 36 ends.

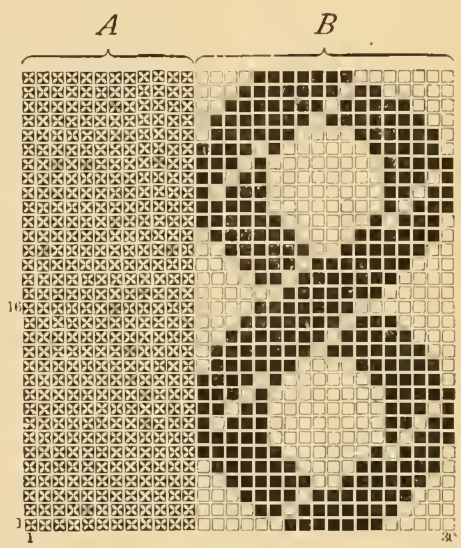


FIG. 805*b*

In both designs (the motive and the weave) only one repeat is shown. ⊠ for pile-warp. ▪ for figure-warp. ⊠ for ground-warp in pile part of weave. ▣ for ground-warp in ordinary weaving part of the design.

ASTRAKHANS.

These fabrics are also formed by adding an extra pile-warp to a single cloth, otherwise interlaced in plain, basket, rib, or common twill weaves, and are the nearest related (some weaves being exactly the same) to the velvet weaves given in the preceding chapter. We may either cut this pile (plush) or leave the pile uncut (terry); or we may use both methods in the same fabric, producing in this way some of the most beautiful novelties for ladies' cloaking—trimmings, and similar fashionable articles.

Texture of Astrakhan Fabrics.

The texture of these fabrics requires 2 kinds of warp: *a.* ground-warp, *b.* pile-warp, and one kind of filling (ground). The ground-warp will, by interlacing with the filling, form the ground or body of the structure, while the pile-warp through being interlaced to this ground structure and raised at certain intervals over wires (as required by the design), forms the face of the fabric.

Ornamentation of Astrakhan Fabrics.

Fancy effects upon otherwise plain interlaced Astrakhan fabrics can be produced by various combinations. Among these are found: The use of different colors in the pile-warp; varying

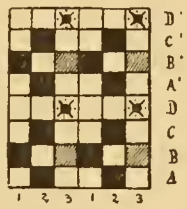


FIG. 806.

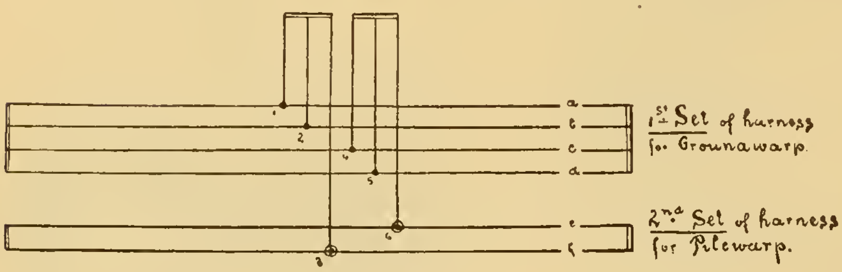


FIG. 807.

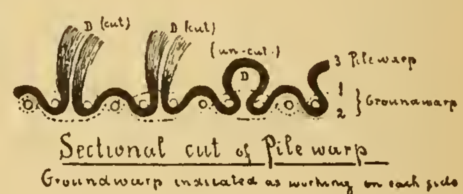


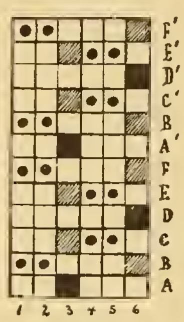
FIG. 808.

the length of the pile; and combining the terry and velvet effects, forming either terry figures upon velvet ground or velvet figures upon terry ground.

Specimen Weaves for Astrakhans.

Fig. 806 represents the weave for a plain Astrakhan fabric. Repeat: 3 threads of warp, 4 picks; the entire pile warp (indicated by 3 and 6 in the figure) is raised at once over the wire

FIG. 809.



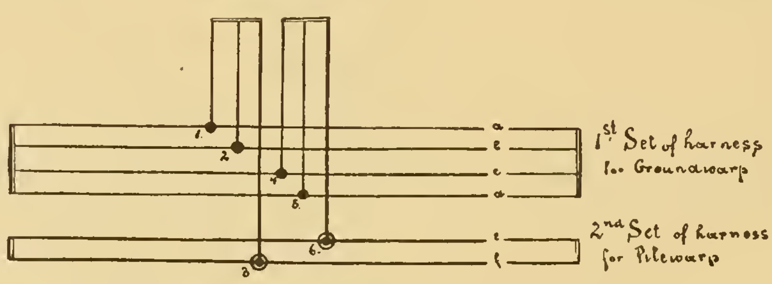


FIG. 810.

as shown in picks *D*, *D'*. Texture of the warp is 2 ends ground or body-warp (cotton) to alternate with one end pile-warp for the drawing-in on 2 sets of harness.

1st set for ground-warp (containing harness *a b c d*).

2d set for pile-warp (containing harness *e* and *f*).

Diagram Fig. 807 represents the drawing-in of the warp on its corresponding two sets of harness (indicated at the right-hand side).

Diagram Fig. 808 illustrates the section of a fabric interlaced on weave Fig. 806. Both ground warp-threads, as working at the right and left, are indicated by dotted lines. The pile-warp indicated in full black is shown in the terry and velvet effect (cut and uncut).

Fig. 809 illustrates another design for Astrakhans. *Warp:* 2 ends ground-warp, 1 end pile-warp, 2 ends ground-warp, 1 end pile-warp (to alternate with the first end pile-warp in weaving).

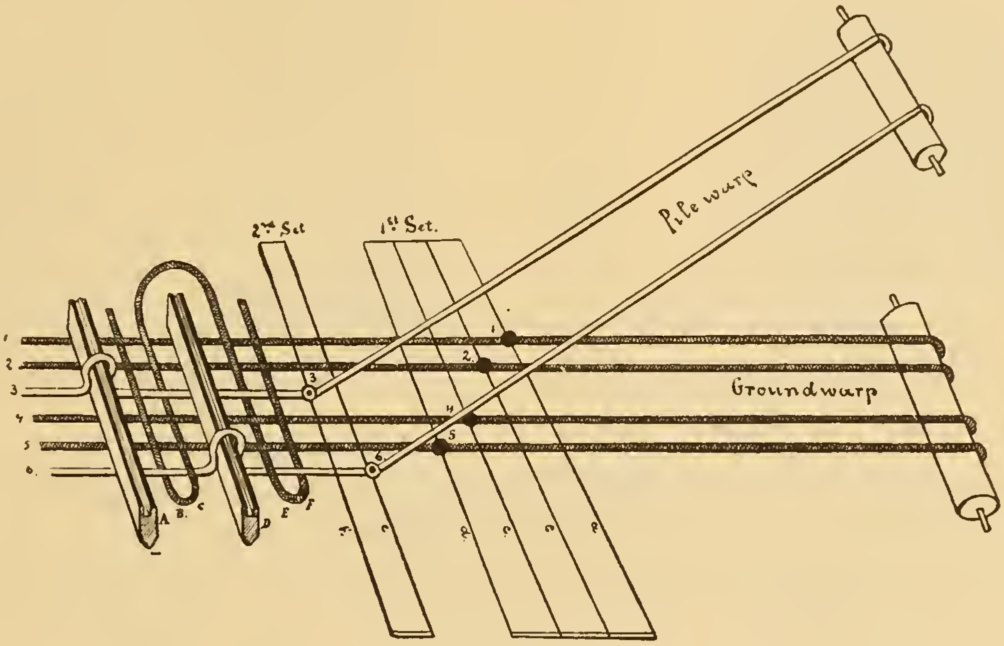


Fig. 811.

Each pile warp-thread is drawn on a separate harness, as shown in Fig. 810. Diagram Fig. 811 illustrates the method of operation in weaving a fabric with the weave just given. 2 picks ground *B*, *C*, *E*, *F*; 1 pick for inserting wire *A*, *D*. In pick *A* the harness *f* raises warp-thread 3; in pick *D* the harness *e* raises warp-thread 6. The interlacing of the body-cloth is done with the common 4-harness basket-weave having the two warp-threads between the pile warp-threads working the same; also the pick before and the pick after the inserting of the wire.

Fig. 812 illustrates a weave for Astrakhans similar to the one above. The same arrangement for texture, 2 ends ground 1 pile, 2 picks ground 1 wire, and 4 harness common-rib (filling effect)

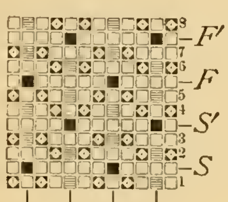


Fig. 812.

Fig. 813.

for the ground structure is used; but the latter weave is arranged to have the two ground warp-threads, situated in the fabric near each other, work opposite; thus the ground warp-threads working nearest on each side of a pile-thread raise and lower equally. In diagram Fig. 813, a section cut of the two pile-threads, as they interlace in a fabric, is shown. One pile-thread marked *A* is represented in outline (forming loops *S* and *F*), while the other pile-thread is shown in full black (forming loops *S′* and *F′*). The letters and numbers indicating the different warp-threads, picks, and openings of a shed for inserting wires, respectively correspond in weave Fig. 812 and diagram of section Fig. 813.

Weave Fig. 814 has the following arrangement of texture and principles of construction: *Warp:* 4 ends ground-warp, 1 end pile-warp, twice over in one repeat of the weave.

Filling: 4 picks for ground, 1 pick for inserting the wire, twice over in one repeat of the weave. Ground-weave: plain. Raising of pile-warp: alternate ends on alternate wires.

A and *B* are pile warp-threads, *C* and *D* the shed for inserting the wires.

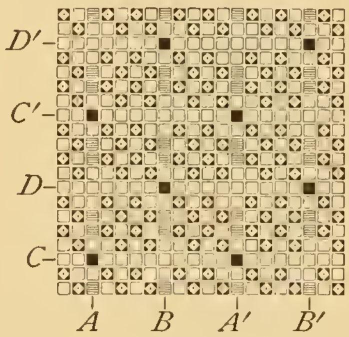


Fig. 814.

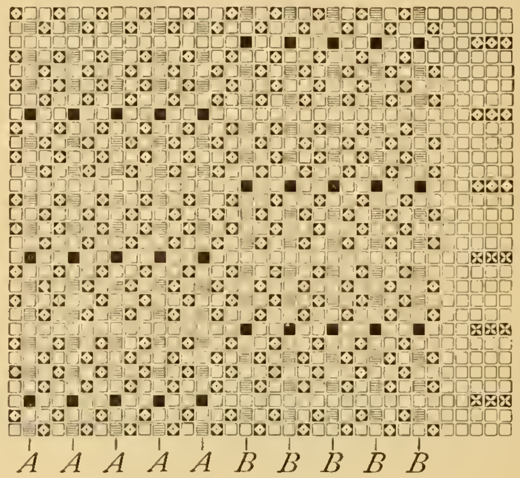


Fig. 815.

Weave Fig. 815 has the following arrangement of texture and principles of construction: 2 threads ground-warp, 1 thread pile-warp, 10 times over in repeat of weave.

Filling: 4 picks for ground, 1 pick for inserting wire ("cut"), 3 times over; 4 picks for ground, 1 pick for inserting wire ("uncut"), 3 times over; hence 30 threads warp and 30 picks in one complete repeat.

Weave for body of fabric: plain.

⊞⊞⊞ on right-hand side of weave for wires "cut."

⊡⊡⊡ on right-hand side of weave for wires "uncut."

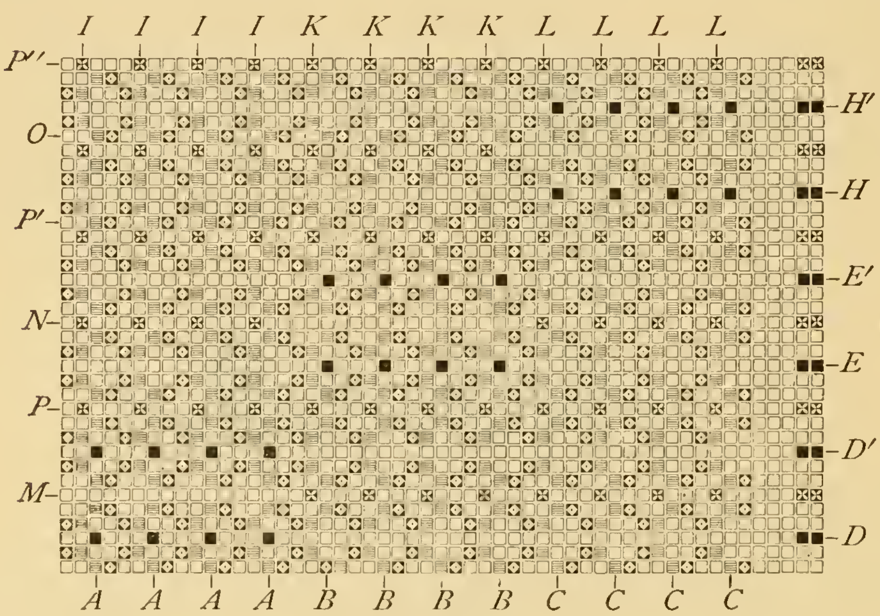


Fig. 816.

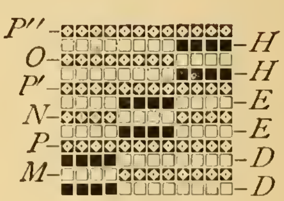


Fig. 817.

Fig. 816 illustrates another fancy weave for Astrakhans, containing the "terry" and "velvet" principles. The arrangement for the warp is: 2 ends ground, 1 end pile-warp (for terry); 1 end pile-warp (for velvet), 12 times over. The warp-threads marked on bottom of the design *A*, *B*, *C*, are for the velvet, and the warp-threads marked *I*, *K*, *L*, (indicated on top of the design), are for the terry. Picks *D*, *D′*, *E*, *E′*, *H*, *H′*, are to be the "cut" effect, and picks *M*, *P*, *N*, *P′*, *O*, *P″*, the "uncut" effect. The weave for the body of the fabric is the common 2-harness rib-weave (two picks in a shed of common plain).

In diagram Fig. 817, the motive for the pile-warp is clearly illustrated (representing the 3-harness twill $^{1}\!\!-\!\!-\!\!-_{2}$, velvet effect upon a terry ground for motive). It will be easily seen by any one that an endless variety of weaves and effects may be secured by combining *cut* with *uncut*

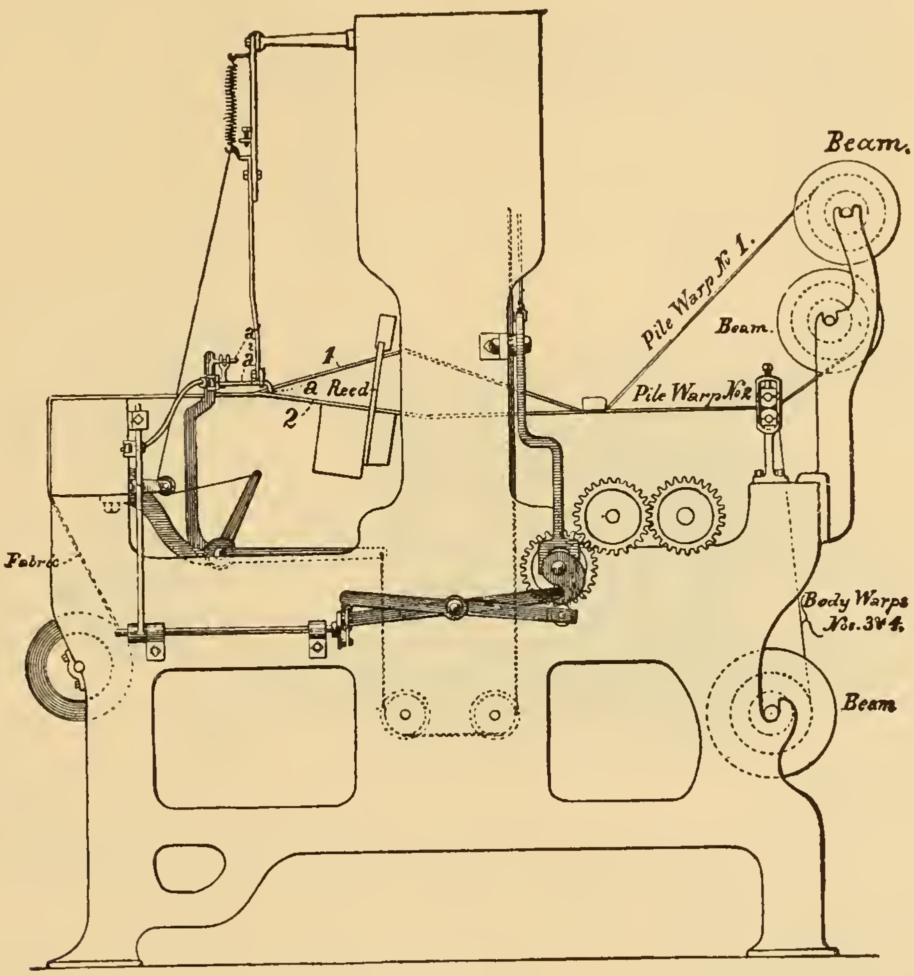


Fig. 818.

pile. And whatever designs may be required, the principles given and illustrated in the preceding examples, will always apply, as they remain unchanged.

In the method of weaving Astrakhan fabrics, as thus far explained, the raising of the pile has been effected with the use of wires, over which the loops of the pile were formed, and which were inserted and withdrawn at intervals. These wires being constructed in a single piece, the

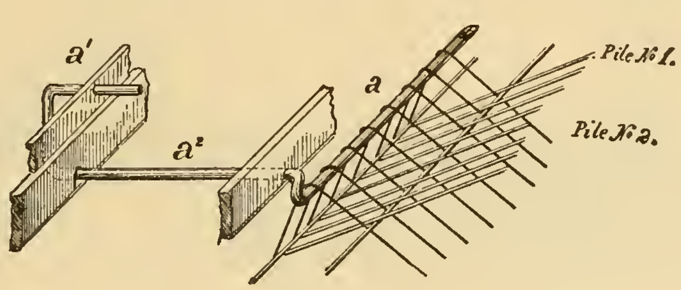


Fig. 819.

width of the fabric which can be made on them is necessarily limited, as a very long wire cannot be withdrawn and inserted with precision automatically by the loom. Also, the means for operating such wires are of a character to prevent rapid weaving; hence it requires a special loom of complicated construction.

In fabrics of a "cut" pile character and in fabrics in which the warp pile is not cut but interwoven very loosely, this process of interlacing and its loom (power or hand) must be used; while in "terry" pile Astrakhans, which have their pile warp rather solidly interlaced with the body-structure, a device has lately been invented by T. Harrison, which he claims can be applied to almost any power loom, and is not limited to the width of the fabric which it can produce, and which can be arranged so as to form the pile at any desired interval upon the surface of the body fabric. It consists of a movable frame carrying a series of short "wires" upon which the

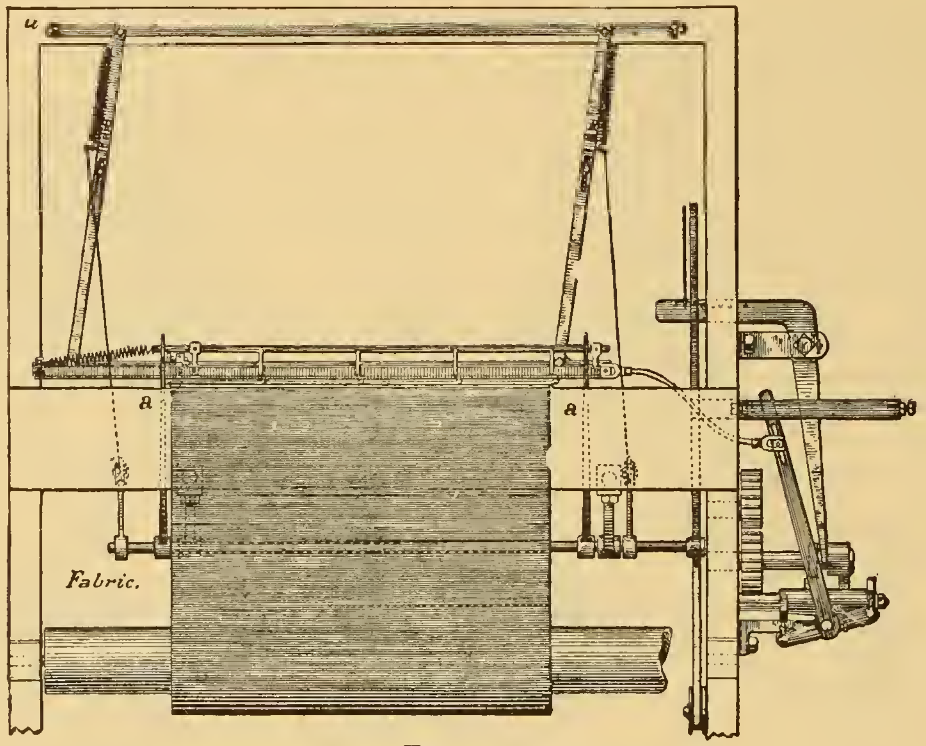


FIG. 820.

pile loops can be formed, each wire being pivoted at right angles to the plane of its longitudinal movement and provided with means for depressing its free end at proper intervals, so as to engage beneath the warps which are to form the pile.

In Fig. 818 an exterior side-view of a loom embodying the arrangement is given. In this, as well as in the following drawings, referring to the present subject, those parts are omitted

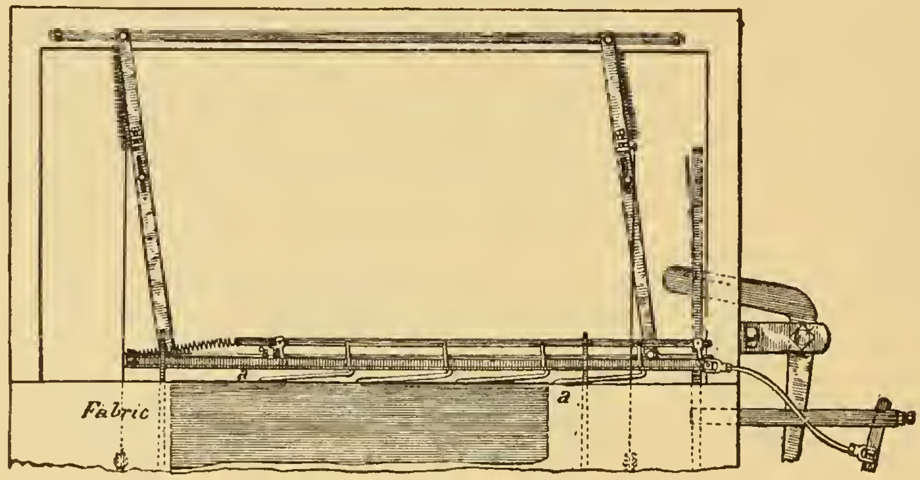


FIG. 821.

which are well understood in their action and whose insertion in the drawings would only tend to confuse the mind, and render a comprehension of the special parts to which the present arrangement relates, less clear.

Fig. 819 is a view in detail of a portion of the sectional wire which forms the basis of the arrangement, showing various parts connected with the portion of the sectional wire, as also a number of warp and filling-threads.

Fig. 820 is a front elevation of the loom with its attachment for raising the pile-warp. In this drawing the working parts are shown in one extreme position, while in Fig. 821 (corresponding to Fig. 820) they are shown in the other extreme.

In diagrams I to X in Fig. 822 are represented the positions which the threads assume at each stage of the formation of the fabric.

Two pile-warps may be used, which are indicated respectively by 1 and 2. The body-warps 3 and 4 of the fabric are brought from a separate beam. To form a row of loops with the pile-warp 1, the operation commences, as shown in Diagram I of Fig. 822—that is to say, the points of the wires *a* are all depressed, and the frame is at the extreme right-hand position shown in

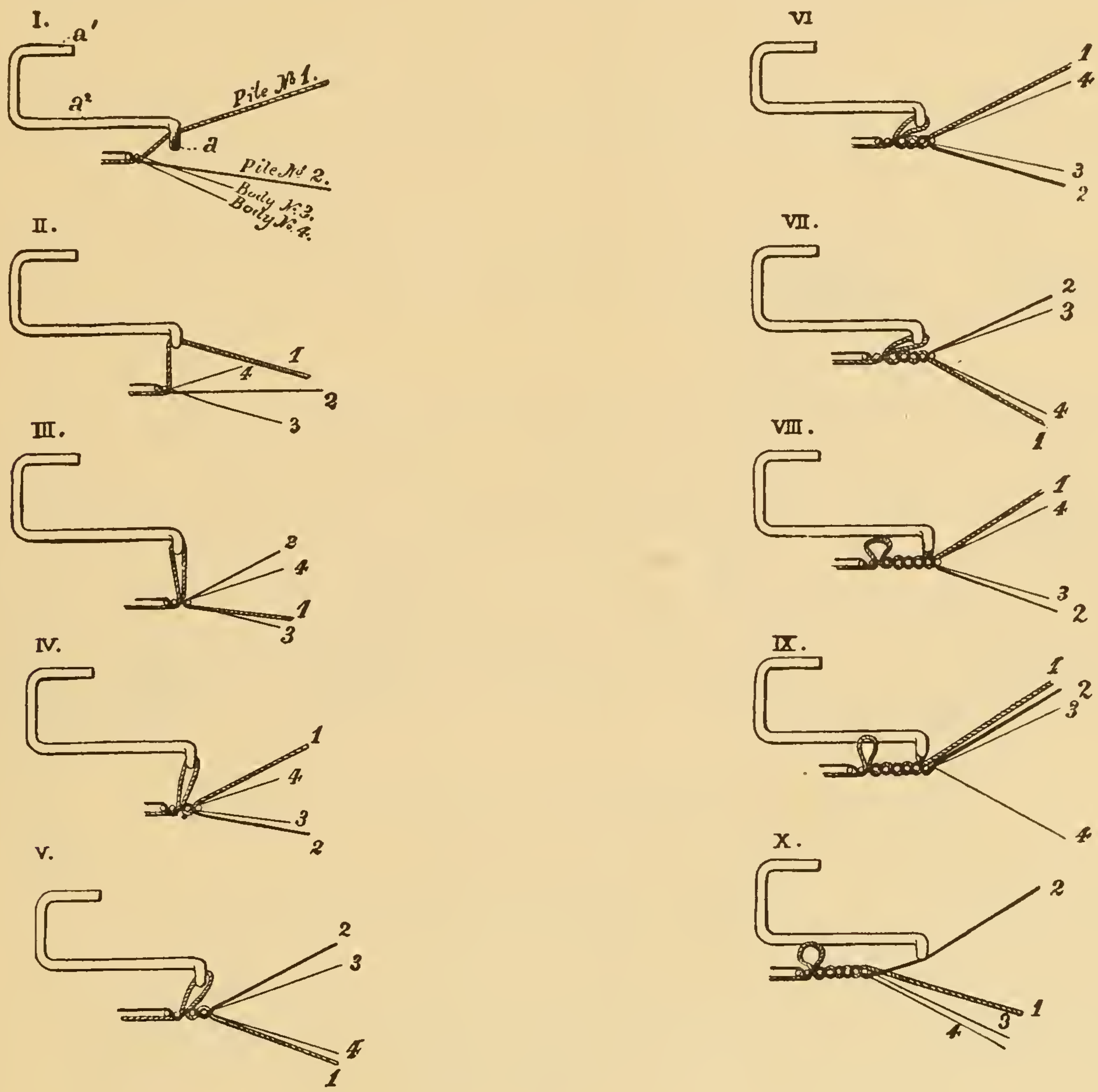


Fig. 822.

Fig. 821. Each wire *a* thereupon enters beneath a number of warp-threads and raises them slightly above the plane of the fabric. A shuttle is then shot through, after which the body-warp 4 rises and the pile-warp 1 descends, as shown in Diagram II of Fig. 822. The pile-warp 2 rises and a pick of the shuttle follows, and the action of the reed throws the filling-thread toward the wire *a*, so as to close the row of pile-loops thereon, as indicated in Diagram III of Fig. 822. The weaving then continues, as indicated from IV to VII inclusive, in Fig. 822, by means of both pile-warps and both body-warps, the shuttle operating in the ordinary manner. During all this period the taking up of the cloth has drawn over the bottom of the pile-loop somewhat to the left in the diagrams, and as soon as a sufficient number of picks have been made to securely lock the pile-loops the frame and the wires *a* are thrown to the right of Fig.

820, or toward the observer from the point of view in the diagrams. This disengages the wires from the loops which they have heretofore supported, and leaves them as shown in diagram VIII in Fig. 822. So long as the wires have been surrounded by the loops and have rested upon the body of the fabric they have been maintained in a horizontal position; but upon their being withdrawn from the loops and upon the rise of the frame bodily, this support ceases and the ends of the wires *a* dip downward by the tension of the spring. This position immediately follows upon their withdrawal, and occurs when the frame is at the extreme right-hand position (shown in Fig. 821), or, in other words, is ready to engage with a fresh set of pile-warps.

Returning now to the Diagram IX, Fig. 820, it will be seen that both the pile-warps are up; but in the Diagram X, Fig. 820, the pile-warp 1 (which has just formed the first series of loops) is down, and with it the body-warps 3 and 4 have descended, leaving only the pile-warp 2 up and ready to be engaged by the wires *a*, whereupon a repetition of the ten positions indicated will occur with the pile-warp 2, and so on throughout the weaving operation, the rows of pile-loops alternating from the warps 1 and 2.

In the method illustrated in the diagrams six picks of filling are represented between the rows of pile-loops; but this number can be varied by varying the frequency of movements of the frame and wires relatively to the picks of the shuttle, and in many cases a much less number of picks will be found sufficient to lock the pile-loops, so as to prevent them from pulling out.

The invention claims further that the frame and its sectional wires can be applied to almost any well-known form of loom without interfering with the general arrangement thereof, and by merely increasing the number of wires *a* the fabric may be produced of as great width as the loom is capable of weaving. In the drawings the number of wires has been arbitrarily reduced and their individual proportions exaggerated, in order to more clearly show their construction; but in practice for making Astrakhans good results are obtained with wires one-eighth of an inch gauge, each about four inches long. Wires of any gauge may, however, be used, according to the fineness of pile which it is desired to produce, the only limit being in the stiffness of the wire, which of course may be relatively increased by diminishing the length of the individual sections.

Machines for Curling Warp-threads for Astrakhans.

In the manufacture of "Astrakhans" (and similar fabrics) it is necessary to impart a permanent curl or twist to the warp-threads which are to form the face of the fabric. The yarn is crimped, the length of the crimp being regulated by the amount of waviness it is desired to give. The crimping is set in the yarn by a steaming process; the yarn is then made into a warp and woven over wires and cut, or the wires are withdrawn without cutting, as explained in the preceding articles on weaving these fabrics. The moment the wire is withdrawn (cut or uncut, as required,) it falls into crimps again, and thus is produced that wavy shagginess which characterizes the surface of these fabrics.

Until lately, the method of producing these wavy yarns was a very slow one, the operation having been performed by hand. At present, however, they are produced quickly and entirely automatically by one operation of the machine.

Figs. 823, 824 and 825 illustrate a machine for performing this work.

The main part of the machine is a solid metal spindle, on which the thread is wound from a bobbin having a rotary motion around the spindle. As soon as the thread begins to wind on the spindle it is forced between two rolls, which are pressing against the direction of the winding of the thread on the spindle, and through their rotation draw the thread from the spindle.

These rolls are heated by a gas jet and transfer their heat to the thread. Through the pressure and the heat the required curling of the thread is fixed.

Fig. 823 represents a side view of the machine. Fig. 824 represents the top view. Fig. 825 represents the mechanism for curling the thread (enlarged from Figs. 823 and 824).

In Figs. 826, 827, 828, 829 and 830, we illustrate another machine (patented by T. Harrison) for preparing these pile warp-threads for Astrakhans or similar fabrics. Fig. 826 represents the front elevation of the machine. Fig. 827 a vertical central section through the coiling device. Fig. 828 illustrates a side elevation of the uncoiling device. Fig. 829 represents the top view of the latter, and Fig. 830 a view of the stop, by means of which a positive motion is imparted to the coiling mechanism.

We will next give a description of the different parts of this machine as mentioned in the invention.

B represents the frame of the machine, consisting of two parallel housings, with an inclined upper portion marked B^1.

A^3 is the driving shaft, to which the power is imparted by a belt upon the pulley A^1. Upon the driving shaft is mounted a drum, extending entirely across the interior of the machine, and

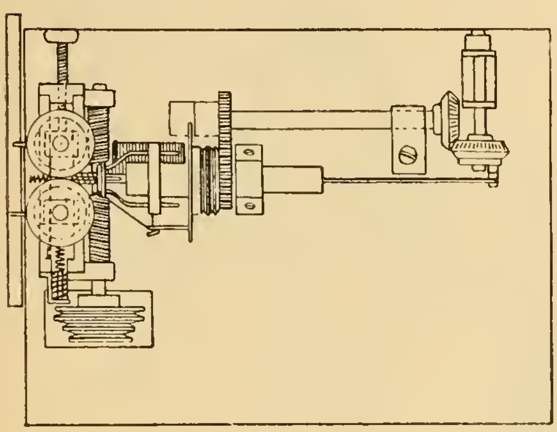


Fig. 824.

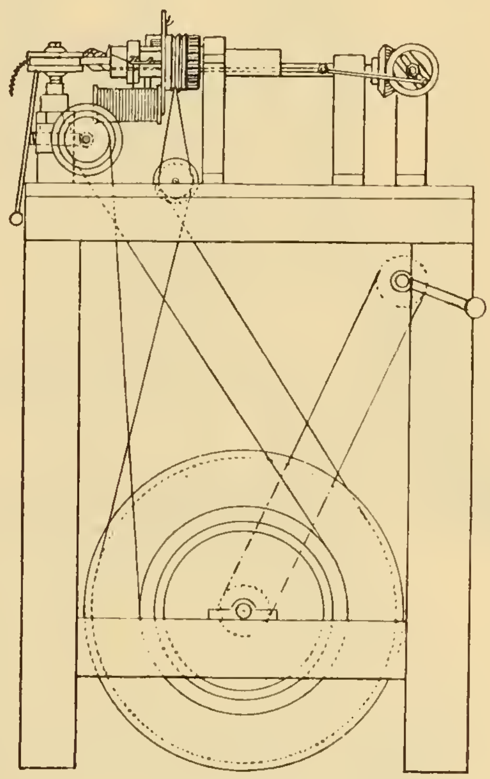


Fig. 823.

which is provided at intervals with grooves to receive a series of small driving cords or belts, which, after being brought into a horizontal plane by passing the inclined part of the belt over idlers, pass around a series of horizontal "whirls," which are journaled upon vertical rings *H* secured in a series of openings formed in the transverse platform L^2. These whirls are formed with a circumferential flange on their upper side, thus providing seats for the "fliers" *G* and *F*. The three fliers marked *G* are coiling devices, the three marked *F* being the uncoiling devices. The coiling fliers each consist of the two uprights, mounted at the bottom upon a ring which fits snugly within the flange of the wheel. At the top the two uprights are connected with a central sleeve which revolves upon a vertical tubular stem, which passes downward through the axis of rotation of the flier and for some distance below, where it is secured in the transverse piece E^1, extending across from side to side of the machine at the front thereof. The spool upon which the warp that is to be coiled is wound in the first instance, fits snugly, but so as to revolve freely upon the outside of the before mentioned stem and rests upon a standard, through whose centre the said stem passes freely.

The last mentioned standard passes freely through the ring H and is supported upon a fixed platform K. The coiling flier is provided with eyes $l\ l^1\ L$, the latter of which is situated at the top of the sleeve G^4, and is at right angles to the axis of rotation. At the bottom of the coiling fliers are stop-pins K^2 (see Fig. 830) projecting into slots in the flange of the whirls. These stops make the rotation of the coiling-fliers positive.

As before stated, there are in the machine shown in the drawing, Fig. 826, six of the horizontal whirls, three of which drive the coiling-fliers, the other three driving the uncoiling-fliers. These latter resemble the coiling-fliers in shape, having uprights connected by bottom rings, which rest loosely within the flanges of the whirls, but which (unlike the coiling-fliers) are not positively connected therewith, the weight of the flier alone being the means by which it receives

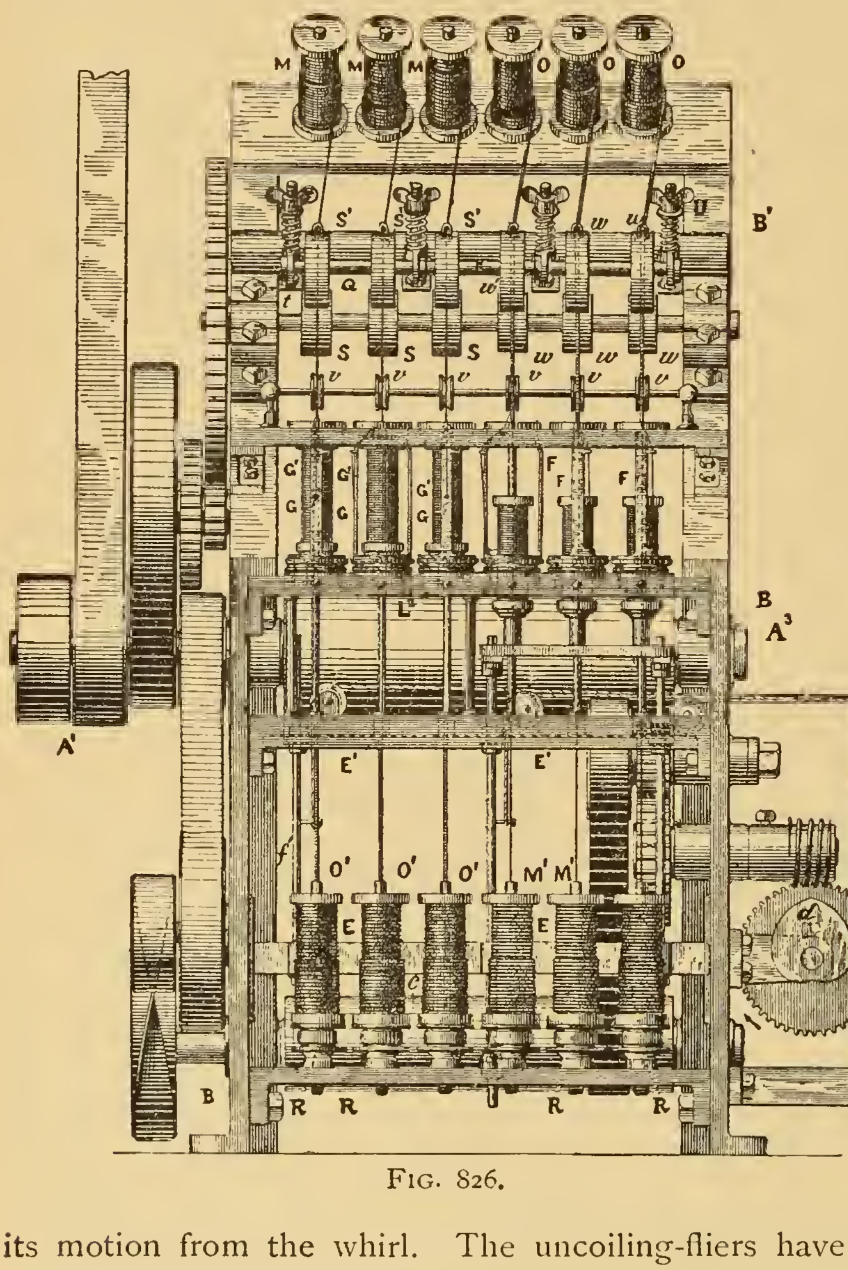


Fig. 826.

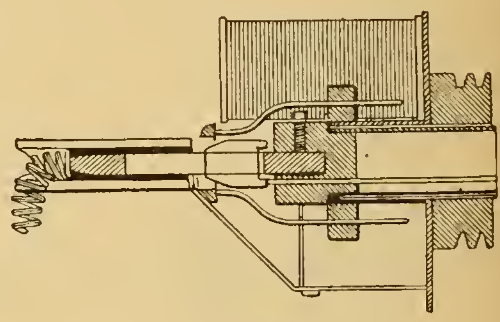


Fig. 825.

its motion from the whirl. The uncoiling-fliers have eyes $i\ i^1$ at top and bottom, respectively, the latter being the eye which delivers the thread to the spool or body. They have also at the top a brake mechanism.

A tubular stem extends down through the axis of rotation of each of the uncoiling-fliers, and is held in the cross-bar E'. These stems receive bearings at the top of the uncoiling-fliers. The spools or bobbins of the uncoiling-fliers fit snugly around the stems and are supported upon standards which also surround said stems, but which are mounted upon a vertically-movable cross-piece arranged to be reciprocated in a vertical direction. The spools or bobbins of the uncoiling-fliers are thus adapted to receive a rising and falling movement within the flier during the rotation of the latter, and in this respect differ from the spools of the coiling-fliers, which are stationary so far as vertical movement is concerned. The upper ends of the fliers extend into openings in the shelf or platform, provided with rings, and are thus shielded during rotation. The latter shelf is hinged at the rear, so as to be thrown back when the fliers are to be removed.

The brake mechanism of the uncoiling fliers is constructed as follows: Upon the top of each sleeve there is pivoted upon one side a lever, through the centre of which there is a vertical hole coinciding with the opening of the stem. This lever has at its rear end a cam-surface, which, when the lever is in a horizontal position, rests without substantial pressure against the stem. At the front end of the lever is an eye through which the thread, which is being uncoiled, passes,

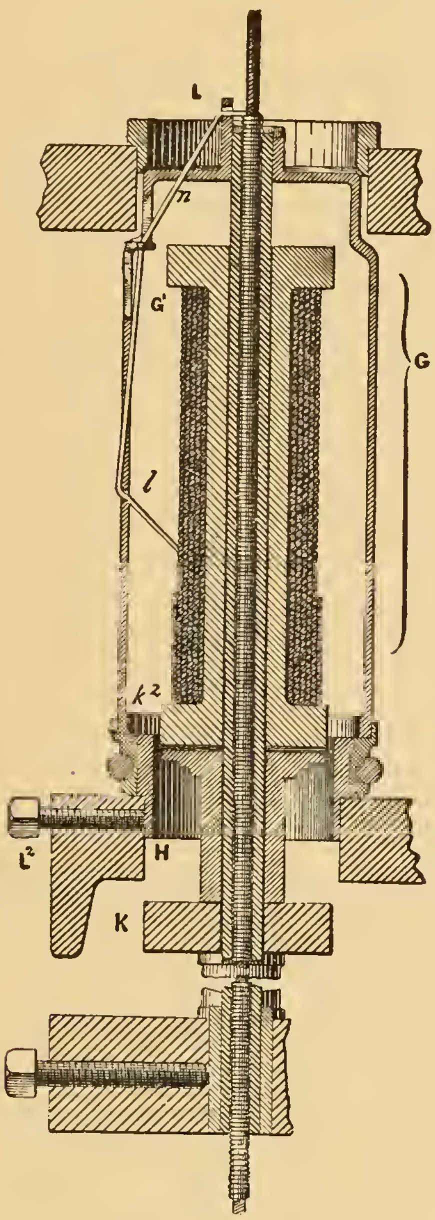


FIG. 827.

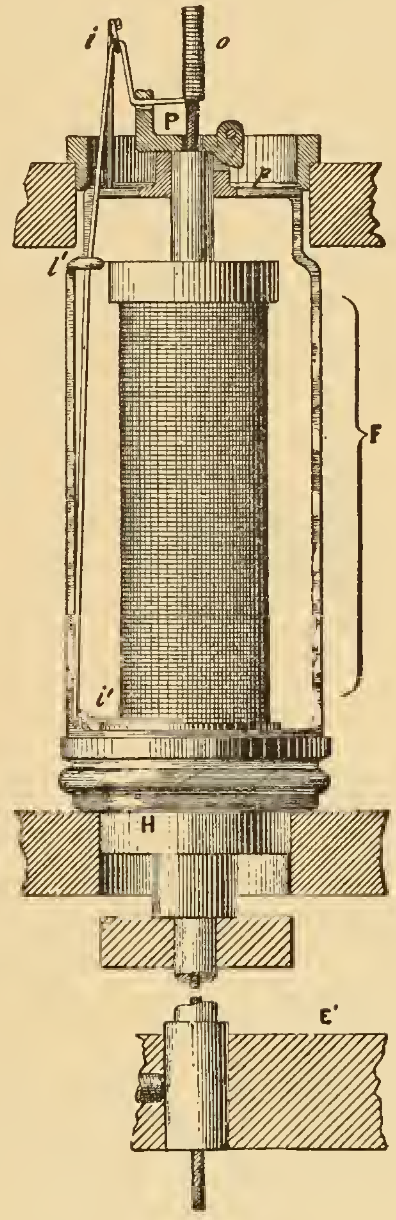


FIG. 828.

and thence rises to the eye *i*, mounted upon the top of the flier. So long as the portion of the thread between the eye and the axis of rotation of the fliers is substantially horizontal the lever will remain in a horizontal position; but if that portion of the thread rises to an angle with the horizontal, then the strain upon the eye will raise the front end of the lever and bring the cam *p* gradually around, so as to press upon the top of the stem. The cam-surface being eccentric, as it turns in the direction of its longest axis, it will raise the flier *F* bodily by bearing upon the top of the stem, and in so raising it will lift the flier clear of the whirl, so that motion will be no longer imparted to the flier. If desired, the lift may be such as to bring the upper part of the flier into frictional contact with the under side of the ring.

At the top of the machine is mounted upon suitable pins the spools or bobbins *M*, which contain the cord which is to form the core for winding the Astrakhan warp upon. These bobbins, like the coiling-fliers, are three in number, and the cord from them passes through feeding mechanism, down over pulleys mounted upon a horizontal shaft, and through the central stem of the coiling-fliers.

A belt conveys motion from the driving-shaft A^3 to a pulley, and thence by gears and pinions a very slow rotary motion is imparted to the shaft, which extends entirely across the top of the machine, near the bottom of the incline. Upon this shaft are mounted friction-rollers *S*, three in number, over which the cord passes on its way from the spools *M*. Upon the cross-piece *v* are mounted overhanging arms which support the shaft *Q*, on which are mounted friction-rollers bearing down upon the rollers *S*. The shaft *Q* is provided with a spring pressure device, consisting of a vertical stem having a sliding collar with a hook-shaped projection, which engages with the shaft, and a spring whose tension is adjustable by means of a thumb-nut. By means of this tension device the rollers *s'* can be caused to bear upon the rollers *S* with any desired degree of pressure. Therefore, although the take-up devices at the bottom pull the cord with some strain, it is fed to them by the positive motion of the rollers *S*, and cannot be drawn more rapidly than the rotation of the latter will permit. A similar set of feeding-rollers, *w w'*, the latter mounted in similar spring-bearings, are arranged to deliver the cords from the bobbins *O* to the three uncoiling-fliers upon the other side of the machine; but the diameter of the positive feed-

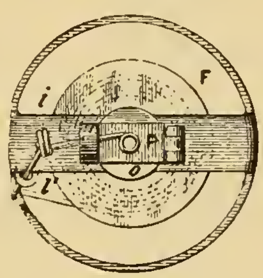


Fig. 829.

Fig. 830.

ing-rollers *w* is less than that of the feeding-rollers *S*, and with the effect of feeding more slowly to the uncoiling-fliers than to the coiling-fliers.

The take-up bobbins *O' M'* for the cords, which pass from the coiling-fliers and uncoiling-fliers respectively, are mounted upon horizontal rotating seats *R*, placed at the bottom of the machine and driven by the twist-belts passing around pulleys secured to the seats. The twist-belts are so arranged that they can slip upon their respective pulleys, in case the feed from above requires such slipping.

In order to wind the cords upon the respective bobbins *O' M'* evenly, a traveling guide-bar, *E*, is provided, which receives a slow vertical reciprocating motion. This traveling bar carries vertical rods, which rise and fall with it, these rods being guided by suitable openings in the cross-bar *E*. The rod *f'* serves merely as a guide-rod, but the other two rods *f*, carry at their tops a cross-piece, which supports the standards of the bobbins *F*. Thus if a vertical reciprocation is imparted to the traveling bar *E* its motion will cause the bobbin to rise and fall in the same manner.

The traveling bar *E* is provided with openings or eyes opposite to the bobbins *O' M'*, which openings guide the thread during the rise and fall of the bar, so as to distribute it equally upon the bobbins.

The operation of the machine in coiling and uncoiling the yarn is as follows:

Upon the three bobbins *M*, at the top of the machine (see Fig. 826), are coiled cords which are to form the cores for winding the Astrakhan warp upon. These cores are carried down between the feeding rollers *S S'*, over three of the rollers *v*, and on down through the axes of the three coiling-fliers; the passage being of course through the tubular shafts. They then are brought down and passed through the three left-hand eyes of the traveling guide-bar *E*, and are secured to the three bobbins *O′*. The Astrakhan warps which are to be coiled are wound in the first instance on the bobbins *G′*, and placed in position within the three coiling-fliers. The ends of the Astrakhan thread, having been brought through the eyes *l l′ L*, are tied fast to the three cores at a point just above the fliers *G*. Assuming now that the proper feeding and take-up movements occur at top and bottom of the machine, respectively, and that the fliers *G* are rapidly rotated, it will be seen that the Astrakhan thread is drawn off from its bobbin and coiled tightly around the core. As the coiling progresses the feeding and take-up movements cause the composite cords to pass down through the tubular shafts, and thence to the bobbins *O′*. The traveling guide-bar *E* causes the composite cords to be evenly wound upon the bobbins *O′*.

When a sufficient quantity has thus been formed, the composite cord—that is to say, the core with the Astrakhan warp wound tightly around it—is removed, steamed, or otherwise treated to render its twist permanent, and is then ready for uncoiling. A portion of the core *m* at the end of the composite cord is left uncovered for a clearer illustration.

The uncoiling operation is as follows: The uncovered end portion of the composite cord (now upon the three bobbins *O* at the top of the machine) is brought down through its feeding-rollers *w w′* over the three right-hand rollers *v*, and thence down through the tubular shafts, through the three right-hand end eyes of the guide-bar *E*, and secured to the three bobbins *M′*. The uncovered portion having been fed down until the commencement of the covered portion or composite cord reaches the top of the uncoiling-fliers. Then carry a loose end of the Astrakhan warp through the eyes of the lever *P* up to the eye *i*, and then down to the eye *i* at the bottom of the uncoiling-flier, when it is taken across to the bobbin and there fastened. The feeding movement at the top and the take-up movement at the bottom being continued and the uncoiling-fliers being rapidly rotated in the proper direction, they will uncoil the warp from the composite cords and wind up the now twisted warp upon the bobbins. These bobbins have the proper rising and falling motion to distribute the warp evenly upon them. The uncoiling movement is necessarily a trifle slower than the coiling movement, hence the composite cords do not require to be fed so fast as do the cores upon the other side of the machine. This difference of speed is produced by smaller diameters of the feeding rollers *w* as compared with the feeding rollers *S*. The uncoiling operation continues and the cores *m* are wound up in a proper manner upon the bobbins at the bottom of the machine so that they can be again transferred to the positions indicated by *M* and the operation repeated. If the uncoiling tends to progress too rapidly, it is checked by the brake mechanism upon the uncoiling-fliers, which are operated by the portion *n′* of the warp assuming an inclined position, instead of substantially a horizontal one, between the eye and the core from which it is unwound. If the uncoiling takes place too rapidly, relatively to the downward feed of the core, the point of the uncoiling will rise higher and higher upon said cord, and will thus produce that inclination of the warp necessary to operate the brake mechanism. The uncoiling of the warp is thus automatically regulated by this brake mechanism and cannot progress with such rapidity as to tangle the warp or to break it.

TAPESTRY CARPET.

Tapestry-carpet is a warp pile fabric in which the loop formed by the face warp-threads is not cut. The demand for its production is found in the need of a cheaper and more economical imitation of what is known as Brussels carpet. In its general appearance it resembles the latter to a great extent, but in its method of construction differs wholly from it, as may be seen by any one that examines the two methods. In tapestry carpets three different systems of warp-threads are used: *A*, the ground-warp; *B*, the pile-warp or face-warp; *C*, the stoffer or thickening-warp.

The general arrangement for the warp is:

1 end ground or binder-warp,

1 end double or three-ply thread, of stout linen for strengthening or thickening the body of the carpet, resting in the fabric below the pile-warp and actually forming the main part of the back of the structure.

1 end double thread of worsted for face-warp forming the pile, by being interlaced into every third opening of the shed over a wire, as required for the face of these fabrics.

1 end ground or binder-warp.

—

4 ends in repeat of arrangement of warp (= one set); to be reeded into one dent.

The pile or face-warp, before being wound upon the warp-beam, has the pattern printed on it by wrapping the threads around a large cylinder, and coloring them according to the design.

The length of a certain color for each pile-thread, required for each individual loop when woven, is regulated by the size of the needles used.

Fig. 831 illustrates the example of a pile-warp printed as required before weaving. The same illustrates four different colors: black, white, heavy-shaded and light-shaded.

Fig. 832 illustrates the same pile-warp as it appears when interlaced into the fabric; each effect in the warp being reduced to its required size or proportion to the corresponding effect in the design.

Fig. 833 illustrates the sectional cut of the fabric.

A and *A′* represent the ground-warp; *B*, the thickening-warp; *C*, the pile-warp; *W*, the wire requiring every third opening of the shed. Picks 1 and 2, requiring the first two openings of the shed in the repeat of three, are the means for interlacing the ground-cloth as well as fastening the pile to this ground structure.

Fig. 834 illustrates the complete draft, or weave for producing a tapestry carpet. Each warp-thread and pick is marked in accordance with previously given explanations.

Different Qualities of Tapestry Carpets.

The fineness as well as the value of these carpets is regulated by the quality of the material used as also by the height of the pile and number of pile-pick (technically known as number of wires) per inch. Seven to eight wires per inch are about the usual number in the arrangement.

Method for Ascertaining Size of Designing Paper Wanted.

The designs for tapestry carpets are generally painted on the squared designing paper in about a size equal to the design upon the face of the fabric when woven. Thus the number of small squares to one inch in a horizontal as well as a vertical direction on the designing paper is regulated by the number of loops in the woven fabric, both in the direction of the warp and the filling.

In some cases the number of loops is equal in both directions, while in others it differs to some extent. Designing papers known as 8 x 8 to 1 inch and 8 x 7 to 1 inch are those most frequently used. Tapestry carpets are generally produced 27 inches wide; therefore the design will have to be of equal width. That arrangement for the design may be selected known as the "half-over pattern," or one that has one complete repeat in one width; or a design may be produced which repeats twice (or oftener if small figures are wanted) in one repeat of 27 inches in the fabric.

Lately a method of producing effects in tapestry carpets, classified as "sheeny" or "variegated," has been patented in this country, England and France, but is nothing more than a method of arranging the design of the carpet so as to make use of more or less solid colored pile-warp yarn, hence requires no printing for this amount of warp. In Fig. 835 such an effect is illustrated; *a* represents the solid colored threads, *b* represents the printed threads. Each

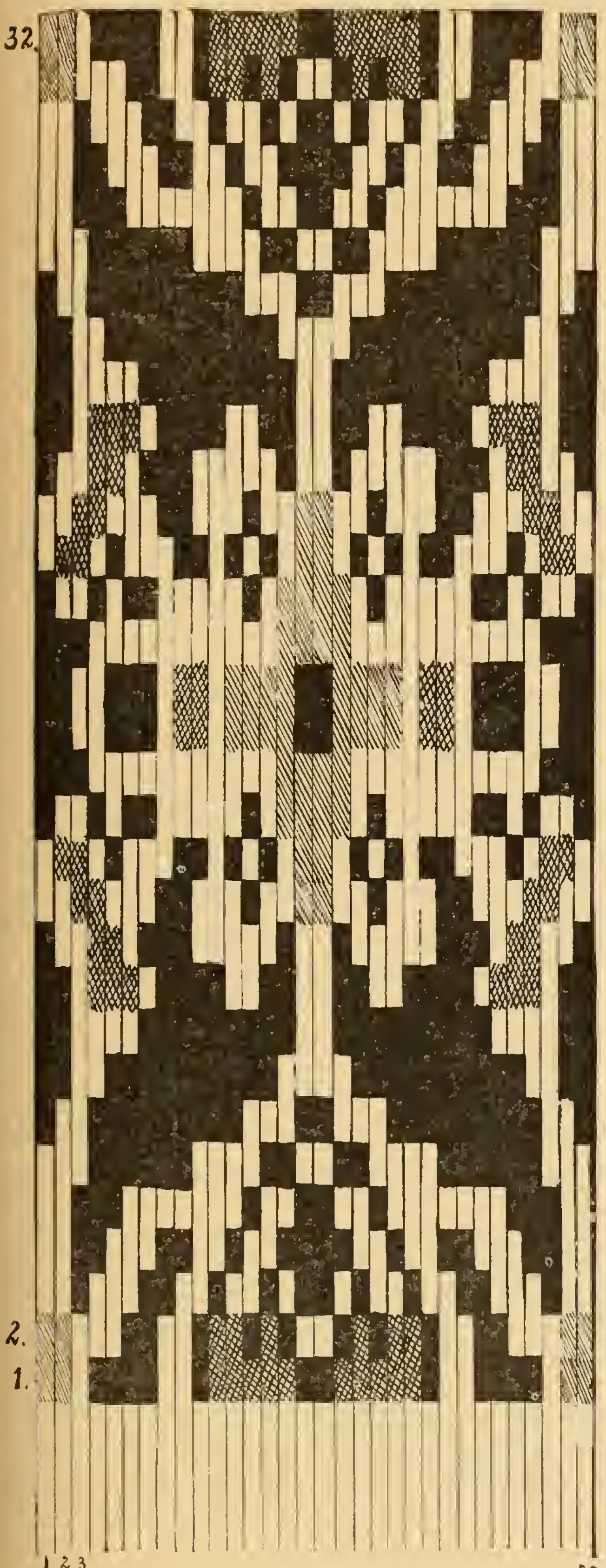


FIG. 831.

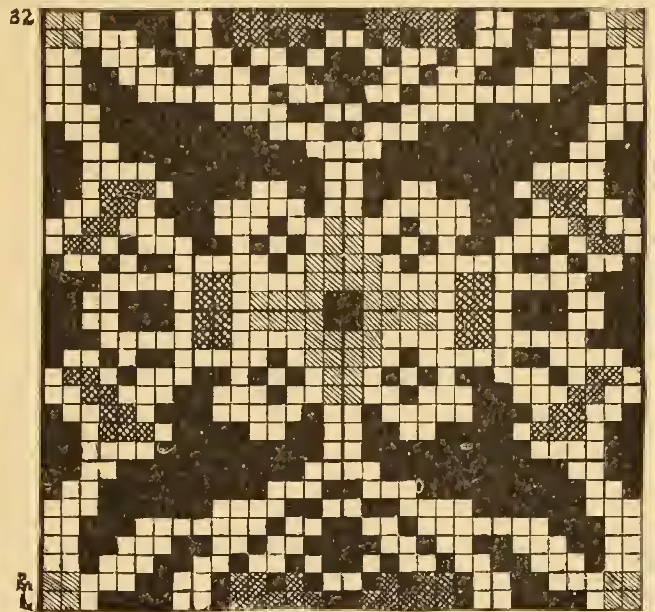


FIG. 832.

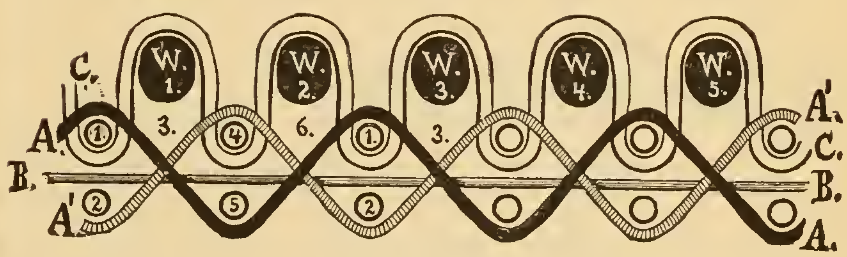


FIG. 833.

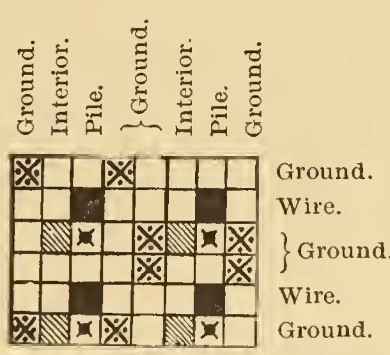


FIG. 834.

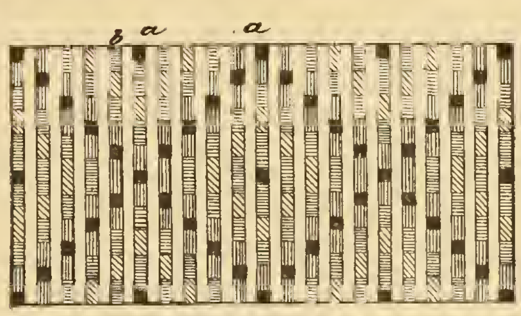


FIG. 835.

kind of pile-warp is operated from a separate beam; so it will be seen that a general range of effects can be produced by simply varying the solid colored threads in each style, leaving the printed warp entirely undisturbed.

BRUSSELS CARPET.

Brussels carpet is a warp-pile fabric in which figures are produced by raising over the wire different solid colored warp-threads at certain places according to the design. Brussels carpets are of a far superior character, as respects color, quality of material used and the structure, than the tapestry carpets which have been just explained.

In Brussels carpets the colors used are generally "fast," as the yarn is hank-dyed and not colored in the warp as is done with the tapestry carpets.

Brussels carpets are technically classified by "frames," or in other words by the number of different colors called for in a vertical row of squares on the designing paper, as also one row of loops in the direction of the warp in the fabric.

In tapestry carpets one double thread of worsted, printed according to the design, is used for one row of loops (warp-ways) while in Brussels carpets a similar double thread is used for each color as required by one row of squares warp ways in the design. One color only is raised at the time, while the threads then not called for rest in the body and partly on the back of the fabric; therefore the thickness and substance of the fabric is not due to cotton or jute thickening threads, as in the body of the tapestry, but the same pure wool-thread which forms the face will at every place not called for by its color in the design, form part of the "body."

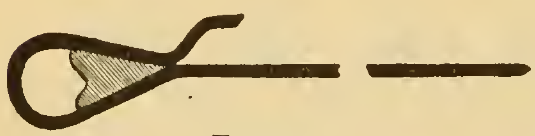


Fig. 836.

The ground-warp in Brussels carpets is interlaced with the filling on the common four-harness basket-weave () arranged so as to have each two successive picks insert in the same opening of the shed (of the ground-warp) and only separated by the pile warps. One pick passes above, and its mate pick below the pile warp-threads holding the latter firmly secured between; thus, if the raising of the pile warp over its wire for forming the characteristic loop should be omitted, we would produce nothing more than a fabric interlaced on the common four-harness basket-weave having a stout packing or thickening thread in the centre.

As mentioned before, Brussels carpets are graded by "*frames*." There are three-frame, four-frame, five-frame and six frame Brussels carpets.

Under "frame" we classify the number of different colors found in the different rows of squares in a vertical direction on the designing paper; thus a three-frame Brussels carpet has three different colors in one row of loops (warp-ways) in the fabric. Any of these three colors can at any other row of loops (warp-ways) be exchanged to a different color without changing the principle of a "three-frame" carpet.

A "four-frame" Brussels carpet will extend the number of colors for each row of loops to four colors. Thus, a "five-frame" Brussels carpet will show five different colors in one row of loops warp-ways. A "six-frame" Brussels carpet will extend these number of changes to six colors.

Having an individual warp-thread for each color in the formation of the loops will also speak greatly in favor of the Brussels as compared to the tapestry carpets. By means of these separate threads the design will be more clearly defined and its various parts more pronounced, while in tapestry carpets the figure is always more or less indistinct, which arises from the method of operation by which the pattern is produced.

In Brussels carpets the different colors used are variously distributed, one color being used to a greater extent than the other, etc. This method of using every pile warp-thread at will and in a different amount than another, requires us to use instead of ordinary warp yarn beams, bobbins or miniature beams fixed in frames, or a huge creel, stationed behind the loom. The manner in which the different colors are controlled, in other words, in which they are concealed from or brought into view upon the face of the fabric is of great importance in the manufacture of this article.

Method of Structure of the Brussels Carpet.

The pile (loop) is formed the same as in common (uncut) velvet fabrics by the insertion of wires (see Fig. 836) under the pile-threads; but the method of selection is different. In producing a common velvet fabric we raise either the entire warp or one-half, etc., over each wire, while in Brussels carpet we select for each individual loop from a series of duplicate threads (set-frame) each of which has a different color. Another difference between a common velvet fabric and a Brussels carpet is found in the manner of operating the pile-warp during the insertion of ground-picks. In common pile fabrics, as explained in preceding articles, the pile-warps interlace up and down in the body of the fabric, while in Brussels carpet the face or pile-warp rests during the time it is not used for forming loops in a straight line in the body of the fabric.

Three-frame Brussels Carpet.

Fig. 837 illustrates part of a design technically known as a "three-frame" Brussels carpet. In the same the different colors for 8 loops, warp and filling-ways (which equals in the present

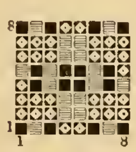


FIG. 837.

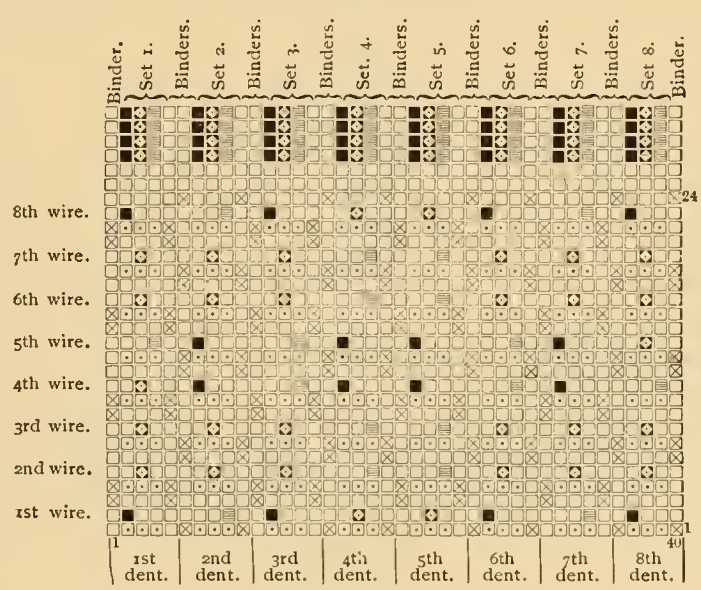


FIG. 838.

example 8 by 8 = 64 loops) are indicated for each color by a separate kind of type. In the same line of the design (looking at the design lengthways), apparently in the same thread, three colors form the pile in succession, which is practically produced by employing three distinct threads, each of which is so controlled that it only appears in the pile when required to produce the design.

In Fig. 838 the ground plan of the method of interlacing is shown. On the top of the plan the arrangement of the warp is indicated.

1 end binder-warp.

3 ends face or pile-warp, each representing a two-fold end of worsted and each of these 3 so indicated pile-threads to be of a different color than the other.

1 end binder-warp.

---

5 ends in the repeat of arrangement for the warp. Thus 5×8 = 40 threads of warp in ground plan, representing the construction of a 3-frame Brussels carpet, similar to the one shown in design Fig. 837.

In plan Fig. 838 every shed for inserting the wire is represented on the left side of the design; and on comparing with the part of the design of the face, Fig. 837, it represents the threads as indicated in the latter raised from each set.

Pick 1 in the design calls for 1 ■, 1 ▤, 1 ■, 2 □, 1 ■, 1 ▤, 1 ■. Examining wire 1 in the plan we find the selecting of the different colors from each set arranged accordingly.

Thus we select—

From the first set ■.
" second " ▤.
" third " ■.
" fourth " □.
" fifth " □.
" sixth " ■.
" seventh " ▤.
" eighth " ■, etc.

Pick 2 in the design calls for 3 □, 2 ▤, 3 □, and the colors of the face-warp for raising over wire number 2 in the plan are selected accordingly.

From the first set of 3 pile warp-threads we call for □.
" second " " " " " □.
" third " " " " " □.
" fourth " " " " " ▤.
" fifth " " " " " ▤.
" sixth " " " " " □.
" seventh " " " " " □.
" eighth " " " " " □.

Pick 3 is a repetition of pick number 2.

Pick 4 in the design calls for 1 □, 1 ■, 1 ▤, 2 ■, 1 ▤, 1 ■, 1 ▤, and the colors of the pile-warp raising over wire number 4 in the plan are selected to correspond.

From the first set of 3 pile warp-threads we call for □.
" second " " " " " ■.
" third " " " " " ▤.
" fourth " " " " " ■.
" fifth " " " " " ■.
" sixth " " " " " ▤.
" seventh " " " " " ■.
" eighth " " " " " ▤.

Pick 5 in the design calls for 1 ▤, 1 ■, 1 ▤, 2 ■, 1 ▤, 1 ■, 1 □, and the colors of the pile-warp raising over wire number 5 are selected to correspond.

From the first set of 3 pile warp-threads we call for ▤.
" second " " " " " ■.
" third " " " " " ▤.
" fourth " " " " " ■.
" fifth " " " " " ■.
" sixth " " " " " ▤.
" seventh " " " " " ■.
" eighth " " " " " □.

Picks 6 and 7 are duplicates of picks numbers 2 and 3.

Pick 8 in the design calls for 1 ■, 1 ▤, 1 ■, 2 □, 1 ■, 1 ▤, 1 ■, and the pile warp-threads raising over wire number 8, as shown in the plan, are selected to correspond in colors.

From the first set of 3 pile warp-threads we call for ■.
" second " " " " " ▤.
" third " " " " " ■.
" fourth " " " " " □.
" fifth " " " " " □.
" sixth " " " " " ■.
" seventh " " " " " ▤.
" eighth " " " " " ■.

Any pick that will be called for in any complete design always has its method of interlacing arranged similar to the principle explained in the specimen 8 picks of part of a design given for example.

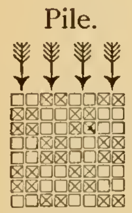


FIG. 839.

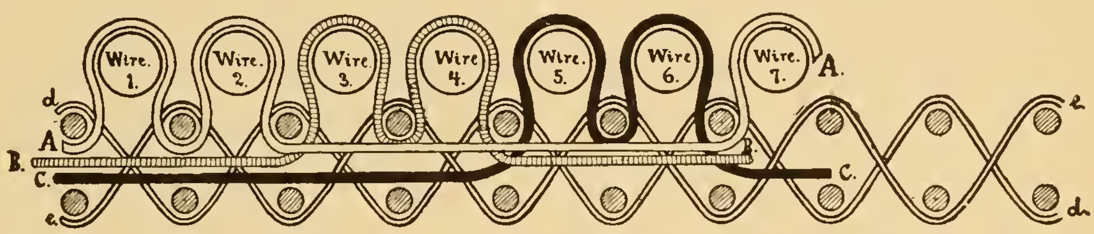


FIG. 840.

The two binder warp-threads working between each set of threads in Brussels carpet of any "frame," interlace with the filling as shown in Fig. 839.

The reeding of a 3-frame Brussels carpet is arranged for "1 binder, 3 pile, 1 binder," in each dent; thus splitting by the reed *always* the two binder warp-threads.

Fig. 840 illustrates the section of a 3-frame Brussels carpet. In the same, threads marked *d* and *e* represent the binder-threads. *A*, *B*, *C*, represent the 3 different colored pile warp-threads. Wires 1, 2, 3, 4, 5, 6, 7, illustrate the section of the wires as used in the opening of the 3d, 6th, 9th, 12th, 15th, 18th, and 21st opening of the shed. Picks 1, 2, 4, 5, 7, 8, 10, 11, 13, 14, 16, 17, etc., of the ground structure of the fabric are indicated by shaded circles.

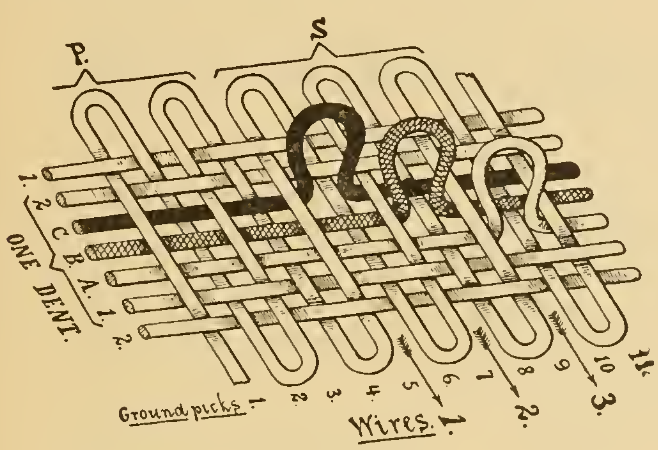


FIG. 841.

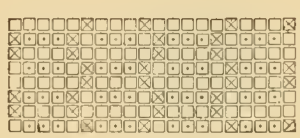


FIG. 842.

The binder-warp is drawn in two common harness frames which are placed in front of the Jacquard-harness. The face or pile is drawn in the Jacquard-harness, which is tied up for as many sections as there are frames in the carpet, so that in the present example of a 3-frame carpet we must use a 3-section tie-up. (See section on "tie-ups" in my treatise on The Jacquard, etc.) By forming the shed for the insertion of a wire only one pile warp-thread from each set is raised, as is required by the design. If the pile-warp in a carpet, constructed as thus far explained, is cut, the name Brussels is changed to *Wilton*.

Diagram Fig. 841 illustrates the method of interlacing a 3-frame Brussels carpet. This diagram readily explains itself on examination. Warp-threads indicated by *A, B, C,* are the three different colored pile-threads required (as explained before). Thread *A* is shown blank, thread *B* shaded, and *C* black. The binder or body warp-threads, situated in the fabric on each side of the face-threads, are indicated by *1* and *2*. The ground picks and places for inserting the wires are

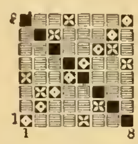


FIG. 843.

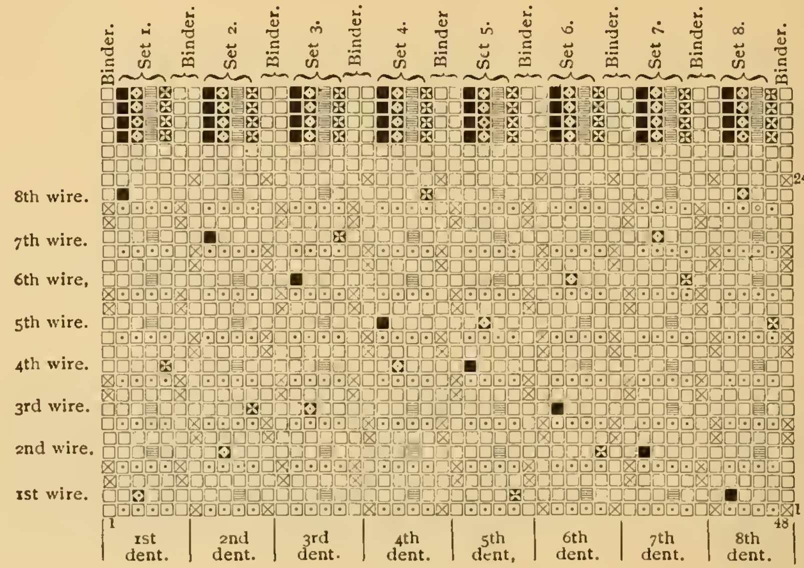


FIG. 844.

marked on the bottom of the diagram. *P* on the top of the drawing represents the interlacing of the fabric, omitting the loops, and thus giving, at a glance, the correct principle of interlacing the body.

Fig. 842 illustrates the weave for this part. Shed for "wire" omitted. *S on the top of the drawing* Fig. 841 *represents the entire procedure.* The wire marked *1* calls for the raising of warp-thread *C* (= black) for forming the face of the fabric. Wire marked *2*, the successive wire, calls for the raising of warp-thread *B* (= shaded) for forming the face of the fabric.

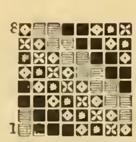


FIG. 845*a*.

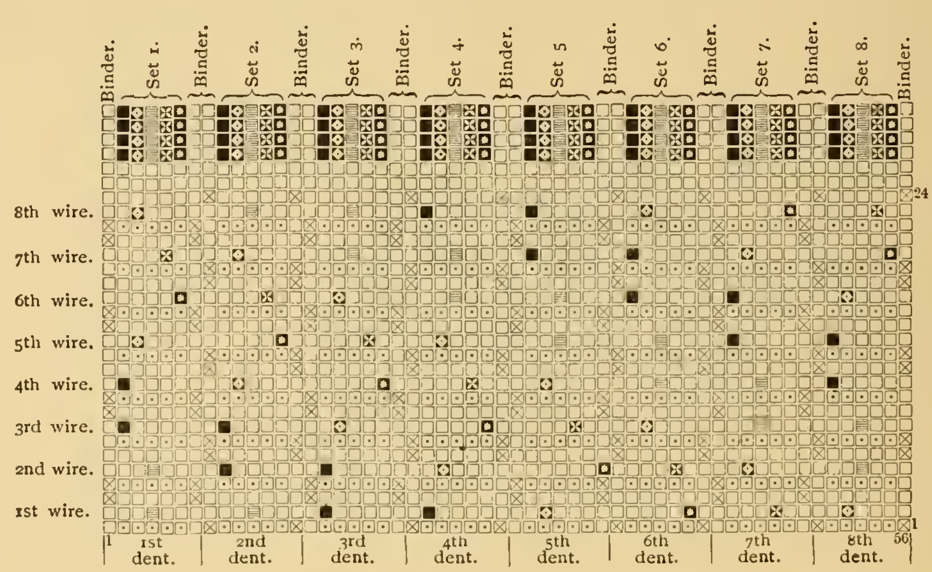


FIG. 845*b*.

Wire marked 3, the next successive wire, calls for the raising of warp-thread *C* (= blank) for forming the face of the fabric.

Warp-threads 2–*C*–*B*–*A*–1 are drawn in one dent of the reed, as indicated on the left-hand side of the drawing.

Fig. 843 illustrates part of a Brussels carpet design classified as a "four-frame."

Fig. 844 furnishes an analysis of the latter. The difference in the construction of a "four-frame," as compared to a "three-frame" carpet, consists in its having four different colored pile warp-threads, instead of only three, as in the latter, so that the figuring possible in both carpets is equal in proportion as 4 is to 3.

Having thoroughly described the method of constructing the "three-frame" carpet, the present "four-frame" design will the more readily explain itself.

Fig. 845 *a* illustrates part of a design for a "five-frame" carpet, which in Fig. 845 *b* is also analyzed.

Brussels and Wilton carpets are made up to and including "six-frames," also "*in part of full frames*" (after the "three-frame"), as may often be required in order to cheapen the fabric.

DOUBLE-FACED PILE CARPETS

In which the Pile is Produced by Inserting a Special Heavy Filling-Cord Instead of a Wire.

The construction of these fabrics has for its object the production of a cheap, strong, firm and durable double-faced carpet, wherein the figure at each side of the fabric is derived from

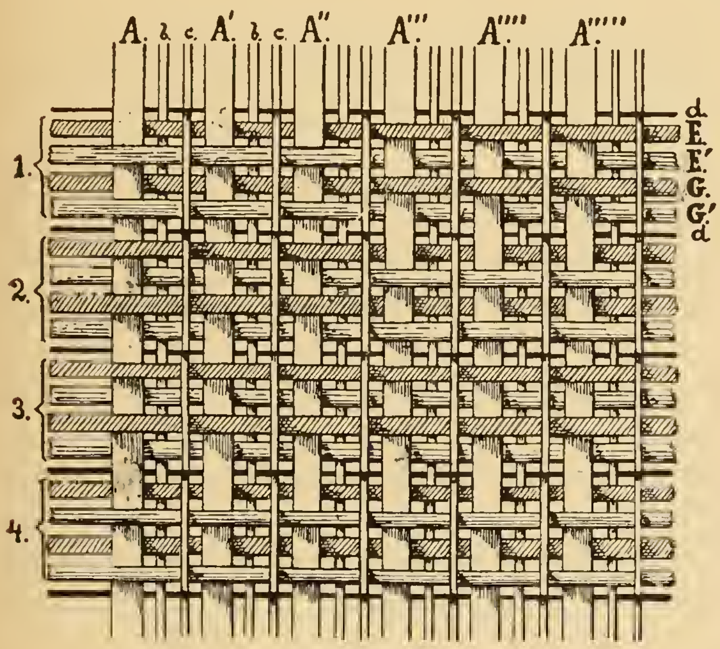


FIG. 847.

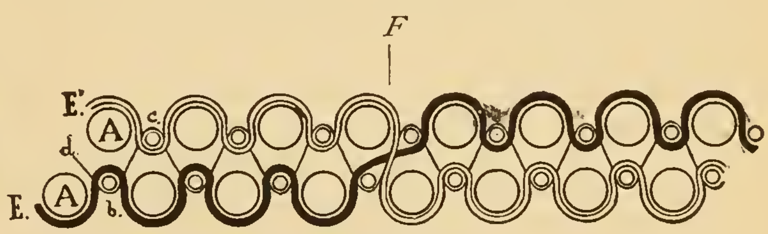


FIG. 846.

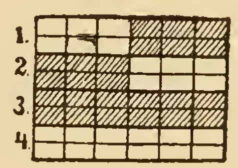


FIG. 848.

face-warps appearing upon one and then upon the other side of the fabric for one or more rib-picks. In addition to the face-warp there is also used a binder-warp, usually having two threads worsted face-warp alternate with one end binder-warp. These face and binder-warp-threads are interlaced into one fabric by means of two kinds of filling, the interior (heavy) filling and the binder-filling. The binder-filling at alternate picks passes above all the face-warps and then below all the face-warps. The binder-filling is tied to the upper and then to the lower side of the face-warp by the binder-warp, two picks of binder-filling and two picks of stuffer (interior, heavy or cord) filling being put in in succession. The binder-warp is lifted into the upper half of the shed between the insertion of the first and second picks of stuffer (cord) filling, the binder-warp thus splitting the stuffer or interior filling. The crossing of the warp and filling is such as to enable the two picks of interior or stuffer, when beat up into the shed, to lie nearly one over the other, forming ribs opposite each other at opposite faces of the fabric.

Fig. 846 represents a longitudinal section.

Fig. 847 is a diagram representing the arrangement of the warp and filling as they interlace in the fabric.

Fig. 848 illustrates part of a design (face and back) corresponding to diagram Fig. 847.

The threads shown in Figs. 846 and 847 are separated for a clearer understanding of their working; but in the actual fabric they are beat closely together by the reed and appear somewhat similar to those illustrated in part of a design (effect) Fig. 848.

Method of Operation.

These carpets are produced on an ordinary two-box Jacquard loom with the addition of front-harness. For the binder-warps an independent harness or set of harness is provided, being operated through a cam on the picker shaft. The sheds for the binder-filling are formed by the binder-warps on the one hand and by all the face or body-warps on the other hand. The face-warps (indicated by letters *E*, *E'*, *G*, *G'* in Figs. 846 and 847), which are generally of worsted and of different colors, and dyed or printed according to the colors and patterns it is desired that the carpet shall show, will be operated on by a Jacquard machine of the usual construction, so as to split the face-warps at suitable intervals to form sheds for the introduction of the stuffer or interior filling (indicated by letters *E*, *A'*, in Figs. 846 and 847) carried by a shuttle. The face warp-threads uppermost or at one side of the fabric remain at that side of the fabric for as many picks as desired, and then are carried to the other side of the fabric.

The binder-warps (indicated by letter *d* in Figs. 846 and 847) are carried by one or two harness frames and are distributed at suitable intervals between the face-warps. They are arranged so as to appear at both sides or face of the fabric between each two picks of interior (or stuffer) filling.

Method of Successive Interlacing of the Warps and Fillings.

Examining Figs. 846 and 847 from the right to the left, it appears that pick 1 has all the face-warp down and the binder-warp raised, thus forming a shed between all of the face-warp and binder-warp to receive a pick of binder filling.

Pick 2—the second binder-pick—has all the face-warp raised and all the binder-warp lowered.

Pick 3 has one-half of the face-warps raised, which with the binder-warp then down, forms a shed for receiving the first stuffer or interior filling.

Pick 4 has one-half of the face-warp and the binder-warp in the upper part of the shed, and the other half of the face-warp in the lower part. (This pick is not illustrated in Fig. 847, it being opposite to pick 3.)

This operation is repeated until such time as it is desired that the face-warp uppermost in the last shed to receive the stuffer or interior filling shall be made to appear at the opposite side of the fabric. When it is desired to make the warp upon one face of the fabric show for one or more sheds upon the opposite face of the fabric, these face-warp-threads are themselves bodily carried, as indicated at the line *F*, from the upper to the lower part of the shed.

DOUBLE-PILE FABRICS.

Principles of Construction of the Plain "Double Plush."

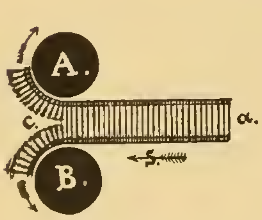


Fig. 849.

The end to be gained in the manufacture of warp pile fabrics of the present division is, the production of two single velvet (or similar) fabrics with one operation of the loom. In the manufacture of double plush the wires so conspicuously referred to in speaking of warp pile fabrics, are omitted. The pile-warp-threads, after interlacing into the "body structure" of one of the single fabrics, pass across to the "body structure" of the other fabric, where in turn they are interlaced before returning to the fabric from which they started. Constantly exchanging pile-warp-threads from one cloth to the other forms the principle of double-pile weaving, and is illustrated in diagram Fig. 849 by *a*. After combining the pile of a two-ply fabric in the manner previously explained, its pile-warp-threads, running across the centre or interior of the fabric, are cut automatically by means of an attachment on the loom known as the "*cutting knife*." The variously constructed knives in practical use, as well as the methods of their operation, are treated later on.

Methods in Use for Interlacing the Pile-warp in Double-plush Fabrics.

Various methods for exchanging the pile-warp in weaving "double plush," as also the different ways of interlacing (or fastening) these pile warp-threads to the ground-cloth of each fabric, are in practical use. An explanation of a few of these is given, whereby a pretty clear conception

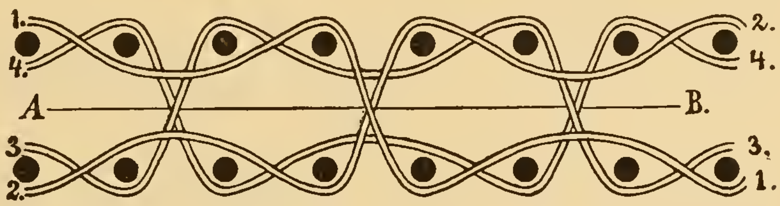


Fig. 850.

may be had of the method of interlacing double plush. Diagram Fig. 850 illustrates the section of a double-plush fabric. In this, four distinct warp-threads are visible, and are indicated by the numbers 1, 2, 3 and 4. These four warp-threads and the sixteen sections of the filling illustrate one repeat of the arrangement of the warp and filling, as well as the method of intersecting both systems, technically known as their weave. Line *A* to *B* in the diagram indicates the direction for cutting the pile-warp.

In diagram Fig. 851, another method for forming double plush is shown. The diagram illustrates the section from a specimen fabric.

In this, two distinct sets of warp-threads (shown by dotted lines) form the body structure for each individual single "plush fabric," while the pile is produced by a separate set of warp-threads which alternately interlace into one and then the other body-structure. The body-warp for the upper fabric is indicated by letters *A* and *B*, and that for the lower by *D* and *E*. Line *F* to *G* shows the course through which the pile is cut to produce the two separate plush fabrics.

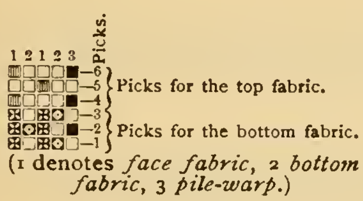


Fig. 851*a*.

Fig. 851.

An analysis of the section shown in Fig. 851 gives as follows: Picks 1, 2 and 3 for the lower fabric and picks 4, 5 and 6 for the upper fabric.

Fig. 851*a* is a plan of the method of interlacing, technically known as the "weave." 2 harnesses are required for the body-warp of the upper fabric; 2 harnesses for the body-warp of the lower fabric and 1 harness for carrying the pile-warp; thus 5-harness in repeat. In reeding the warp five threads must be put in one dent.

To produce a well covered full face in the fabric, two kinds of ground or body-warp must be used. One kind for threads working as shown by warp-threads *A* and *E*, or tighter than the other body-warp, or threads working the same as warp-threads *B* and *D*, which operate with less tension; hence two beams are necessary for the body or ground-warp, with one beam for carrying the pile-threads.

The adjusting, or "setting" of the harness is such that when the loom is at rest the set of warp-threads for the upper section of the fabric is in a sufficiently elevated position as compared to those for the lower cloth. The method of operation for the harness is such that for the picks of the upper cloth harnesses are lowered, and for picks for the lower fabrics harnesses are raised. This method of weaving double plush only requires one shuttle, and the weaving is performed the same as ordinary weaving.

Fig. 852a.

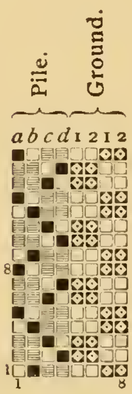


Fig. 852.

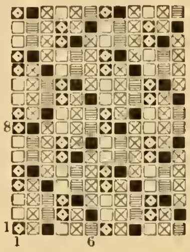


Fig. 852c.

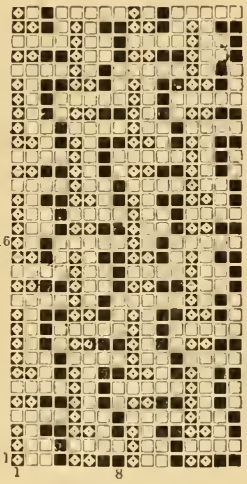


Fig. 852d.

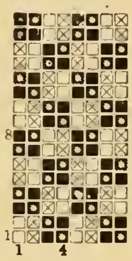


Fig. 852e.

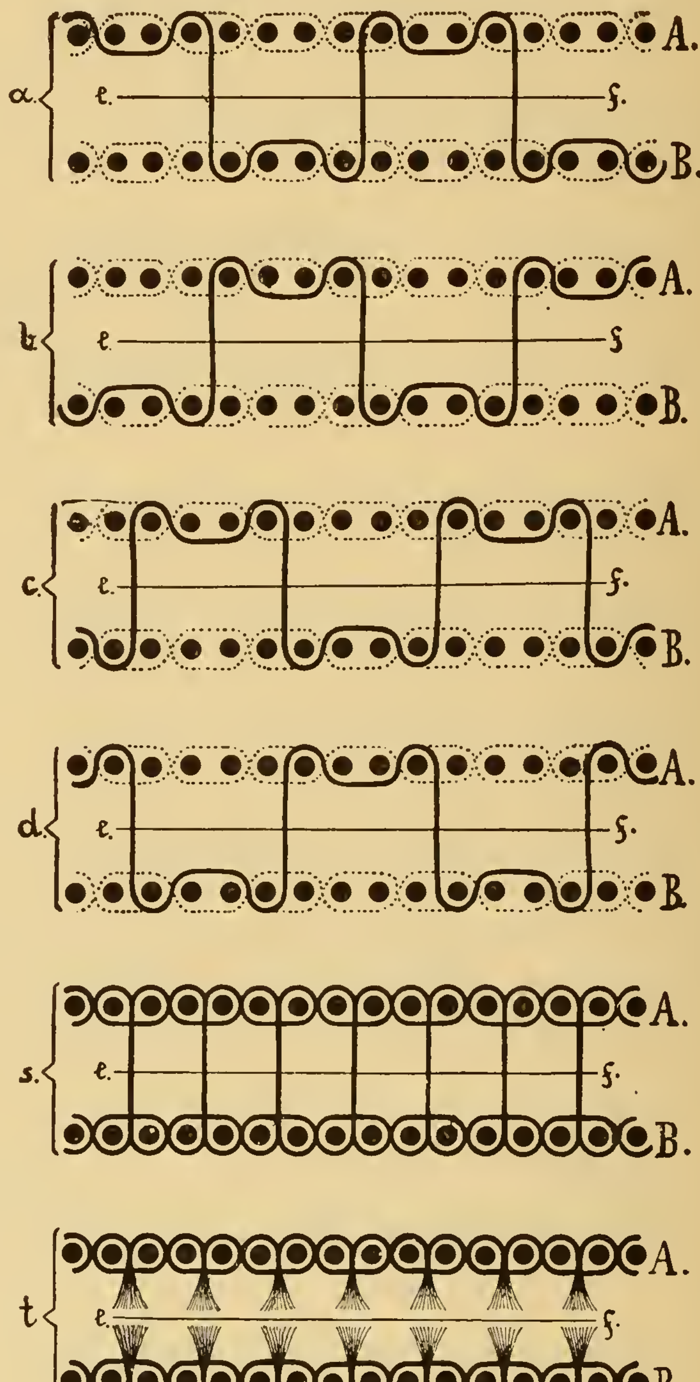


Fig. 852b.

The arranging of three successive picks alternately for each fabric is of no disadvantage to either structure. Each plush fabric will show the same smooth surface after cutting. Diagram Fig. 800, on page 170, in the chapter on the construction of single plush and velvet fabrics represents the section for each separate single cloth of the double plush illustrated in Fig. 851.

Fig. 852 illustrates another plan for weaving double plush. In this instance a double shuttle loom is used (cam-loom principle), using each shuttle for interweaving in the one system of the structure. Consequently two sheds must be formed at one operation of the loom, which is effected by using for the pile-warp "Cams" which are capable of holding the harness frames in three different positions, "the bottom," "the centre," or "the top" part of the complete double shed. It will be readily understood that "the centre" refers to the upper division of the lower shed, as well as the bottom division of the upper shed.

In Fig. 852 the first 4 harnesses, for future reference indicated by letters *a*, *b*, *c* and *d*, represent the pile. In the same the ■ type indicates the raising of a harness in the top division of the upper shed or "the top," the ▤ type indicates the placing of the harness for forming "the centre" (being also the temporary "shuttle-race" for the shuttle interlacing the upper ground fabric). This position is also technically known as "dwelling." The □ type indicates the lowering of the harness for forming "the bottom" of the lower shed in the loom. The rear 4 harnesses indicate the working of the ground warp. Harnesses indicated by 1 form the one body-structure, while the harnesses indicated by 2 form the other body-structure. Each set of the ground-harnesses (1, 1 and 2, 2) is placed by a respectively high or low strapping into its proper position for guiding either the ground or body warp of the upper or lower ground-cloth. The drafting for the present weave is 1 end ground-warp for the top cloth, 1 end ground-warp for the lower cloth, 2 ends pile-warp, thus 4 threads in one repeat.

Fig. 852*a* illustrates the separate weave for interlacing each body-structure, being the common (2-harness, 4 picks) rib-weave, or the common plain two picks in a shed.

In Fig. 852*b*, six respective diagrams are given for illustrating the compound weave Fig. 852. Diagram indicated by *a* represents the section of the corresponding pile warp-thread *a* in the weave; diagram *b* shows the section of pile warp-thread *b* in the weave; diagram *c* illustrates the section of pile warp-thread *c* in the weave, and diagram *d* refers to pile warp-thread *d* in the weave. The ground or body-warp working close by the pile-warp is shown by the dotted lines in each diagram. Letter *A*, in all the diagrams shown under Fig. 852 *b*, indicates the upper fabric and letter *B* the bottom fabric. Horizontal line *c* to *f* indicates the direction for cutting the pile as performed afterwards. In diagram *s* of Fig. 852*b*, the complete interlacing of all the four pile-threads in a fabric is shown. In the same, ground-warps (as previously shown) are omitted so as to give a clearer understanding of the subject. Letters of reference are also selected to correspond with the previously explained diagrams *a*, *b*, *c* and *d*, as well as to diagram *t*, which illustrates the section of the four pile warp-threads when cut (ground-warp again omitted).

In Fig. 852*c*, a separate analysis of one fabric from the double structure is given, showing 4 pile and 2 body warp-threads and 8 picks for its repeat. Warp-threads 1 and 4 for body, warp-threads 2, 3, 5 and 6 for pile. ▣ shows the raising of the body-warp, □ shows the lowering of the body-warp; ■ shows the raising of the pile-warp; ▤ shows the lowering of the pile-warp for two picks down so as to interlace with the body-structure by means of raising in both adjacent picks; ⊠ shows the lowering of pile-warp for four picks so as to form the pile by means of interlacing with the mated body-structure (not shown).

Fig. 852*d* shows the complete analysis executed in the regular double-cloth principle, ordinary weaving, one shuttle work; thus only raisers or sinkers and no centre or "dwell," and hence 8 warp-threads and 16 picks. Warp-threads 1, 2, 5 and 6 are for the body-warp and the warp-threads 3, 4, 7 and 8 for the pile-warp.

In Fig. 852*e*, a special plan illustrating the working of the pile-warps, as previously explained, is given. □ and ■ show the interlacing in fabric 1 or *A*. ⊠ and ▣ show the interlacing in fabric 2 or *B*.

Methods of Operation in Use for Producing Double-Pile Fabrics and the Different Systems of Cutting the Pile-Threads.

As mentioned at the beginning of the present chapter on double-pile fabrics, both single-cloth fabrics after being woven on the double-cloth system must be separated, or the pile cut in the centre of the float from the one body-structure to the other. Two methods are in practical use for cutting this pile. First, the pile-warp is cut automatically on the loom on which it is woven, and second, the pile-warp is cut after the fabric has left the loom. The first method is the one most generally adopted, and the illustrations and explanations of some of the processes most frequently used are given. Diagrams 853, 854, 855, 856, 857 and 858 illustrate C. R. Garratt's invention as to the mechanism for cutting double-pile fabrics.

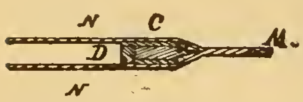


Fig. 853.

Fig. 853 illustrates at *M* the section of the double-pile fabric, at *D* the section of the cutting knife, liberating with it both separate pile-cloths as shown at *N N*.

Fig. 854 illustrates a plan-view of part of a loom having the before-mentioned arrangement attached.

Fig. 855 is a front elevation, with the bracket, which supports the operating shaft as well as this shaft and its driving-pulley and bevel-gear, removed.

Fig. 856 is a plan-view of the knife, showing the manner in which the cords are attached.

Fig. 857 is the side-view of a loom (of a different make than the one before) which has the cutting arrangement attached.

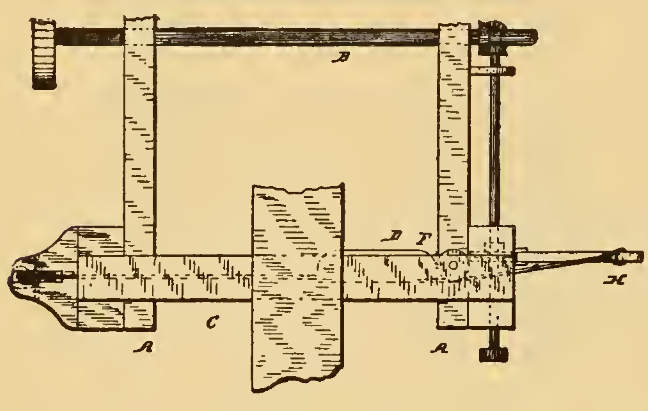


Fig. 854.

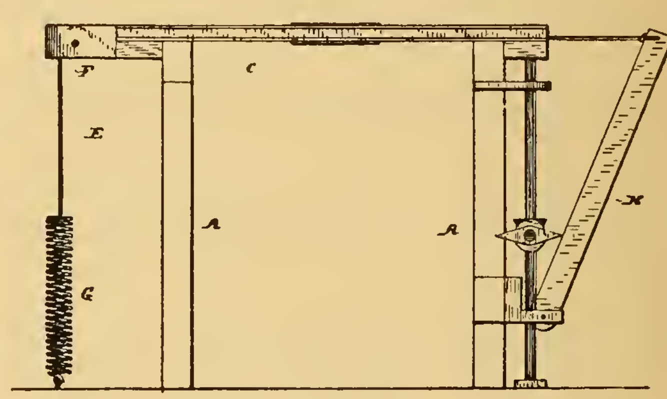


Fig. 855.

The letters used for indicating the different parts in these five diagrams are identical. An examination of the same gives us as follows:

A illustrating the framework of a loom.

B representing the mainshaft, journaled in the framework, and provided with a driving pulley.

C is a cross-piece located at the front of the loom, provided with a groove extending across the loom, in which the knife *D* reciprocates. The main portion of the cutting-edge of this knife is straight, but the ends, or corners, are rounded, so that the knife will cut equally well when moving in either direction, while the straight cutting edge between the rounded corners is adapted for cutting the pile in a smooth and effectual manner through very short reciprocating movements of the knife. At the opposite ends of the knife cords are attached, which pass over pulleys *F*. One of these cords is attached to a spring *G*, which is secured to the floor. The other cord or wire is attached to a lever, which is pivoted in a bracket secured to the framework. This lever can be arranged to vibrate either by means of a cam or crank.

Fig. 856.

In the present illustration the first mentioned arrangement is used. The acting of the cam upon the lever *H* forces the latter outward, and consequently forces the knife to the extreme right of the groove against the power of the spring *G*. The action of the spring as it contracts is to draw the knife to the extreme left of the groove, and at the same time to draw the lever inward.

Fig. 853, as previously alluded to, illustrates at *N* the two separate single pile fabrics. In diagram Fig. 857, the method of " taking up " these fabrics without injuring the pile is shown. After drawing the fabrics over the edges of the " breastbeam " of the loom, they are guided over two "take-up rollers," *X*, opposite each other, which have a roughened surface, and by which the fabrics are held taught and drawn backward from the knife, so that the centres of the uncut pile will be evenly presented for the cutting. After passing the " take-up " rollers *N*, the fabrics fall into the cloth-box *S*.

This method of keeping the fabric loose, and not tightly wound around its "take-up" or cloth beam as in common weaving, preserves the beauty of the pile. The previously explained method of operating the cutting knife may also be changed so as to have it operated on by the lay. This principle is illustrated in diagram Fig. 858. In this, the one cord (formerly connected to a lever) is shown attached to the lathe *O* of the loom. This lathe is operated in any ordinary manner, so that the knife will be reciprocated in its guiding-groove at each throw of the lathe.

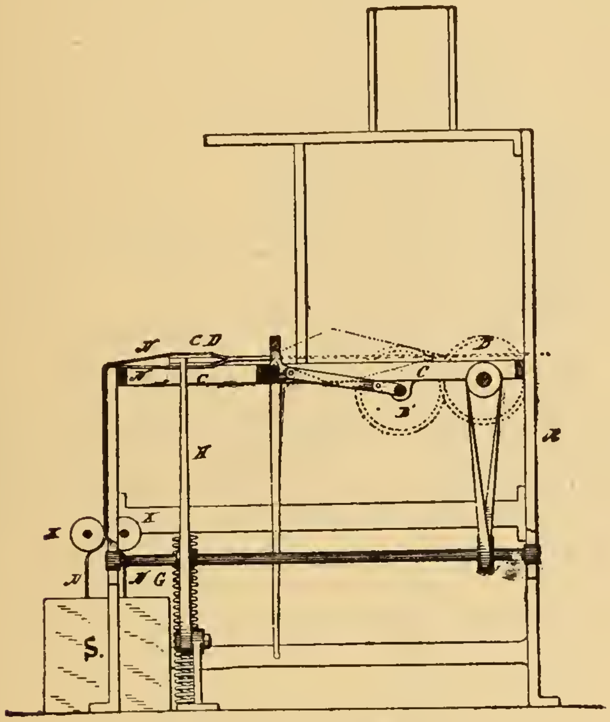


Fig. 857.

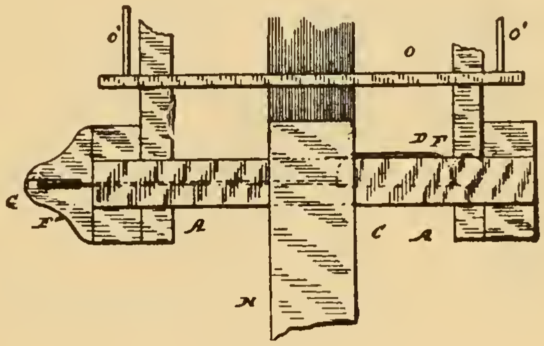


Fig. 858.

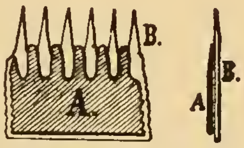


Fig. 859 *a*. Fig. 859 *b*.

Another kind of "cutting knife" is shown in Figs. 859*a* and 859*b*. Fig. 859*a* illustrates the plan-view, and Fig. 859*b* the section. In operating this " cutting knife" the long teeth enter between the two pieces of cloth while the lateral movement of the top blade cuts the pile-threads. In the diagram blade *A*, shown shaded, is the movable blade, and is situated upon *B*, the fixed blade which is shown in outline.

Figs. 860, 861, 862, 863 and 864 illustrate a mechanism for severing double-pile fabrics in the loom in which it is woven, as invented by A. Bacon.

Fig. 860 is the side-view of a loom necessary to illustrate the construction and mode of application of the attachment for severing the double-pile fabric produced on the loom.

Fig. 861 is a front-view of the same loom and the cutting device, with the sharpener for the cutting knife removed.

Fig. 862 is a plan-view of the same loom and the cutting device.

Fig. 863 illustrates a perspective view of the cutting device; the sharpening attachment for the knife is illustrated separately, in front, and detached from its supports, so as to give a clearer understanding of the main features of the device.

Fig. 864 is a transverse section (enlarged) on the line 1, 2, in Fig. 862.

The letters indicating the different parts of the cutting device, as well as the loom, are identical. The following description will readily show the manner in which the cutting device is attached to the loom. Also the method of operation of the former, with a general description of its construction.

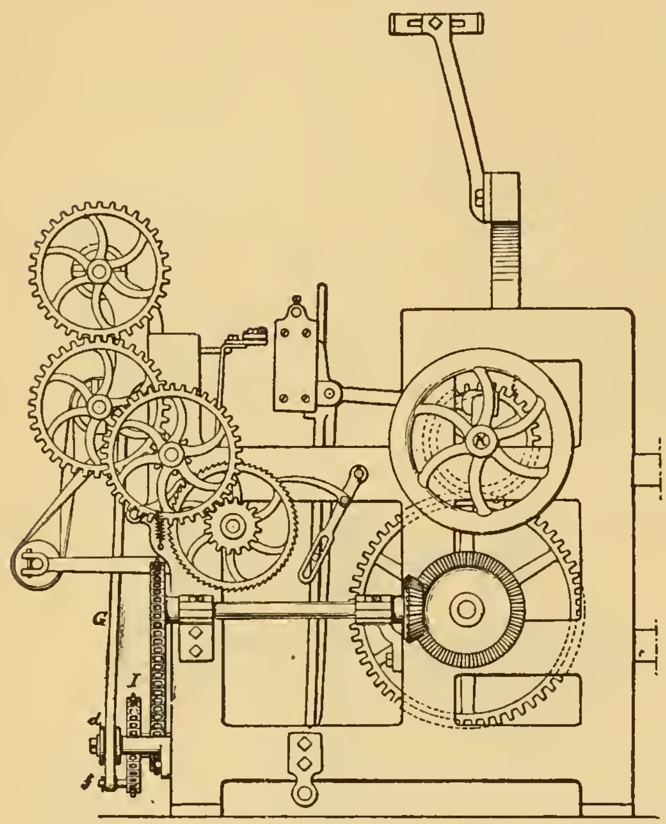


FIG. 860.

(This device, as claimed by the inventor, can also be adjusted to any other kind of loom with a few appropriate changes, such as may be required by the style of loom to be adjusted.)

Parallel with the breastbeam of the loom (see *A* in drawings) and a short distance in front of it is a bar *B*, which is carried by projecting brackets *X*, and forms a guide for a slide *D*, the latter carrying a stud, on which is free to turn a spur-wheel *a*, to the upper face of which is secured a circular cutter *F*. This spur-wheel engages with a rack *b*, which is secured to the upper face of the guide-bar *B*, so that as the slide *D* is caused to reciprocate transversely in the guide a rapid rotary motion, first in one direction and then in the opposite direction, will be imparted to the cutting-disk *F*. One end of the slide *D* is connected to one end of a belt *G*, which passes around pulleys *d*, supported on the frame of the loom. The opposite end of this belt is connected to a stud *f*, projecting from one of the links of a chain-belt *H*, adapted to sprocket-wheels *I*, mounted upon studs g^2, secured to and projecting from the loom-frame. A similar belt *G*, passing

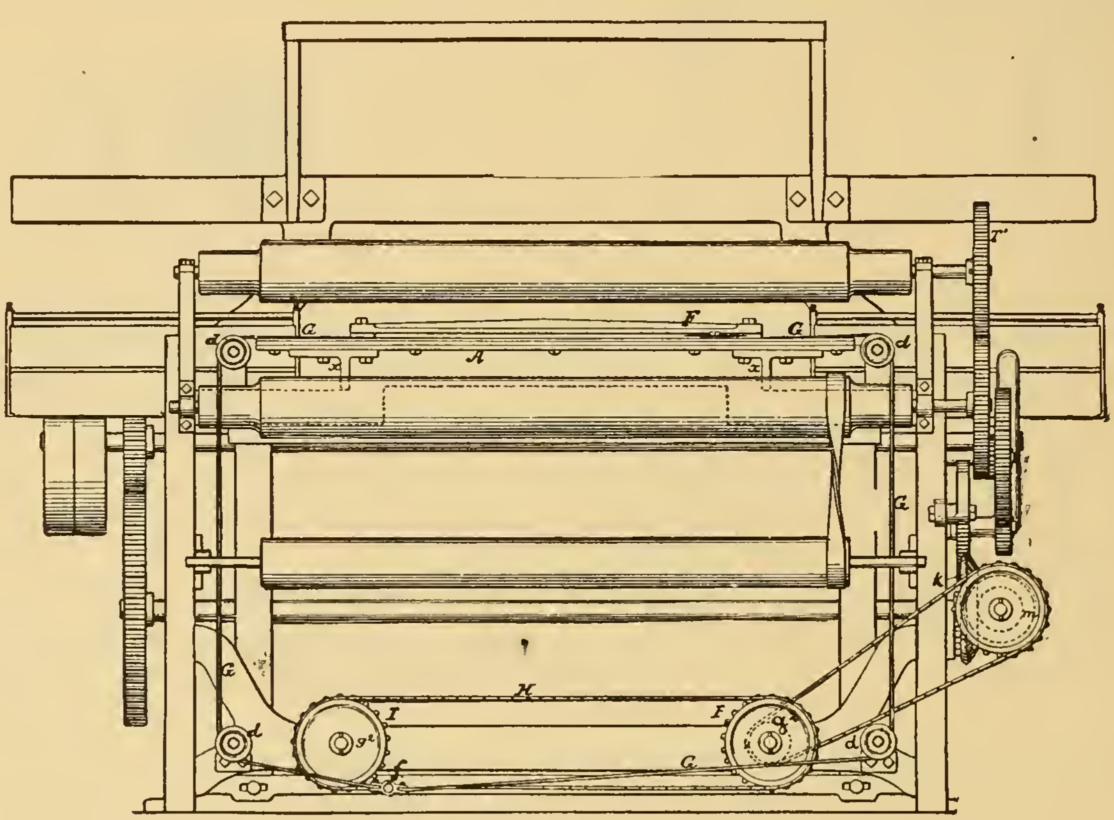


FIG. 861.

around like pulleys *d*, serves to connect the opposite end of the slide *D* to the stud *f*, so that when rotary motion is imparted to the sprocket-wheels *I* the stud *f*, traveling with the belt *H*, will, through the medium of the belts *G*, impart a transverse reciprocating movement to the slide *D*, and thus cause the cutter *F* to pass to and fro through the web of fabric, so as to cut the pile-threads and separate the compound fabric into two single fabrics, each having a cut-pile surface.

In order to insure uniform cutting of the pile, the movement of the slide and its cutter must be smooth and steady, as any jarring or jerking of the slide or cutter causes irregularity in the

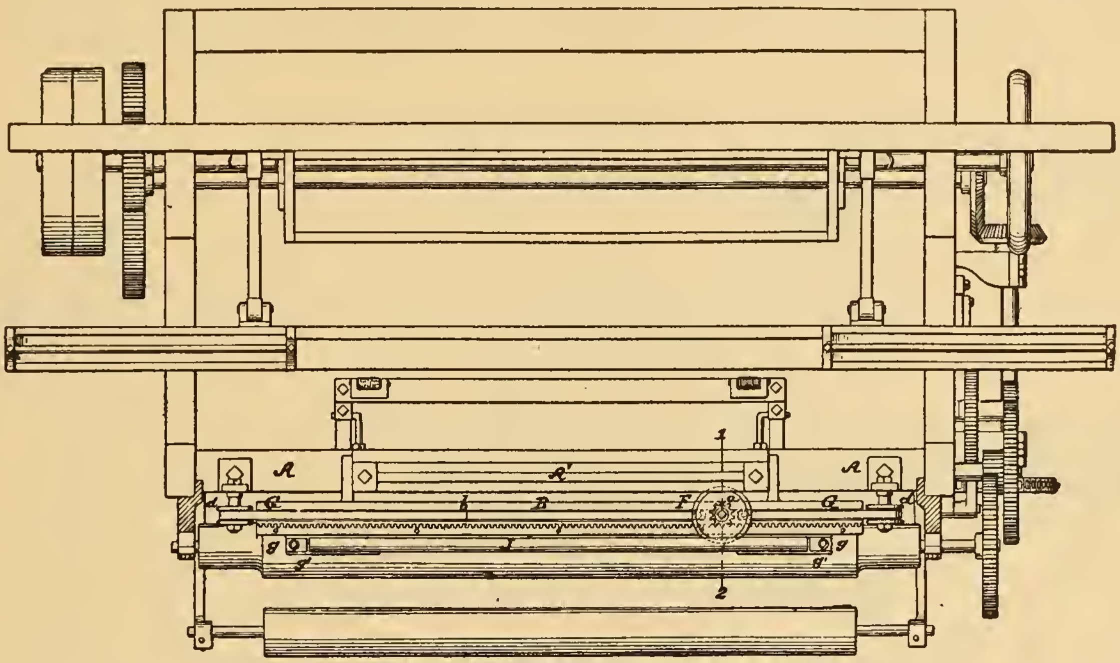


FIG. 862.

cut and unevenness in the length of pile on the fabrics produced. This smooth and steady movement is secured by means of the driving mechanism shown; there is a gradual dimunition in the speed of the slide at and near each end of its traverse and a gradual acceleration of speed as it starts on the return movement.

Rolls *J' J*, between which projects the cutting edge of the knife *F*, are acted upon so as to press the rolls *J J* toward each other and into contact with the opposite sides of the knife.

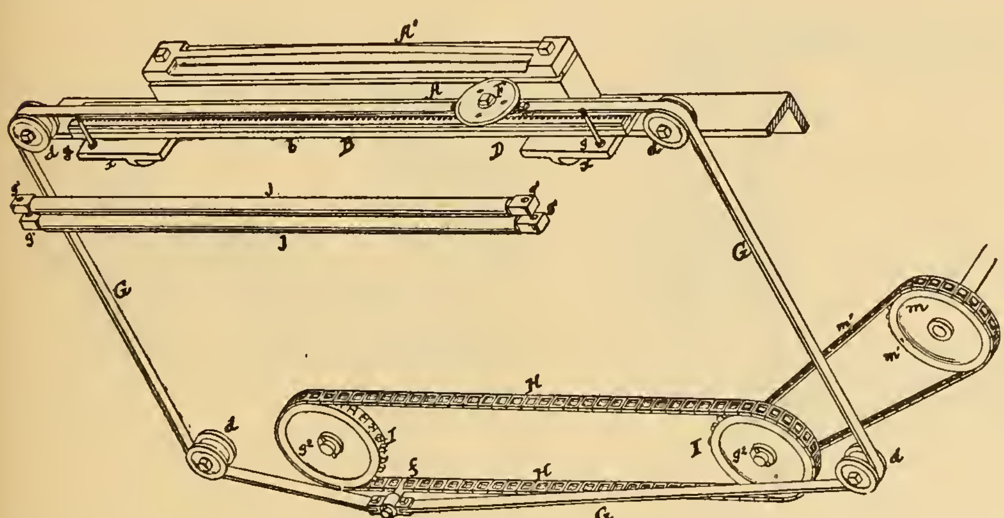


FIG. 863.

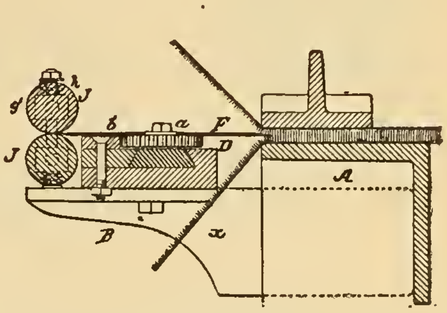


FIG. 864.

The rolls *J* are coated with abrading material, and extend throughout the traverse of the knife, so that the cutting-edge of the latter is at all times under the sharpening influence of the rolls, and a keen edge is thereby maintained. (This cutting device can also be used, applied to a machine for cutting double pile fabrics after the woven cloth has left the loom, instead of being used directly in connection with the loom in which the fabric is woven.)

Drawings Figs. 865, 866, 867, 868, 869, 870, 871, 872 and 873, represent C. Pearson's invention for cutting on the loom double pile velvets and similar pile fabrics during the weaving process.

The invention of the present system for separating the double pile fabric into two separate single pile fabrics, consists in employing two pile-severing knives, which are caused to travel laterally, each a distance only half the width of the fabric, in a transverse guide-plate or race.

The letters of reference in the drawings denote like parts in the several views given.

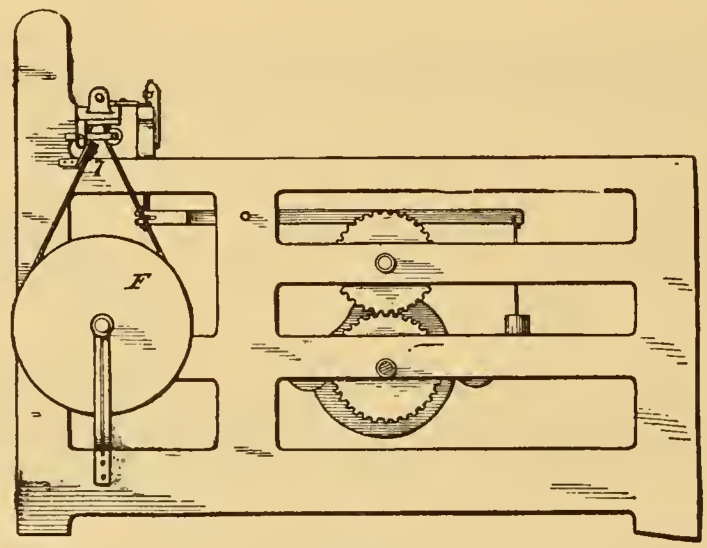


FIG. 865.

Fig. 865 represents a side elevation of part of a loom for weaving double pile fabrics. The drawing also illustrates one of the "knife carriages" with its actuating mechanism, and part of the sharpening mechanism adjacent to it with a part of its actuating mechanism. Fig. 866 is a front view of part of the loom. Fig. 867 illustrates a transverse vertical section of the grooved race-bar; also one of the cutting-knives mounted in its carriage, and one set of the sharpening-rollers with its frame or "housing."

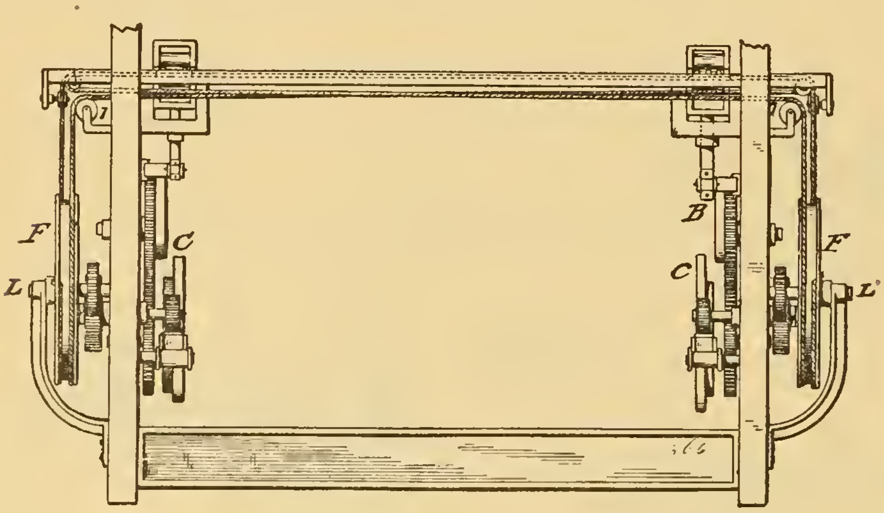


FIG. 866.

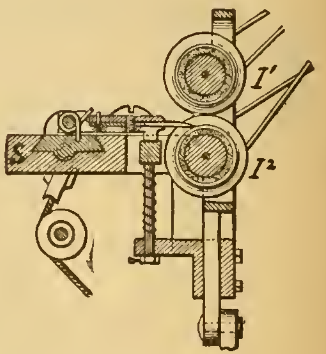


FIG. 867.

Fig. 868 is, partly, a sectional front-view of a pair of the sharpening-rollers mounted in their frame with a portion of the velvet rail or cutting bar.

Fig. 869 is a top-view of the transversely grooved guide-plate or race-bar in which the knife-carriages are reciprocated, and the parallel supporting-bar in which the fabric is cut by the laterally-traveling knives.

Fig. 870 is an enlarged view of the parts at one end of Fig. 869, showing the transversely grooved race-bar, a knife-carriage with its knife, and the stopping mechanism in the race-bar.

Fig. 871 is a cross-section view of the velvet delivery rollers, one of the pile severing knives, and the supporting bars, showing the relative position of these several parts.

Fig. 872 is a transverse section of the inside of that part of the loom shown in Fig. 865 from the outside.

Fig. 873 is a transverse sectional view of the loom, showing the location and arrangement of the crank-shaft and connecting-gear, one of the pulley-wheels, and the sharpening mechanism with its actuating mechanism for one of the knives.

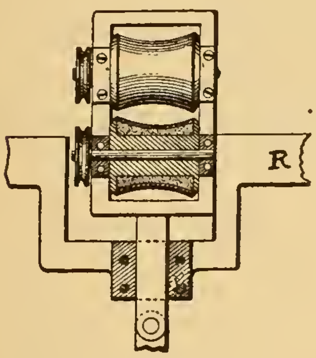


Fig. 868.

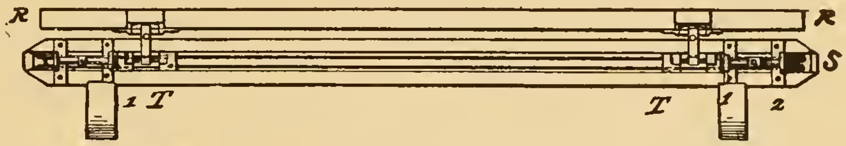


Fig. 869.

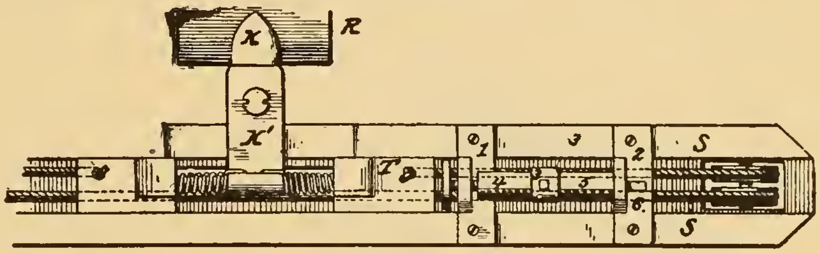


Fig. 870.

The method of operation and principle of construction of the cutting-device is illustrated by drawings Figs. 865 to 873 inclusive.

By means of the double cam *C*, operating the rack-bar and cog-gearing, alternate partial revolutions in each direction are given to the pulley-wheel *F*, to which are secured two cords or bands, the other end of each of which is attached to the "knife-carriage," one cord on one side and one on the other side thereof, so as, by the alternate partial revolutions of the pulley-wheel in

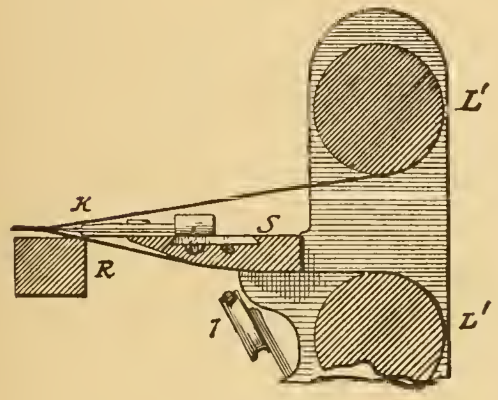


Fig. 871.

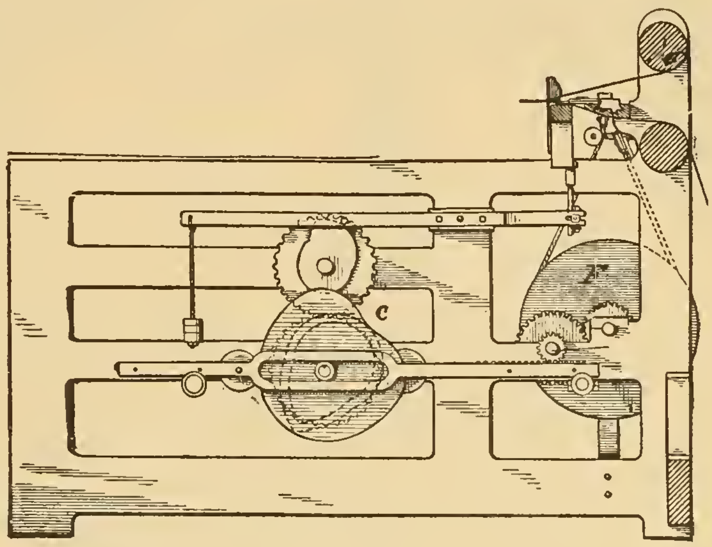


Fig. 872.

opposite directions, to pull the carriage backward and forward transversely along the grooved guide-plate or race of the loom. A similar set of cords and a knife-carriage are provided for each side of the loom, both knife-carriages moving in the same guide-plate alternately, each only about half the distance across, and each alternating in its lateral travel from side to centre of the race-plate.

Transversely across the frame of the loom are arranged two bars or rails, *R* and *S*, their relative positions being as shown in Fig. 869, the former being merely a bar or rail supporting the double pile fabric while it is being severed in two through the pile by the laterally-moving cutting-knives. Bar *R* is recessed near each of its ends (see Figs. 868 and 869) to admit of the insertion and support therein of the housings for the sharpening-rollers, and so that the upper and lower sharpening-rollers shall come alternately in contact with the upper and lower sides, respectively, of the knife-blade, as shown in Fig. 867.

The bar *S* is a grooved transverse guide-plate recessed at each of its ends, to hold two sets of friction-rollers, over which the knife-actuating cords pass to the corresponding pulley-wheel *F*, and having one wide groove its entire length, serving as a race for the knife-carriages *T T*. At the bottom of this groove are two smaller parallel grooves, extending to the recesses at each end of the plate, and within which the knife-cords are moved. Two cross-bars, 1 and 2, are secured to the bar *S* at each end, supporting a guide-rod, 6, having an enlarged inner end, which serves as a stopper for the knife-carriage, and upon the rod 6 are placed two pieces of india-rubber tubing, 4 and 5, and between them a metal band, 3, which may be slipped along the rod against

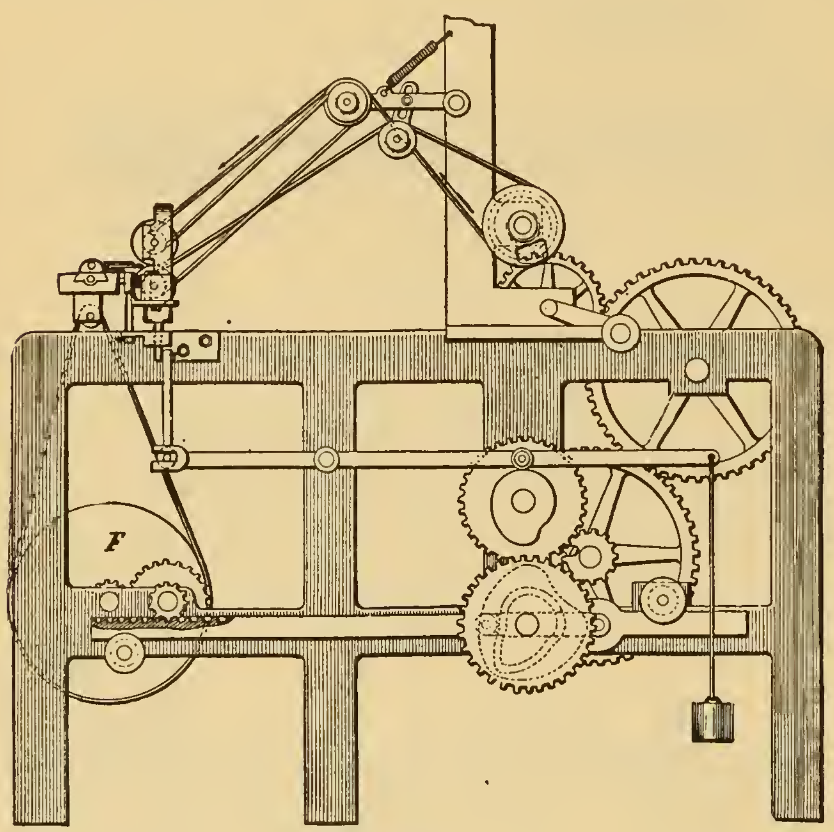


Fig. 873.

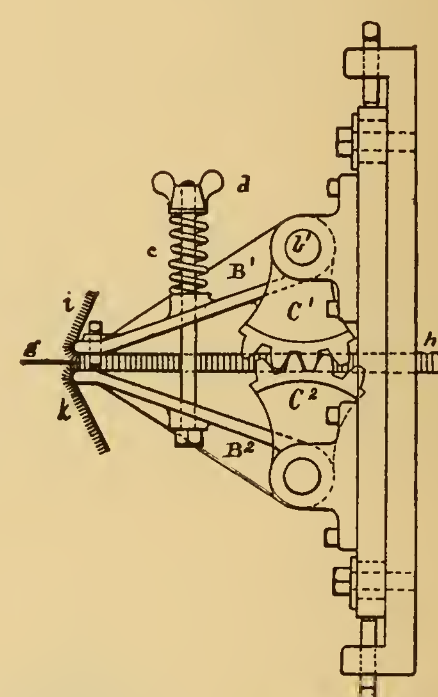


Fig. 874.

the tubing and fastened tight at any point thereon by a set-screw. By this arrangement the rubber tubing acts as an elastic cushion for the stopper-rod and in turn for the knife-carriage. The movable metal band also permits of lateral adjustment of the stopper-rod, thereby producing a variation in the resistance encountered by the knife-carriage. This mechanism is shown in detail in Figs. 869 and 870, the latter showing only one end of the bar *S*, the other end containing similar mechanism for the other knife-carriage.

The knife *K*, to cut the connecting pile latterly between the two backings, is secured in a holder, *K'*, mounted in a carriage, *T*, moving laterally in the large groove of the race-bar *S* backward and forward half the length of the bar, from about its centre to its either end, by means of the pulley and cords before mentioned. The end of the knife-holder *K'* swings upon a cross-bar, passing through it and having its bearings in the carriage *T*. A spring is coiled around this cross-bar on either side, with its ends fastened to the carriage, so that the tendency is to press the knife-blade down upon the supporting-bar *R*, or upon the velvet resting thereon, and cause the knife to travel in its reciprocating motion in a straight line and cut the pile evenly.

Each knife-carriage is provided with two pulley-cords—fastened one at each end thereof, one cord passing from the right-hand carriage over the friction roller at that end of the bar *S* to and partially around the pulley-wheel *F* in one direction, and has its end knotted in the periphery thereof. The other cord, fastened to the other end of the knife-carriage, passes along one of the small grooves in the bar *S* to the other or left-hand end thereof, where it passes over a similar friction-roller and back under the bar *S* to another friction-roller, 7, and thence to and partially around the pulley-wheel *F*, (in an opposite direction from the other cord) to which it is fastened. A like set of cords are arranged for the other or left-hand knife-carriage. This arrangement causes the knife-carriages to be moved backward and forward in the carriage-race when and as the pulley-wheels wind up either cord successively; the wheels being turned by means of the mechanism operated by the cam *C*.

Upper and lower velvet-rollers *L'L'*, Fig. 871, suitably mounted in the frame of the loom, take up the two pieces of pile fabric cut apart through the connecting pile by the laterally-reciprocating knives *K*, and draw forward the uncut double pile fabric to the traveling knives as it is delivered over and upon the velvet-rail or cutting-bar *R*. These rollers *L'L'* are geared together and actuated by a worm, to which motion is communicated from the picking shaft, or any other suitable actuating mechanism.

Machine for Cutting Double Pile Fabrics After Leaving the Loom.

As previously mentioned in the chapter on double pile fabrics, in some instances the separating of both pile cloths is not done in the loom during the process of weaving, but a separate machine is necessary for cutting the fabric afterwards. In using such a cutting device for separating both cloths the former must produce a suitable feeding and tension upon the fabric during the operation so as to divide the pile-threads midway between the two "body-structures" (backs). As the length of pile in any such fabric is not always uniform, it is difficult to maintain the cutting line midway between the webs, and in order to avoid the risk of cutting into the fabrics at places where the weaving is irregular it is necessary to use a longer pile than would otherwise be required, thus consuming more material than is needed for the finished fabric, and also requiring the divided fabric to be "shorn" (afterward) to a greater extent than would otherwise be necessary.

An invention, lately patented by J. A. Campbell of Philadelphia, is designed to obviate these difficulties by making the straining-bars, over which the newly-divided fabrics are drawn, self-adjusting and self-centering, so that, whether the original double pile fabric be thick or thin, the dividing-line shall always be midway between the two fabrics.

Diagram Fig. 874 is a side-view of that portion of a machine which has this improvement attached.

The method of operation is made fully comprehensible by the following explanations given with reference to the letters used in the diagram.

At *h* is shown the double pile fabric passing in between the plates B' B^2, and at *g* is shown a section of the dividing-knife, while at *i* and *k* are shown the divided fabrics passing off.

The operation of the device is as follows: The uncut fabric, being drawn in at *h* by the action of any suitable feeding mechanism, passes between the plates or jaws B' B^2, and is divided by the knife *g*, after which the divided fabrics pass off at *i* and *k*, being drawn taut by suitable winding mechanism. The springs *c c*, being adjusted to a proper tension by the thumb-nuts *d d*, tend to draw the jaws or plates B' B^2 together, and so the fabric which is being divided is held firmly between the said jaws B' B^2 during the operation of cutting. The divided fabrics *i* and *k*, being drawn taut, tend to draw the jaws B' B^2 apart; but this tendency is resisted by the springs *c c*. As the toothed segments C' C^2 are firmly fastened to the jaws B' B^2, it follows that any motion of the jaw B' will be communicated to the toothed segment C', and from thence through the toothed segment C^2 to the jaw B^2, and so any motion of the jaw B', to or from the cutting-line, will be accompanied by a corresponding motion of the jaw B^2. If, from any irregularity in weaving, the two fabrics of the double pile fabrics are closer together or farther apart at various points than the normal distance, the jaws $B'B^2$ will press together or be forced apart, but always to an equal extent, and hence the two webs will always be kept at an equal distance from the cutting-line, no matter how irregular their distance from each other may be.

Weaving Two, Three or more Narrow Widths or Pieces of Double Pile Fabrics at once.

The weaving of two or more narrow widths of double pile fabrics, side by side, in a broad loom, also requires the production of fast selvages for each special narrow width. For this purpose we must form two adjacent selvages with fast edges at any desired part of the width, both of the upper and lower cloths of the double pile fabric, as also selvages in the upper cloth immediately above the selvages in the lower cloth. To form a fast edge to each inner selvage, a warp binding-thread to cross with the outermost warp of the selvage and becoming knit together therewith must be employed. Any desired number of fast inner selvages may be formed in this way in the width, so that the fabric may be divided into widths of any required size by cutting

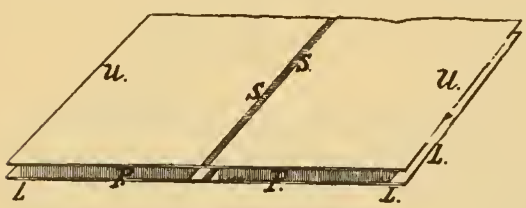


FIG. 875.

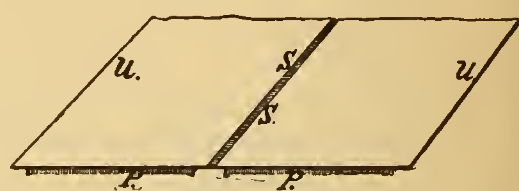


FIG. 876.

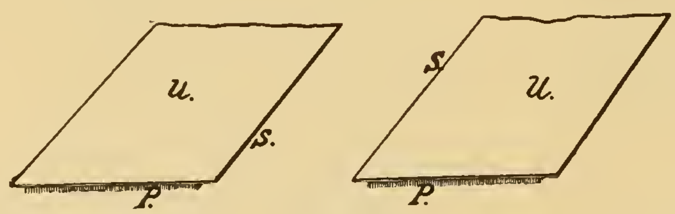


FIG. 877.

both the upper and lower cloths lengthwise between the pairs of fast selvage edges, which have been made in these cloths.

The construction of such "fast" selvages, properly belonging to the division on gauze or cross-weaving, will be explained later on.

Diagram Fig. 875 illustrates a perspective view of a short length of a double pile fabric woven face to face, with fast inner selvages.

Diagram Fig. 876 shows a perspective view of one-half of this fabric when the pile has been severed and the upper cloth separated from the lower cloth.

Diagram Fig. 877 shows two separated pieces, obtained by dividing the fabric shown at diagram 876 longitudinally between the fast selvages which are formed in it. In these diagrams U is the upper cloth, L is the lower and P is the pile.

The two parallel lines S S, which run lengthwise of each cloth, represent the fast edges of the inner selvages.

Let-off Mechanism for the Pile Warp for Weaving Double Pile Fabrics.

In double velvet weaving there is one great difficulty to contend with, namely, to keep the two pieces of cloth an equal distance apart. To do this a regular supplying, guiding and delivering of pile-warp is required, otherwise any additional strains would draw the two pieces nearer together, and the pile would be irregular.

Diagrams Figs. 878*a*, 878*b* and 879 illustrate the arrangement for effecting the letting-off, supporting, guiding and delivering of the pile-warp, and represent C. Pearson's Patent.

Fig. 878*a* illustrates a side elevation of that part of a loom containing the necessary mechanism as mentioned.

Fig. 878*b* is a detached view of some of the parts and taken from Fig. 878*a*.

Fig. 879 is a diagram showing the arrangement and position of the several rollers and parts constituting this mechanism.

The letters indicating the different parts in this mechanism are as follows: *A* represents the frame of a loom. *G* and *H* are the beams containing the pile-warp. The latter threads are delivered from these to a guide-roller *R*, secured in the frame of the loom, and thence to a pair of metal rollers, *C C*, turned perfectly true and covered with cloth, plush, or other like rough-surface material, in order to create friction between the surface of the roller and the warp-threads. These rollers are mounted upon shafts having bearings in a bracket bolted to the frame of the loom. They are independently rotated toward each other with unvarying uniformity and precision by means of worm-wheels *d d* on the axes thereof, which engage with two screws, *F F*, one for each

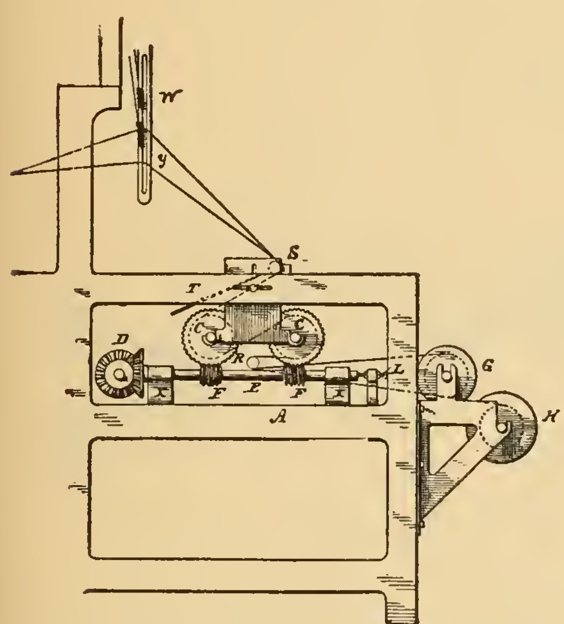


Fig. 878*a*.

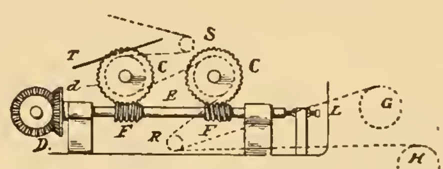


Fig. 878*b*.

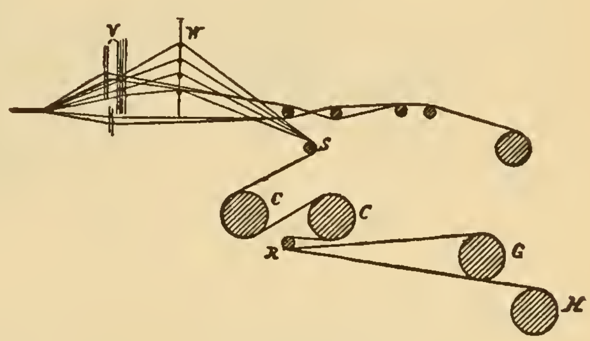


Fig. 879.

roller, one being a left-hand screw and the other a right-hand screw, on a horizontal shaft, *E*, which has its bearings in brackets *X X*, also secured to the side of the frame *A*. One end of this shaft *E* is provided with a beveled gear-wheel, which engages with a similar beveled gear-wheel on the end of the picking-shaft *D*, and is thus continuously driven. The other end of shaft *E* bears against a rod, *L*, in the bracket *X*, provided with jam-nuts, in order thereby to secure desired pressure against the shaft and its actuating-wheel, more especially when actuated by friction as a substitute for the gear-wheels shown. The pile warp-threads are delivered directly from the guide-roller *R* to one of the metal rollers *C*, and under and around the same, and from thence in like manner under and around the other roller, *C*, these rollers rotating toward each other, and from the last-mentioned roller *C* the pile-warp is carried to a second guide-roller, *S*, supported horizontally in the frame *A*, and is from thence taken up by vertical rods *Y*, held up by pull-springs *W*, to support the warp in its passage to the heddles, and to create the necessary tension thereon to hold the same taut.

Carrying the pile warp-threads to a point over the main rollers *C* the loose waste driven off by the operation will drop onto the warp after passing the second roller, *C*, injuring the pile-warp and clogging the mechanism. To prevent this, a shield, *T*, is arranged over the second roller, *C*, consisting of a flat tin or other suitable plate extending from side to side of the loom and secured to its frame.

Another arrangement for delivering the pile warp in looms for weaving double pile fabrics has been lately invented by Mr. Fred. Pearson. This invention consists of a mechanism for the proper feeding of the pile warp into the harness, and is placed in such a position in the loom as to prevent any fibres or other substances, which may be freed from the warp yarn as it passes over the mechanism (friction rollers), from falling into the latter, and thus injuring the warp-yarn as well as clogging the mechanism. Another advantage Mr. Pearson assigns to his invention is the means provided by which this feeding mechanism can be easily thrown out of action, so as to allow the weaving of the ordinary close-stitched double-cloth required for the weaving of a proper heading at the beginning and ending of each cut. The mechanism is also arranged to permit a quick and correct changing of the amount of pile warp to be delivered, as regulated by the height of pile required for the fabrics woven, by substituting a smaller or larger worm-wheel upon the axle of the main roll.

Diagrams Figs. 880 and 881 illustrate this mechanism.

Fig. 880 is a side elevation of the rear part of a loom or attachment to a common cam-loom, and embodying Mr. Pearson's invention.

Fig. 881 is a sectional elevation, showing the delivering of pile warps (from two beams) and

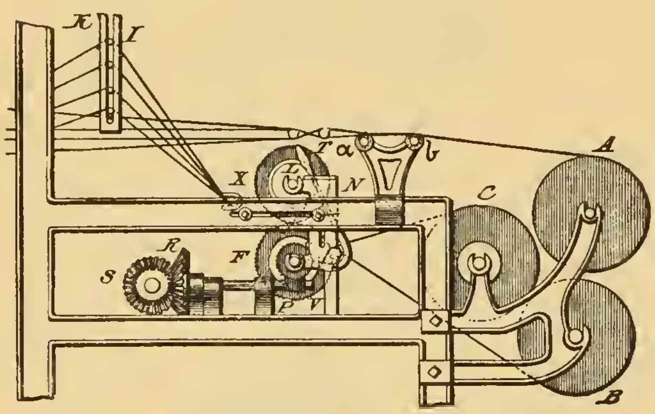


Fig. 880.

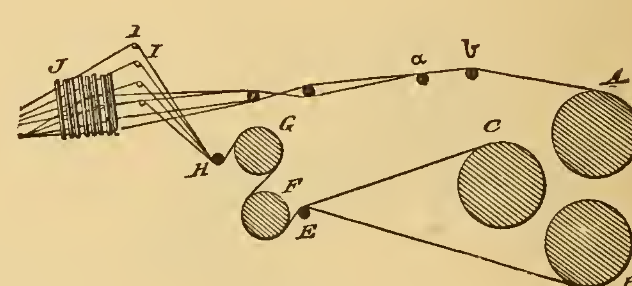


Fig. 881.

the direction of the running off of the ground warps (from one beam). The respective parts with the letters of references given (the same for both Figs.) will in a great measure explain the *modus operandi*.

A represents the beam for the ground-warps; *B* and *C*, the beams for the pile warps; *E* and *H*, the guide-rollers; *F* and *G*, the main or friction-rollers, whose axes are mounted in open bearings in an adjustable bracket *N*, attached to and mounted upon the main frame of the loom.

The axis of the lower friction-roller is provided at one end with a worm-wheel which gears into a worm *P* on one end of a horizontal shaft, which is driven by gear wheels *R* and *S*. Upon the opposite ends of the axes of the friction-rolls are mounted gear wheels *V X*, which gear into each other. *J* represents the harness frames.

An examination of Fig. 881, with regard to the direction of running the pile warps and ground warps of the fabric, gives us as follows:

The pile warp-threads, upon the beams *B* and *C*, are, together, carried over the guide roll *E*, under and around the main roll *F*, and around the main roll *G*, under the guide-roll *H*, and over the horizontal yielding, or spring-supported rods *I* contained in the vertical guides *K*, and are thence run to the heddles. The ground warp-threads upon beam *A* are carried over supporting or guide-rollers *a b* to the harness-frames.

At the beginning of the description of this invention we mentioned that a part of the claim was based upon allowing a quick changing from pile weaving to a weaving of regular close-stitched double-cloth used as headings for the fabrics. This is accomplished by shifting lever *T* to the right (*i. e.*, towards the rear of the loom), thus elevating friction-roller *F* and its worm-wheel, carrying the latter out of contact or gear with the worm *P*, whereby the revolution of the main rollers *F* and *G* will be discontinued and the feeding of pile warp-threads to the heddles will be stopped.

Another method for arranging the beams for pile warps and ground warps in the loom in weaving double plush is that used by Mr. R. H. Patton. In looms of his construction the beam carrying the ground warp is situated in the rear part of the frame, as built in addition to his regular cam loom for operating the harness. The beams carrying the pile warps rest in the upper middle part of said frame. To give a clearer understanding diagram Fig. 882 has been designed. In this *A* indicates the side of the frame previously alluded to, *B* the beam carrying the ground warp, and *C* and *D* the beams for both sets of pile warps. In the present style of arranging the beams for the pile warp and guiding those warps in their run to the delivering

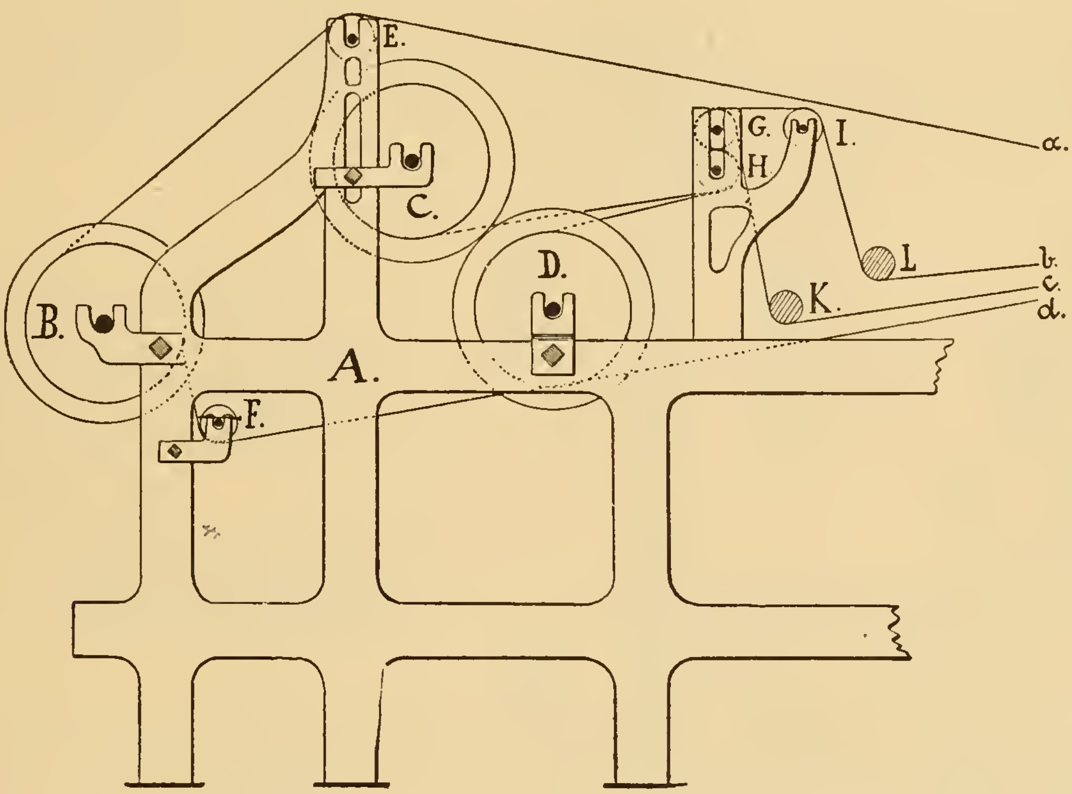


Fig. 882.

rollers *H G*, and from there to the respective harness, one great advantage over that of the previously shown methods will be readily noticed, *i. e.*, that the pile warps are delivered to their respective heddles without crossing the ground system, and consequently any possible chafing is avoided. The ground warp for the upper cloth in the loom passes from the warp beam *B* over stationary guide-roller *E* towards the harness frames; this set of threads being indicated by letter *a*. The other set of ground warps required for the lower cloth passes from beam *B* below guide roll *F* and from there direct to the respective harness frames. This set of ground or body warp has been indicated by the letter *d*. The two sets of pile warp, one from beam *C* and one from beam *D*, are guided from their respective beams into the delivering rollers *G* and *H*. The lower roller (*H*) is covered with a fine sand-paper, while the one above is covered with a plush fabric. After leaving the delivering rollers one set of the pile threads is passed over guide-roll *J* and below guide-roller *L*, and the other set below guide-roller *K*. Each of these two guide-rollers is adjusted to a lever which is on one extreme end connected with the loom frame and on the opposite end has adjusted a spring which is fastened to the floor. These springs will greatly assist in easing up the "beating home" of the pile warp. The let-off of the pile warp is regulated by sproked gears adjustable to the axis of the delivering roller *H* and gets the motion from the "take-up" by means of a chain belt. The present method of delivering pile warps allows the harness in the front part of the loom to be arranged for an extremely high pile, *i. e.*, the keeping of the two sets of ground warp—ground cloth—as far apart as possible.

The bracket for holding guide-roller *F* can also be applied to the centre standard of the frame.

Double Pile Fabrics Made with a Proportionally Higher Pile.

In some double pile fabrics a greater length of pile may be required than the one which can be produced on a common loom. To overcome this difficulty James, Fred. and George Priestley have lately invented an improvement on the lay, suitable to be adopted for any loom. To secure a proportionally higher pile their patent advises the cutting away of a large portion of the solid part of the lay and inserting small steel plates set upon edge. Each plate reaches across the cut-out part of the lay, and the tops of all the steel plates are in a line and carry the shuttle when in operation. The warp-threads of the bottom fabric drop into the spaces between the steel plates and are well out of the way of the shuttle when the top or upper fabric is being woven, and at the same time the pile-threads are kept tight and at full stretch between the two fabrics.

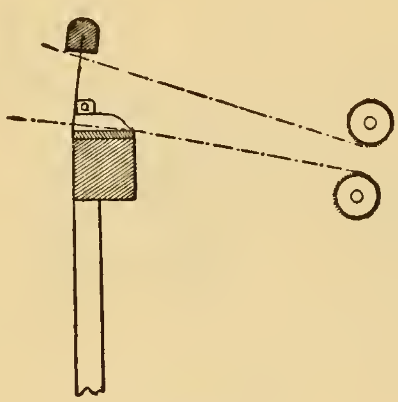


Fig. 883*a*.

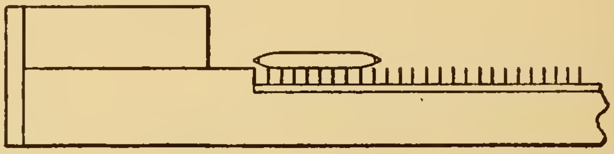


Fig. 883*b*.

Fig. 883*c*.

Diagram Fig. 883*a* illustrates the sectional side-elevation of a portion of the lay of a common loom which is fitted up with such steel plates.

Fig. 883*b* represents an elevation of the latter, and Fig. 883*c* illustrates a plan of a portion of the same.

Figured Double Pile Fabrics.

Double pile fabrics are also produced by means of the Jacquard machine. Various methods of operation as well as different makes of looms exist for effecting this process.

Diagrams Figs. 884 to 891 illustrate a specimen of such a loom and the method of operation for weaving figured double pile fabrics, which was invented and patented by T. J. Shuttleworth.

The said diagrams illustrate a loom for weaving figured double pile fabrics for operating the pile-threads whereby on the rise of the Jacquard lifter-board any desired pile-thread may be drawn down from the upper warp into the lower fabric or drawn up from the lower warp into the upper fabric, so as to produce two fabrics having a corresponding figure.

In diagrams Figs. 884, 885 and 886 the method of interlacing the two fabrics is clearly demonstrated.

Fig. 887 represents a loom showing sufficient to give one a proper understanding.

Figs. 888 and 889 are diagrams illustrating the operation of the heddles controlling the ground warp-threads.

Figs. 890 and 891 illustrate the operation of the heddles controlling the pile warp-threads. Each of the fabrics has a number of pile-warps (indicated *x*) and two sets of ground backing threads (see *y*), the number of pile-warps depending upon the number of colors in the pattern to be produced.

The operation of weaving the fabric will be understood upon reference to Figs. 884, 885 and 886. In Fig. 884 the threads are represented as they appear after the figuring pile-warps have been drawn from the upper to the lower and the lower to the upper fabric and bound in by picks 1, all of the upper pile-warps being then elevated and the lower pile-warps depressed and the ground or backing warps of each fabric crossed, so as to form upper and lower sheds for the insertion of

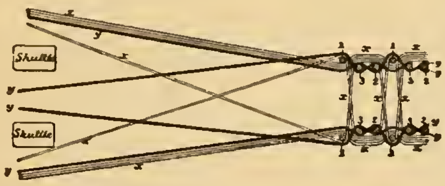


FIG. 884.

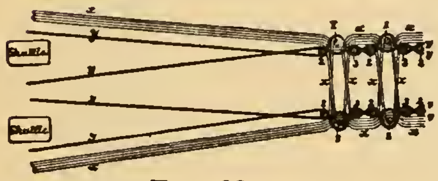


FIG. 885.

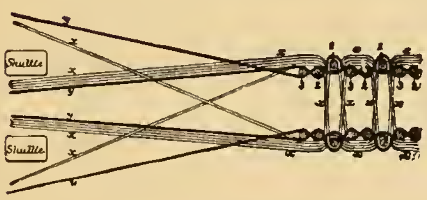


FIG. 886.

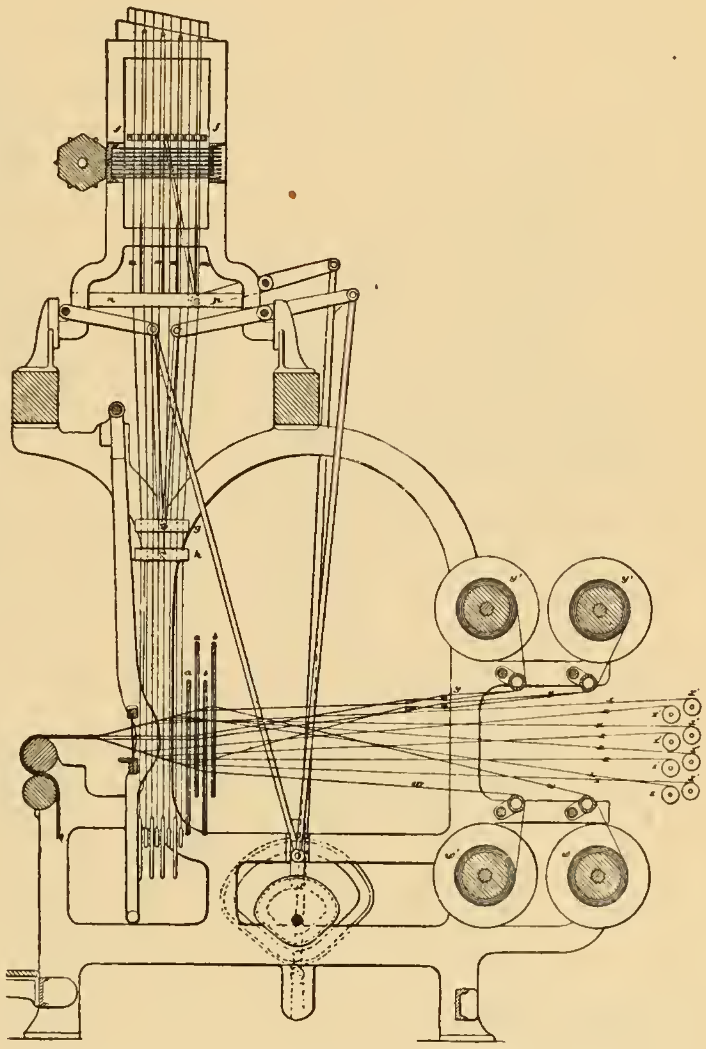


FIG. 887.

the binder picks 2, which are thrown in and beaten up and the ground-warps of each fabric then again crossed, as shown in Fig. 885, to form sheds for the binder picks 3, and after throwing in these picks the ground-warps of each fabric are again crossed to form upper and lower sheds, all of the upper pile-warps except those for the figure being lowered to the level of the bottom of the upper shed, and all of the lower pile-warps except those for the figure being raised to the level of the top of the lower shed, as shown in Fig. 886.

Such of the upper pile-warps as are necessary to form the figure are drawn down into the lower shed; and such of the lower pile-warps as the figure demands are lifted into the upper shed, as shown in Fig. 886, preparatory to throwing in the binder picks which confine said figuring pile-threads on the backs of the fabric; the operations being then repeated. As shown in the drawings, accompanying these explanations, such of the pile-warps as are necessary to form the figures are drawn across from one fabric to the other on every third pick; but, if desired, only one binder pick may be put in on the face of the fabric between successive tufts of the pile. The mechanism for effecting the movements of the threads which we described, is shown in Fig. 887. The heddles which control the ground warp-threads have double eyes, as shown in Figs. 888 and 889. The threads of the upper fabric pass through the upper eyes of the heddles, and the threads of the lower fabric through the lower eyes, these eyes being so related and the lift of the heddles being such as to effect the proper formation of the upper and lower sheds. Each of the pile-warps is controlled by a harness thread connected to one of the needles of the Jacquard, (see Figs. 890 and 891) and passing through the usual notched eye in the lifter board, above the Jacquard needles, each harness-thread having a knot above the lifter-board, so that when the thread is adjusted by the needle to bring this knot over a notch of the board, this knot and that

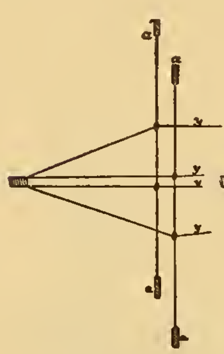


FIG. 888.

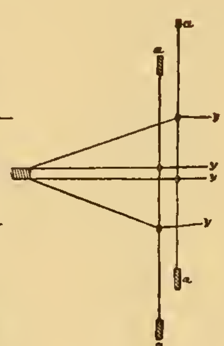


FIG. 889.

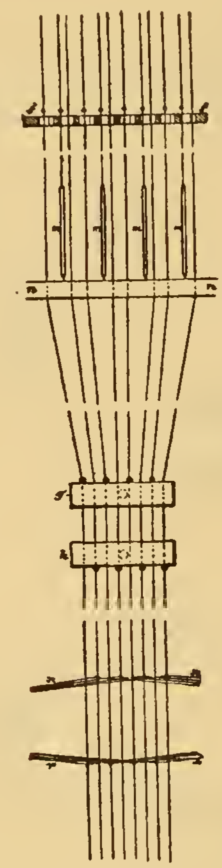


FIG. 890.

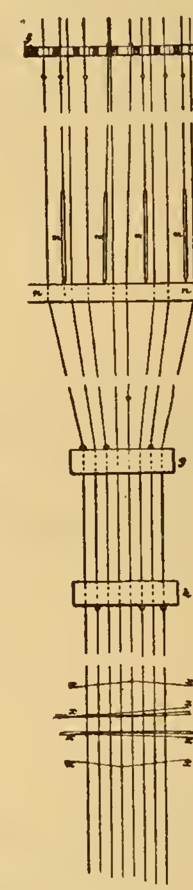


FIG. 891.

portion of the thread in which it is formed will be lifted by the board as it rises, there being no lift of those threads the knots of which remain in line with the eyes of the lifter-board.

The movement of the entire body of warps, except those necessary to form the figure, is effected by comber-boards *g* and *h*, Figs. 890 and 891, the upper of which, in the present instance, acts upon knots upon the harness-threads of the pile-warps of the lower fabric, while the lower board acts upon knots upon the harness-threads of the pile-warps of the upper fabric, and these boards are caused to move toward and apart from each other, so that on the rise of the upper board, *g*, all of the pile-warps of the lower fabric, except the figure-warps, will be lifted from the position shown in Figs. 884 and 885 to that shown in Fig. 886, the descent of the lower board, *h*, causing the corresponding pile-warps of the upper fabric to drop to the same extent. The comber-boards remain separated while the binding-shots 1 are being thrown in, after which they are drawn together, so as to restore the warps under their control to the positions shown in Figs. 884 and 885.

Such of the pile-warps as are desired to form the figure are by means of the Jacquard brought under control of the lifter-board, which has a movement in excess of that imparted to the comber-boards, so that the figuring pile-warps will be carried up or down into the opposite fabric.

The figuring-threads of the lower pile-warp are simply elevated by the action of the lifter-board as the latter rises in the usual manner; but it is necessary to transform this rising movement of the lifter-board into a downward movement of the figuring-threads of the upper pile-warp; hence each of the harness-threads of the upper pile-warps must be passed around a pulley or other bearing so as to double it back upon itself, pass it again through the eye of the lifter-board, and connect it at the lower end to a strip *m*, Figs. 890 and 891, of rubber or other elastic material, secured to the guide-board *n* below the Jacquard apparatus. The lifter-board acts upon a knot on this returned portion of the harness-thread, so that the lift of the board serves to stretch the spring and permit the drop of the weighted portion of the harness-thread which controls the

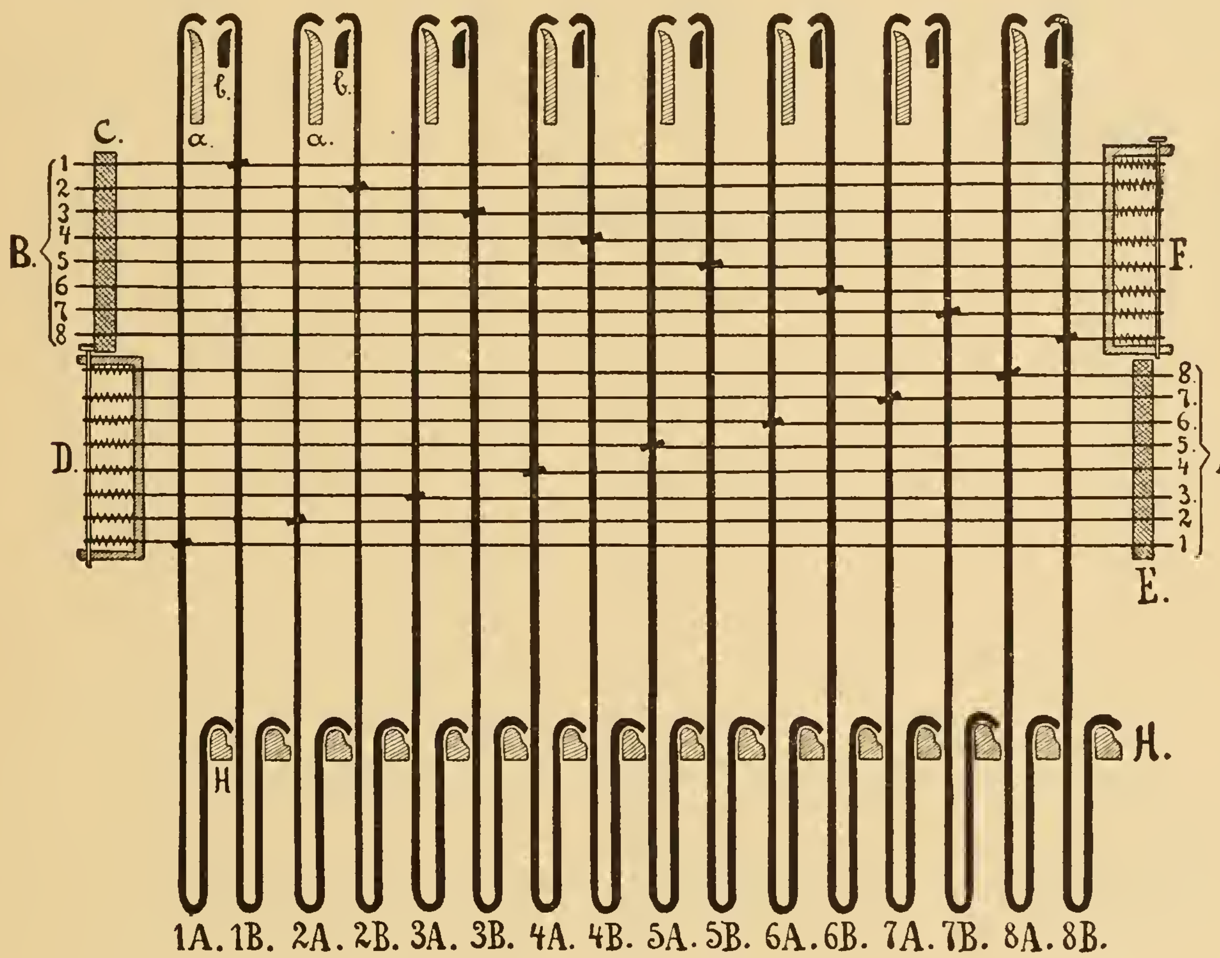


FIG. 892.

warp-thread, this warp-thread being lifted on the descent of the board by reason of the contraction of the spring *m*, which exerts a force considerably in excess of the weight.

The lifter-board of the Jacquard is operated by a cam on a shaft, the cam acting on a slide which is connected by a rod to a lever connected to the lifter-board by a rod.

The comber-boards are operated by another cam on the shaft mentioned before, this cam acting on a slide which is connected by a rod to a lever, and by another rod to an arm; the lever before mentioned being connected by a rod to the upper comber-board, and the arm also previously mentioned is connected by a rod to the lower comber-board, so that the desired movements of both comber-boards towards and from each other are effected.

The principle thus far explained of weaving these double pile fabrics can also be used in connection with a Jacquard apparatus in which griffe-bars are used in place of an eyed and notched lifter-board, and hooks are used instead of knots in the harness.

Figured Double Plush Produced upon a Jacquard Machine Containing a Stationary and a Raising "Griffe," and also a Lowering (Falling) "Grate" or "Rester."

Mr. T. Halton has lately applied for a patent for a Jacquard machine for weaving "*figured double pile fabrics*," which is very simple and effective in its method of construction. This machine resembles to a certain extent a double-lift double-cylinder Jacquard machine used in weaving damasks, dress-goods, etc. This new Jacquard machine has also two sets of griffe-bars (similar to the double-lift double-cylinder), but only one set raises while the other remains

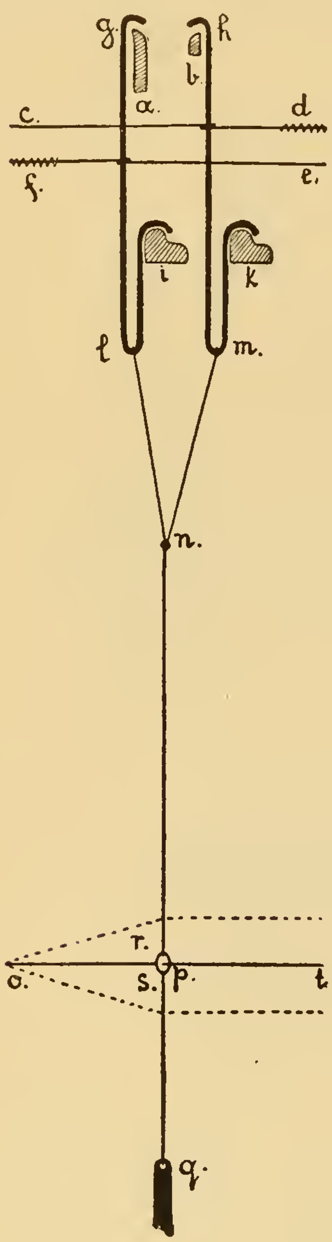


FIG. 893*A*.

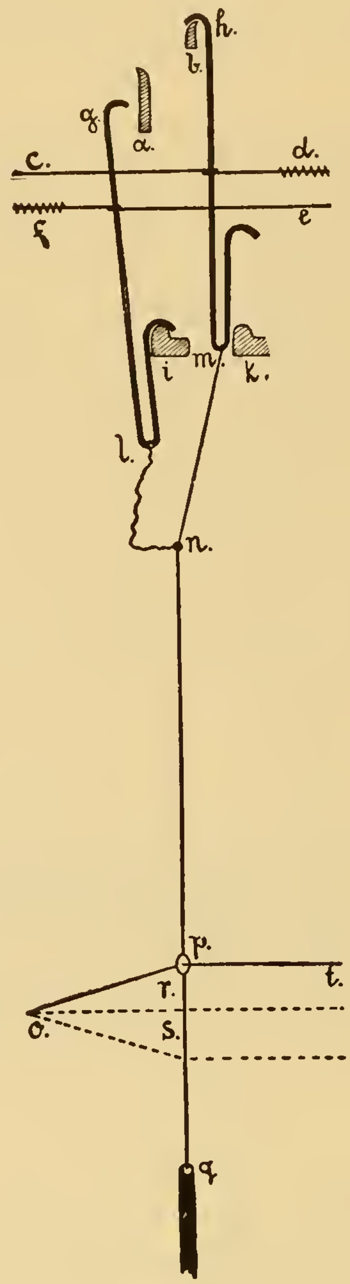


FIG. 893*B*.

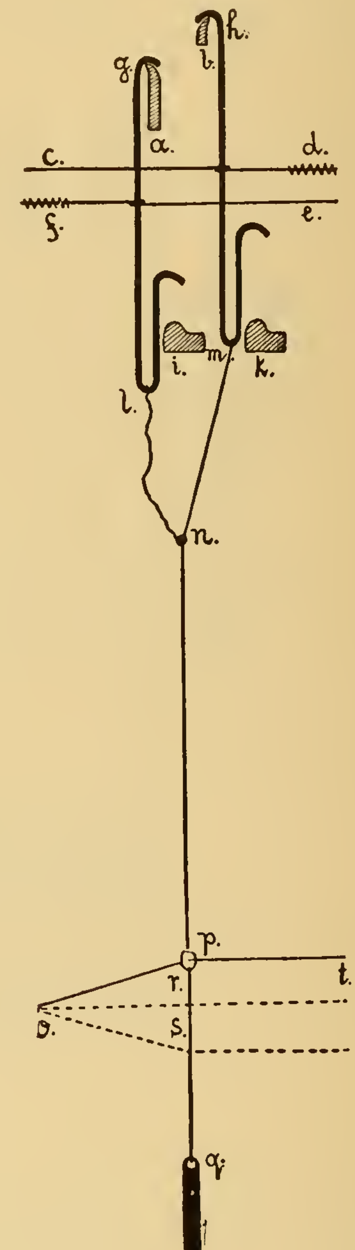


FIG. 893*C*.

stationary. The "grate" or "rester" for the hooks in the new machine is arranged to lower simultaneously when the previously mentioned griffe raises, and again raises to its starting-point as soon as the griffe lowers to its point of starting. The cylinders of the Jacquard machine for weaving figured double pile fabrics are operated on at the same time, while the cylinders of the Jacquard machine, known as "double-lift double-cylinders," are operated on alternately.

To give a clearer illustration of the construction of the machine, Fig. 892 has been designed. It represents the section of a four-hundred Jacquard machine for weaving figured double pile fabrics.

At the point indicated by *A*, one vertical row of one set of needles is shown (*E* = needle board, *D* = spring box). At *B* one vertical row of the second set of needles is shown (*C* = needle board, *F* = spring box).

a represents sections of stationary griffe-bars (shown shaded); *b* represents sections of raising griffe-bars (shown in black); *H* represents sections of the grate or rester (for holding the hooks in the required position and also for guiding the latter in their lowering, if not called for by either one of the griffe-bars).

Hooks 1 *A* and 1 *B* have their neck-cords connected to the same leash. (Also 2 *A* and 2 *B*; 3 *A* and 3 *B*; 4 *A* and 4 *B*, etc.)

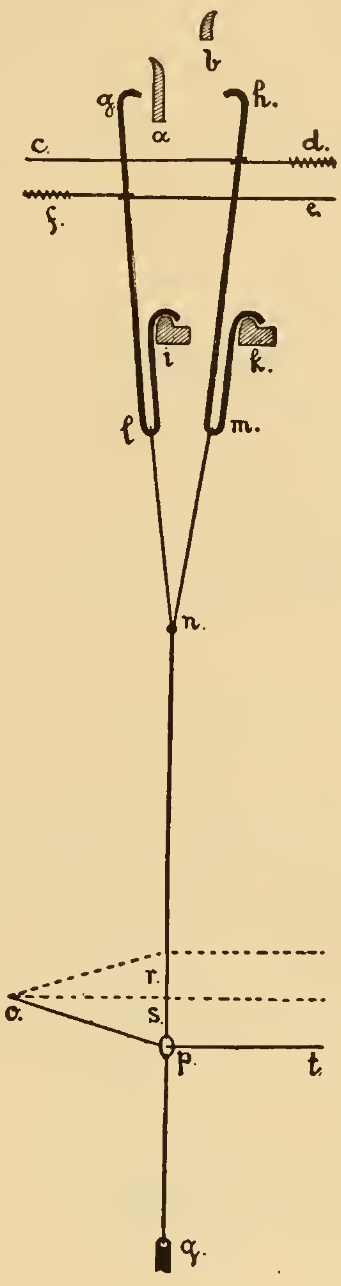


FIG. 893*D*.

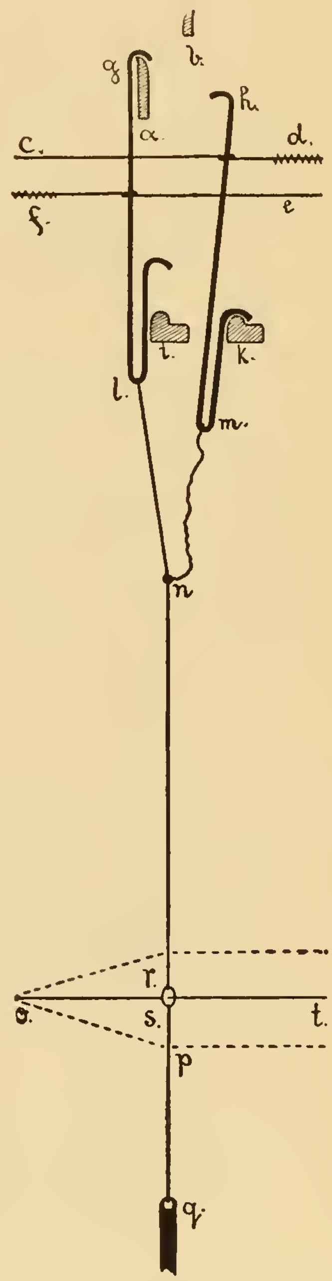


FIG. 893*E*.

Figs. 893 *A*, *B*, *C*, *D* and *E* illustrate the *modus operandi* of the machine and its harness. Two hooks, operating the same warp-threads, are used for illustrating the principle. Letters of reference indicate like parts in each diagram.

g–l and *h–m* are the previously mentioned two hooks; *e–f* the needle for operating the hook *g–l*; *c–d* the needle for operating the hook *h–m*; *a* is the stationary griffe-bar; *b* is the raising griffe-bar; *l–n* and *m–n* are the neck-cords; *p* is the heddle eye; *r* and *s* the double shed required; *q* the lingo, and *o* the last woven part of the fabric.

Diagram Fig. 893*A* shows the hooks at rest; or in a position similar to that in Fig. 892 (the complete section of a 400-machine); thus the warps will rest in the loom in the position shown by the full line *o-p-t*, or in the centre.

Diagrams Fig. 893 *B* and *C* illustrate the raising of a warp-thread in the upper section of the top shed (*r*). (See full line *o-p-t*.) In diagram 893*B* this is accomplished by punching a hole in the cards for needle *c*, and none in the other card at the place where needle *e* strikes. Consequently hook *h-m*, not operated on by its needle (hole in card), will be caught by the ascending griffe *b*, and in turn raise the warp-threads by means of the harness cord in the upper section of the top shed (*r*). (See full line *o-p-t*.) The hook *g-l*, which is thrown backwards by reason of its mate needle *e* having no hole cut in the card, is thus placed out of reach of the stationary griffe-bar and descends with the lowering of the rester *i* until it reaches the base, as shown in the present diagram. This, consequently, will have no effect upon the warp-thread, and nothing else will be produced but the slackening of the corresponding neckcord *l-n*, as represented in the diagram.

In diagram Fig. 893*C* the same effect (as in Fig. 893*B*) for the warp-thread (or its raising into the upper section of the top shed is produced by having two holes cut for both needles (for needle *e* in the card of the other set). Cutting a hole for needle *e* will leave hook *g-l* in its vertical position and the crook of the hook will be caught by the stationary griffe, which will hold it during the downward movement of the rester. The movement of hook *h-m* and its result upon the corresponding warp-threads being the same as in the previously explained diagram, the only difference between adopting either plan *B* or *C*, is the lesser amount of slackening of the neck-cord *l-n* which is out of action in using the plan as illustrated by diagram *C*.

Diagram 893*D* shows the warp-thread in the lower section of the bottom shed *s*. (See full line *o-p-t*.) This movement is accomplished by cutting no hole for either needle in its corresponding place in the card, consequently throwing off each hook from either griffe, which will result in the lowering of both hooks by means of rester bars *i* and *k*.

Diagram Fig. 893*E* shows the method of operation necessary if a warp-thread is required to remain in the centre, thus forming the bottom of the upper shed *r* and the top of the lower shed *s*. In this case no hole must be cut in the card for needle *c*, and a hole in the card from the other set for needle *e* to penetrate. Hook *g-l* will thus remain over the stationary griffe-bar (*a*) while the mate hook *h-m* has its crook thrown out of reach of the raising griffe *b*, and consequently descends with the lowering of the rester.

TERRY PILE FABRICS

In which the Pile is Produced During Weaving Without the Aid of Wires.

Pile fabrics in which the pile-threads are raised without the aid of wires are fabrics known as "Turkish toweling" and certain kinds of scarfs used for ornamentation on chairs, bureaus, etc. In the manufacture of these fabrics two (or more) warp-beams are required—one to carry the "pile-warp" for the formation of the loop and the other to carry the "ground-warp" for forming the body of the fabric.

Method of Operation for Producing the "Loop" or "Terry" Pile.

In the process of weaving a terry fabric the upper or terry series of warps is weighted lighter than the lower or body series, for the purpose of allowing the loops to be formed on the surface by the lay swinging or being driven fully up to the body already manufactured after several or one or two picks of the filling have been shot from the shuttle and but partially beaten up, those picks having in the meantime so tightened upon the upper or "terry" warps that the latter are forced with them by the full beat fully up, and thereby forming the pile loops or terry.

Fig. 894*a*.

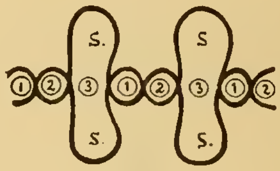


Fig. 894*b*.

The three (or more) picks so interwoven will have slid on the ground-warp, which remains tight during the entire process of weaving.

To illustrate the method of operation more clearly Figs. 894*a* and 894*b* have been designed. In Fig. 894*a* the pick, indicated by *o*, represents the edge of the cloth. At the first stroke of the lay the first pick, 1, is not driven home. At the second stroke the second pick, 2, is driven against the first pick, 1, and no further; but the third pick, 3, is driven home towards *o*. This pick will in turn naturally take picks 1 and 2 along, pressing them up against the finished edge of the cloth (*o*).

The pile or "terry" warp will thus form the loops *s*, as shown in Fig. 894*b*.

Fig. 895*a* illustrates the drawing-in draft for the regular terry cloth. Harness 1 and 2 are for the pile, harness 3 and 4 for the ground-warp. Fig. 895*b* represents the weave or harness-chain for the above illustrated drawing-in draft.

To give a more perfect understanding of the method of operation in the present style of terry weaving, Figs. 896, 897 and 898 are designed, illustrating the operation of a terry loom patented by Messrs. Holt & Mellor.

Fig. 896 is a cross-sectional elevation of part of a terry loom necessary for properly illustrating the explanations to follow.

Fig. 897 is a plan-view of the same.

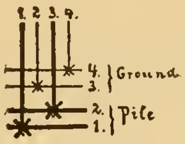


FIG. 895*a*.

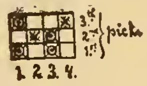


FIG. 895*b*.

Fig. 898 is an enlarged cross-sectional view of the upper part of the lay and the breastbeam.

The operation is as follows: When the cam *D* (see Fig. 897) does not raise the lever *E*, the frame remains lowered, as do also the arms *L*, and when the lay swings toward the breastbeam the outer ends of the arms *L* come in contact with the inner ends of the screws *N* (see Figs. 896 and 897), whereby the arms *L* will be pushed in the inverse direction of the movement of the lay—that is, in the direction of the arrow *b'*—thereby swinging backward the reed and preventing it from driving the last pick home—that is, preventing the reed from driving the last pick against the finished edge of the cloth; but if the cam *D* raises the lever *E* the frame *F* will be moved upward and the arms *L* will be raised so that their shoulders engage with the face of

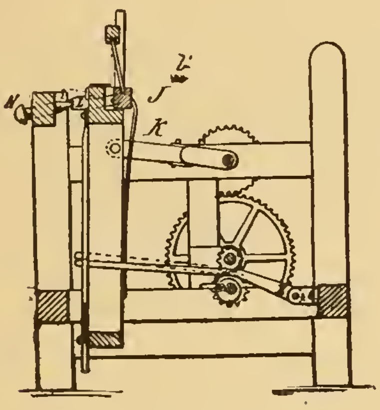


FIG. 896.

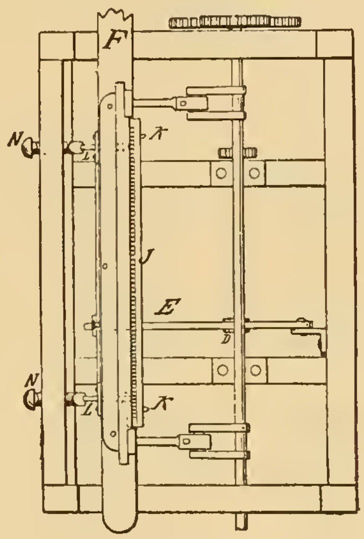


FIG. 897.

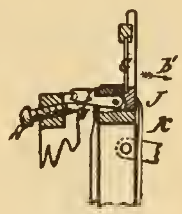


FIG. 898.

the lay, and the free ends of the arms *L* will be raised to such an extent that they will pass over the beveled ends of the screws *N*, and the bar *J*, or lower part of the reed, will not be pressed in the direction of the arrow *b'*, thus permitting the reed to drive the last pick home, as represented in diagram Fig. 898.

The loom can also be so constructed as to drive the second, third, fourth, fifth or sixth pick home, as may be desired, and according to the number of loops desired in the fabric. The length of the loops is adjusted by means of the screws *N*, for the farther the screws project from the breastbeam the greater will be the distance that the bar *J* is swung back, and thus the greater will be the distance between the finished edge of the cloth and the first pick.

Diagrams Figs. 899, 900, 901 and 902 illustrate the principle of construction and the operation of a loom for weaving terry fabrics patented by N. A. Woodhead.

Fig. 899 is an end or cross-sectional elevation of the loom with the movable journal-boxes and crank-shaft thrown fully back, as when partially beating up the filling.

Fig. 900 is a cross-sectional elevation of it without the gear-wheels, showing the journal-boxes and crank-shaft thrown forward and the lay forced fully up.

Fig. 901 is a top view. Fig. 902 is a detail view showing one of the journal boxes and part of its supporting lever, its adjusting screw, and the device for locking the lever and box in a

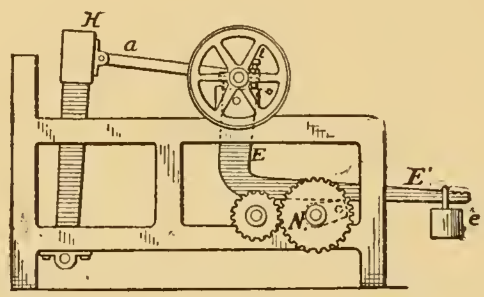


Fig. 899.

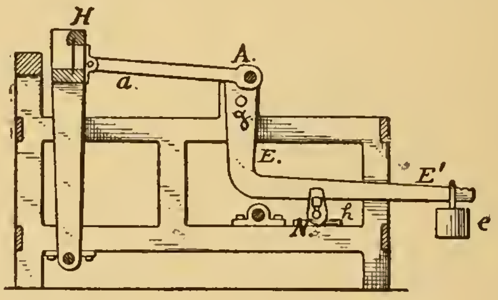


Fig. 900.

forward position for the production of a plain fabric. (Letters indicating the different parts for reference are selected to correspond in all four diagrams.)

The method of operation of the loom thus forming the terry pile is as follows:

The crank-shaft *A* when revolving drives to and fro the lay *H* by means of the rods *a*, communicating with the cranks *b b*, and thus drives the picks partially up at each revolution, when it is thrown back, as illustrated in Fig. 899. In order, however, to produce the terry loop the entire shaft *A* is, after two picks, thrown forward to a point where, when the cranks *b* arrive on a horizontal plane toward the lay *H*, the lay will be caused to make a full beat, driving the picks full up, and producing the terry or pile loop.

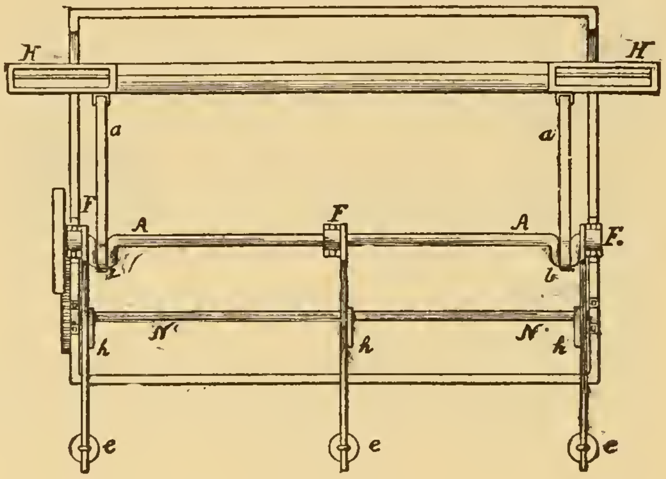


Fig. 901.

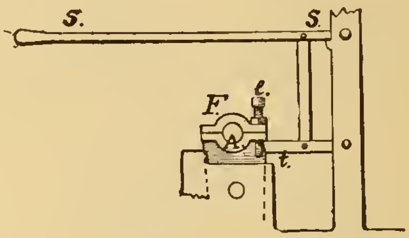


Fig. 902.

The shaft *A*, when it is desired that the loop shall be formed at every third pick, is arranged to revolve by a proper adjustment of the gearing three times while the cam shaft *N* revolves once. When the cams *h* of the cam-shaft *N* are in any position other than an upright position, the lower arm *E'* is at rest, being borne down and held in that position by the weight *e*. As a natural consequence, by reason of the pivotal bearing at *g*, the knee of the arms *E E'* is thrown forward, while the journal boxes *F* of the shaft *A*, being firmly fixed to the arms *E E'*, are thrown back, and the shaft *A*, while revolving in this position, produces by means of the lay but a partial beat of the picks, one throw of the shuttle being made to each revolution of the shaft *A*. When, however, the cams *h* of the cam-shaft *N*, by the revolution of the shaft, begin to assume an upright position, pressing against the lower edge of the arms *E′* as shown in the drawings, the arms *E′* are gradually raised until they assume a horizontal position and thereby, by reason of the pivotal bearing *g*, throw the boxes *F*, adjusted to the extreme upper ends of the arms *E* and containing the crank-shaft *A*, completely forward. Then the shaft, revolving to the proper point, produces a full beat of the lay and makes in the fabric the terry or pile loop at the desired interval.

The length of the terry-loop is regulated by means of the screw *l*, adjusted to the journal boxes *F*. By screwing down the screw the terry-loop is shortened by the shaft *A* being prevented from going as far back as it otherwise would by reason of the lower end of the screw coming in contact with the loom-frame, consequently allowing the short beats of the picks to be driven more nearly full up. When the screw *l* is screwed up, the arms *E′* fall fully down when released from the cam *h* and throw the shaft *A* full back, and this produces an extremely long terry-loop. By this means a terry-loop of any desired length can be produced.

When it is desired to throw the terry devices out of operation and to weave a plain fabric, the lever *S*, connecting with the lug *t*, as shown in Fig. 902, is depressed, the lug *t* thereby engaging the movable journal-box *F*, and, preventing the backward motion, holds it firmly in position and allows of the lay *H* beating full up at every revolution of the shaft *A*.

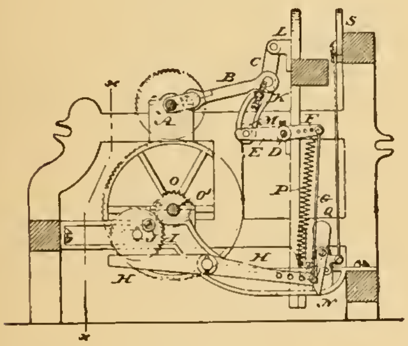


FIG. 903.

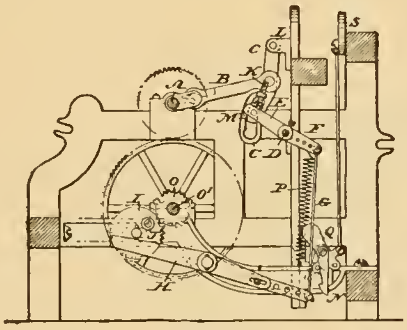


FIG. 904.

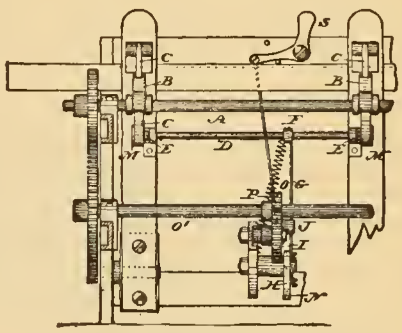


FIG. 905.

Some "terry" fabrics require a combination of the terry pile weaving and the common plain weaving; both systems of weaving to exchange alternately (and sometimes more frequently) in one length of the fabric. For such fabrics the loom illustrated in diagrams Figs. 903, 904 and 905 (as is claimed by its inventor, C. Strobel), is of special advantage.

Figs. 903 and 904 represent vertical sections of the loom; the parts being shown in different positions.

Fig. 905 represents a vertical section of the loom in line *x x* Fig. 903. The shedding, picking and take up motions are substantially the same as are ordinarily used in looms. (The letters of reference in all these drawings are identical.)

The crank and cam shafts *A O′* are geared by gear-wheels, each mounted on shafts and meshing together, and are driven in the usual way. While the rollers *M* are in the bottoms of the slots in the links or levers C the lay will travel forward to a fixed line, this being the cloth making line of the fabric. The roller *J* on the gear *I* at each revolution of the latter, if the lever *H* is not engaged by the hook *N*, presses down the rear end of the lever *H*, causing the forward end to rise, and through the rod *G* and the arm *F* to rock the shaft *D* until the rollers *M* reach the bottoms of the slots of the links *C*. The spring *P*, connected with the arm *F* on the rock-shaft *D*, keeps the rollers *M* in the upper part of the slots of the links *C* when the lever *H* is free from the hook *N* and is not acted on by the roller *J*. When the rollers are in this elevated position, the lay will not travel as far forward as the cloth-forming line, owing to the pivots of the pitmen *B* having been given a lateral movement toward the lay, thus shortening the distance between the crank-shaft and the lay. It will be understood that during these short movements of the lay the filling will be only partially beaten up. The number of short or partial beats to each full beat may be varied by changing the gears *I* or *O*. The present illustrations show the loom arranged so as to have two short strokes to each long or full stroke or beat. At each third pick the lever *H* will be depressed by the roller *J* on the gear *I*, causing it to bring the arms *E* on the shaft *D* to a horizontal position, thus giving the pivots of the pitmen *B* a movement away from the lay, and increasing the distance between the crank-shaft and the lay. By this means the lay in its next forward movement will be moved forward to the cloth-making line, beating home the previously inserted two picks and causing the terry warp-threads to be looped or raised from the body of the cloth. The screws *K*, passing through the side projections of links *C*, act as stops for the roller-supporting levers *E*, limiting their upward movement, thus regulating the length of the terry-loops, making them longer or shorter, as desired. The arms *F* may be given more or less movement by shifting the pivots or screws, by which the connecting-rod *G* is attached to the arm *F* or to the lever *H*. When it is desired to do plain weaving, the

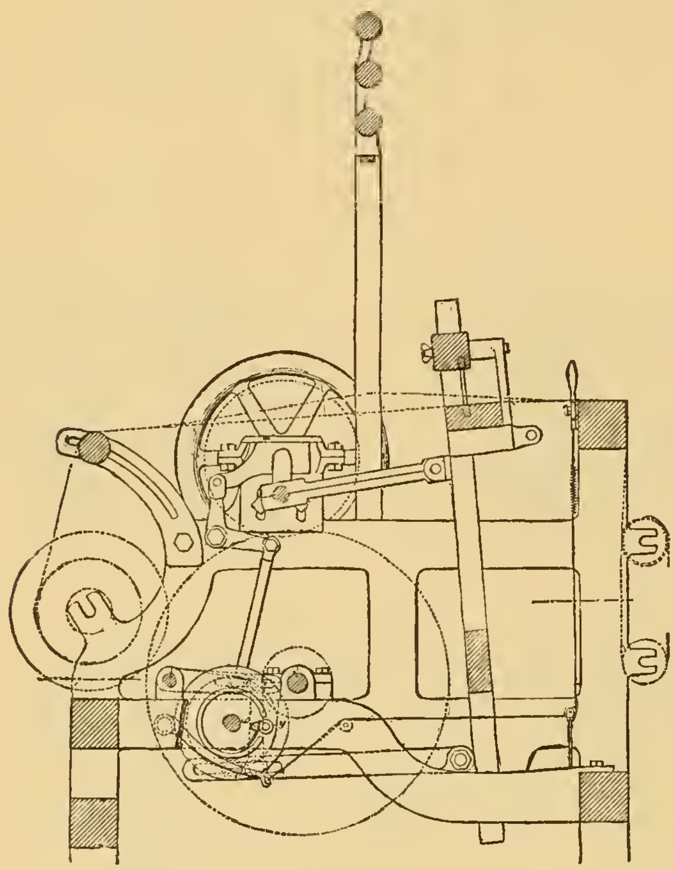


Fig. 906.

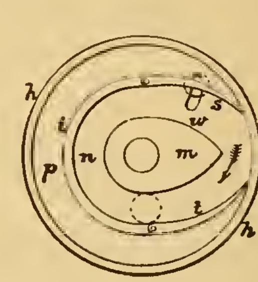


Fig. 907.

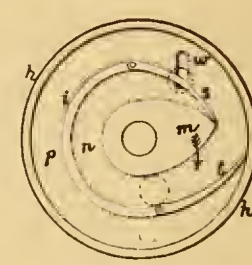


Fig. 908.

hand-lever *S* on the breastbeam is moved to the right, causing the lever *Q* to act on the hook *M*, pressing it toward the lever *H*, when it will hook under and lock the lever *H* as soon as the lever is raised to the proper height. The parts will remain in these positions until the hand-lever *S* is thrown to the left, thus unlocking the lever *H* from the hook *N*, when the loom will be in condition for terry-weaving, all these changes being accomplished without stopping the loom.

Before closing the chapter on the construction of the various looms for weaving terry fabrics we refer to the patent of T. A. Brady, it being a loom for weaving terry-pile fabrics such as Turkish towelings, etc., and in which there is a different throw or beat of the lathe, due to the shifting of the boxes or bearings for the crank-shaft of the loom. The shifting of the boxes carrying the crank-shaft is effected by means of a grooved cam.

Figs. 906, 907 and 908 are drawings illustrating the principle of this operation.

Fig. 906 is a longitudinal section of parts of a loom sufficient to illustrate the present explanations.

Figs. 907 and 908 are drawings representing enlarged face views of the cam by which the parts are operated to effect the shifting of the slides forming the bearings for the crank-shaft, and thus regulating the forward beat (towards the last woven part of the fabric) of the lathe.

The cam has an outer flange, *h*, an intermediate segmental flange, *i*, and a central cam, *m*, the inner portion of which is concentric with the flange *i*, so as to form an inner groove, *n*, while the outer portion of the cam is such as to direct the roller on the stud of an arm fastened on the loom into a groove, *p*, formed between the flange *i* and the outer flange *h*.

Pivoted toes *s* and *t* form continuations of the flange *i*, these toes being such that their ends can be thrown inward, so as to bear upon the nose of the cam *m*, or can be thrown outward, so as to come in contact with the outer flange, *h*, of the cam. The toe *s* has a projecting pin passing through a segmental slot, *w*, in the disk of the cam, and having an anti-friction roller, which is acted upon by a spring, tending to thrust the point of the toe outward against the flange *h* of the cam, so that, supposing the cam to be rotating in the direction of the arrow, Fig. 907, the roller on the stud of the arm would be under the influence of the cam *m* and inner groove *n*, and the arm would be depressed at the proper intervals to effect the forward movement of the slides and the full beat of the lathe. If the toe *s*, however, is adjusted to the position shown in Fig. 908, the roller will traverse the outer groove, *p*, of the cam, and will be free from the influence of the cam *m*, so that there will be no vibration of the arm and no movement of the slides and crank-shaft; thus the lathe will move forward to the full-beat point on each stroke, so as to produce plain or unpiled fabric. The toe *t* serves to bridge the groove *n* when the roller is traversing the outer groove, *p*, there being in such case a practically unbroken flange, *i*, so as to insure the proper guidance of the roller.

In order to permit the ready adjustment of the toe *s* to the position shown in Fig. 908, when such adjustment is desired, hang to one of the frames an arm, which is adapted to act on the roller, carried by the pin of the toe *s*, this arm being connected by a suitable cord to a lever, hung to a stud on the breastbeam of the loom, so as to be within easy reach of the attendant.

For figured terry fabrics as produced on harness-work, the Geo. W. Stafford Manufacturing Company, Providence, R. I., build a dobbie specially adapted for this purpose. This dobbie requires the pegging of two patterns on the chain. By means of the box-chain we can arrange the former to move automatically sideways so as to bring the different patterns, as required by the fabric, under the operation of the hooks. Thus we can weave terry for a certain distance, and then move the chain for ordinary weaving. For very heavy work the "*Positive Dobbie*" must be used, which, by being a "*Double Action*," is very easy on the yarn.

PILE FABRICS OF A SPECIAL METHOD OF CONSTRUCTION.

Smyrna Carpets and Rugs.

These fabrics are made on a loom specially built for their manufacture and is known as the "*Hautelisse Loom*."

Diagram Fig. 909 illustrates a section of this loom. In this loom the warp passes from the beam *g* (upon which it is wrapped) over the guiding roller *f*, through heddles *b*, *c*, down towards the place *a*, where the weaver is situated while at work. The heddles being in a horizontal position are fastened to two rollers, *d* and *e*. The latter (by reason of their turning to the right or left) operate the heddles, which in turn produce the opening of the shed. (The loom, it will be observed, is technically a "vertical loom.")

The pile in these fabrics is produced by inserting, separately, loops of yarn for each square on the designing paper of the respective design. This method of producing the pile in a fabric is a slow and troublesome work, still fabrics showing many varieties of colors can be produced.

The body or ground structure of a Smyrna Carpet or Rug is made with either strong woolen-linen or jute threads, and the pile of a soft woolen yarn.

Diagram Fig. 910 illustrates the method of interlacing (shown in the front view). The vertical threads represent the warp, and the horizontal threads the necessary ground or body picks. At *a* is shown the insertion of a loop (pile). This loop, intertwined with the two warp-threads of the ground structure, is shown separately in its section in Fig. 911.

The body-filling is inserted by a "block," as shown in Fig. 912 (clearly indicating the yarn as wound around it, and leaving this block at the place marked *p*). The beating up of the filling (ground and pile) is effected by means of a comb shown in Fig. 913. In this method of operation

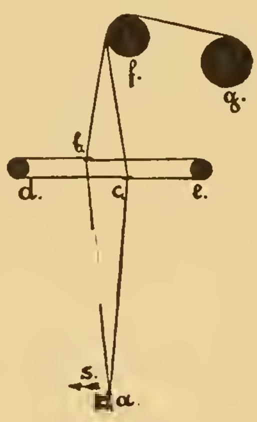


FIG. 909.

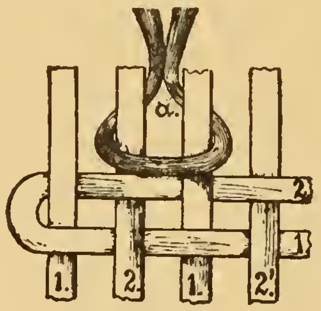


FIG. 910.

FIG. 911.

the weaver inserts two body-picks; next, he places one row of pile loops over the entire width of the fabric (selecting their different colors in accordance with the design which is to be produced). Then he again inserts two body picks (by turning the rollers *d* or *e* for each pick) to be followed by the next row of loops across the fabric; and selecting the colors as required by the design.

This method of alternately exchanging two body picks with one row of loops is repeated until the fabric is finished. On fabrics of a sufficient width two or more persons can operate at once. After the fabric is finished upon the loom it is "sheared" so as to produce an even height of the pile.

This method of tying each individual pile-thread to the ground structure in Smyrna or Turkey carpets and rugs is very laborious, and hence materially increases their cost of manufacture.

FIG. 912.

FIG. 913.

Various methods have been devised to imitate these beautiful fabrics in a way that would give a better production for the manufacturer as well as to provide a mode whereby a certain proportion of any desired number of carpets of the same pattern might be produced in one operation. This has been accomplished quite successfully in a process invented by Messrs. Kohn & Watzlawik and resembles in its main features and principles the explanations given by us in a former chapter, pages 154 to 158, on the manufacture of chenille rugs and carpets, and pages 160 to 165, on the manufacture of chenille fringe.

Such imitations of Turkey carpets are produced mechanically from patterns composed of colored squares that clearly indicate the design and arrangement of the colored squares to be reproduced in the carpet. In the carpet each transverse range of squares corresponds to a pick of pile filling, and each pick of this pile filling consists of a woven strip (or ribbon), the warp of which is composed of wool threads of the required colors. These filling strips have edges containing no filling (fringed) and which are intended to be brushed up for forming the pile of the carpet. These ribbons or filling strips also contain no filling in their centre, for two reasons: To form the imitation of the knot characterizing the real Turkey carpets, and again to reproduce the (pile) pattern of the face in an ordinary woven appearance on the back. These explanations demonstrate that *two operations* are necessary in producing the imitation. *First*, the weaving of the fringed strips or ribbons composed of different colored threads, according to the transverse

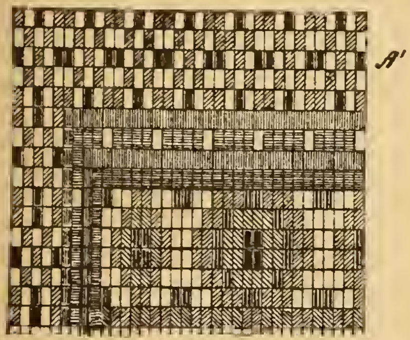


FIG. 914.

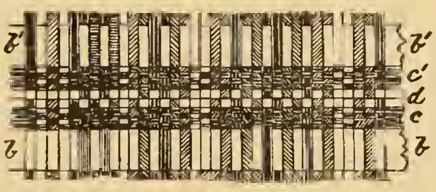


FIG. 915.

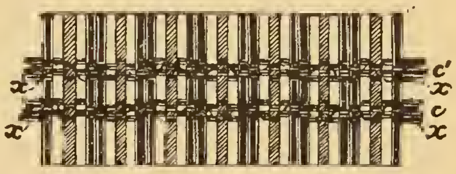


FIG. 916.

ranges of the colored squares in the pattern, and, *second*, the weaving (or setting) of these strips in a common warp to produce the pile carpet.

In diagrams Figs. 914 to 919 a clear illustration of the entire method of operation is given. Fig. 914 illustrates a carpet pattern. Fig. 915 shows one strip (ribbon) cut from a chain corresponding to the upper transverse range (or row) of the pattern Fig. 914. Fig. 916 shows a like strip from which the centre filling has been removed.

Fig. 917 represents the back of the carpet. Fig. 918 illustrates by a perspective view the method of operation at the loom, weaving imitation Turkey carpets. Fig. 919 is a section cut of the shed and two transverse ranges of pile picks previously inserted.

We will next give a short description of the methods for producing the filling strips or ribbons necessary for the construction of the fabric.

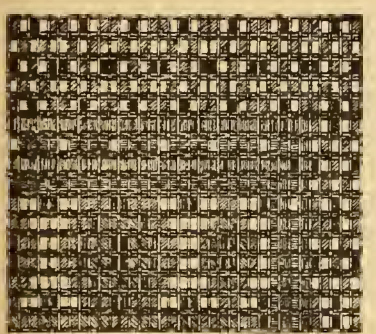


FIG. 917.

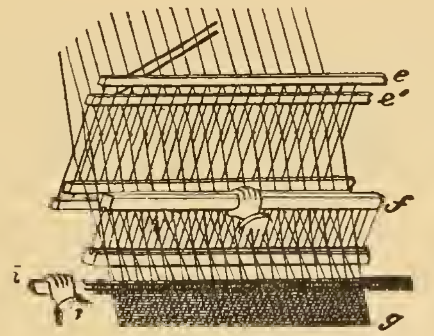


FIG. 918.

FIG. 919.

As many different warps for weaving the chenille strips for a certain carpet are necessary as there are differently figured or colored transverse ranges (rows of squares) in the pattern of the carpet, each warp producing any desired number of fringed filling or pile strips of the same transverse range of colors, that are woven into suitable warps for as many different carpets of the same pattern, or into a warp for one carpet as many times as the transverse range of colors corresponding to the strip or ribbon recurs in the carpet. Thus, for instance, the strip or ribbon shown in Fig. 916 corresponds with the transverse range A' of the pattern shown in Fig. 914, and, supposing that one hundred such ribbons are produced from one chain of warp, they may be used as a strip (pile pick) in one hundred carpets for one transverse range of colored squares in the pattern, or in a given number of carpets for a multiplicity of identical transverse ranges of squares in the pattern. The length of these multicolored warps therefore not only depends on the number of carpets of the same pattern, but also on the number of times the same transverse range of colors is repeated in this pattern, also on the length of the pile of the carpet. After a warp is beamed, it is bound at intervals equal to twice the length of the pile to be formed by a few picks of any suitable filling, the fabric being cut centrally of the fillingless portion on opposite sides of the filling to form the fringes for the pile. The width of these multicolored-wool chains, or, in other words, the length of the filling strips or ribbons to be produced therefrom, corresponds, of course, to the width of the carpet to be produced thereby, and the number of colored-wool threads per inch, which is usually from four to five threads, according to the quality of the carpet. The length of the fringe in the chenille strips is regulated by interweaving a flat bar or lath, b, b', Fig. 915, of a certain width.

After cutting the different strips apart they must be numbered. To prevent the displacement of the wool-yarn filling, these are firmly sewed to the warp with a sewing-machine, as shown by dotted lines x x in Fig. 916, and finally the pack-thread d, between the wool-threads c and c', are drawn out to leave a central fillingless portion in the strip or ribbon, as shown in Fig. 916, that imitates in the completed carpet the knots of the true Turkey carpet, and reproduces the pattern on the back of such carpet, as shown in Fig. 917. By means of these strips or ribbons the carpets are produced as follows, referring more particularly to Figs. 918 and 919: A ground-warp is drawn in two harness, e and e', of an ordinary loom, the reed f of which contains one thread for each split. (The weave used for interlacing is the common plain ▚ weave.)

In beginning a carpet, a few picks of wool-yarn are first introduced into the warp, and then the first strip or ribbon. To prevent the shrinking of these strips they are secured at their ends to a rod or bar, i, triangular in cross-section, which is introduced into the chain or warp in such a manner that the rear or thicker portion will be elevated above the forward or thinner portion of this rod. By means of a brush the fringe at the front edge of the ribbon is brushed up or erected to form the pile. The position of the warp-threads is now reversed, the reed beaten up against the rod i, and the latter tilted so as to elevate its front edge above the rear edge, which will enable the operator to brush up the fringe along the said rear edge of the filling strip or ribbon, and when this has been effected the strip or ribbon is detached from the rod i, and the latter is withdrawn from the warp.

In order to fill out the warp between the pile-threads of adjacent strips or ribbons, a few picks of strong wool yarn are interposed and a new strip of ribbon introduced as a filling into the warp of pack thread and the operation repeated until the carpet is completed, when again a few picks of strong wool yarn are woven in to bind the edges. The carpet so produced is then finished in the usual manner by steaming, beating, brushing and shearing.

Having given in our chapters on pile fabrics (page 149 to 224) a very closely detailed description of their methods of construction, both theoretical and practical, commencing with the simplest structure and finishing with some of the most intricate pile structures known, we feel confident that we have imparted sufficient details to enable any student of technical designing to master the principles of construction of any given pile fabric. These chapters also illustrate the extensive use of pile fabrics for floor and other household decorations, in addition to their use for clothing purposes. The manufacture of these fabrics is of great extent and importance. In some households is often to be found for floor decorations a less durable and effective fabric known as the "*Ingrain Carpet*," which is no pile structure but a common double-cloth structure.

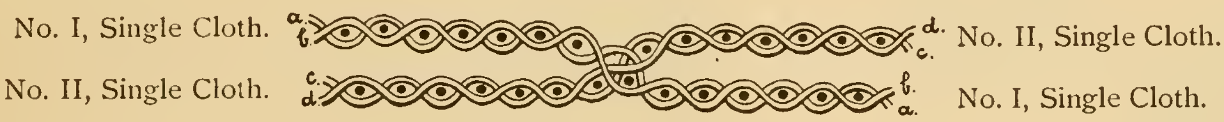
In my treatise on "The Jacquard Machine analyzed and explained, with an Appendix on the Preparation of Jacquard Cards and Practical Hints to Learners of Jacquard Designing," the structure of the Ingrain Carpet fabric and the preparing of designs for the same, as also the practical part of manufacturing, and the tying-up of the harness and operating the loom, etc., are fully treated.

The thorough study of these chapters will prove very profitable, especially the chapters on tying-up Jacquard harness for the different other Jacquard fabrics such as damasks, dress goods, upholstery fabrics, gauze, shawls, etc.

Two-Ply Ingrain Carpet.

We herewith give the reader a brief description of the method of construction and the principles governing the manufacture of the Two-ply Ingrain Carpet, an article composed of two fabrics, produced on the regular double-cloth system. These two fabrics are arranged in the loom to form figures by a simple exchanging of positions (see Fig. 920). A great variety of colors may be put into each of these separate cloths, (I and II), and the most elaborate designs

FACE OF WARP.



Warp-threads *a* and *b* for cloth number I.
Warp-threads *c* and *d* for cloth number II.

FIG. 920.

may be used for exchanging cloth I and II. On every part of the carpet where these two fabrics do not exchange, each works on the plain weave. The exchanging of these two fabrics binds both into one, thus forming the Ingrain Carpet. In the manufacture of this carpet four sets of warp-threads, and also four sets of filling-threads are generally employed; but if occasionally more or less should be used in warp or in filling, or in both, in the same fabric, the principle of exchanging is still observed. If employing four sets in warp and filling, two sets of each are used for forming the figure, the other two sets forming the ground. Each of the figure threads has as its mate one of the ground threads. In the common effects in the Ingrain carpet, (ground up, figure up, or one or the other shot about effects) these threads are so arranged that when a figure thread appears upon the face of the fabric, its mate appears upon the back, and when the figure thread appears upon the back of the fabric, the corresponding ground thread appears upon the face.

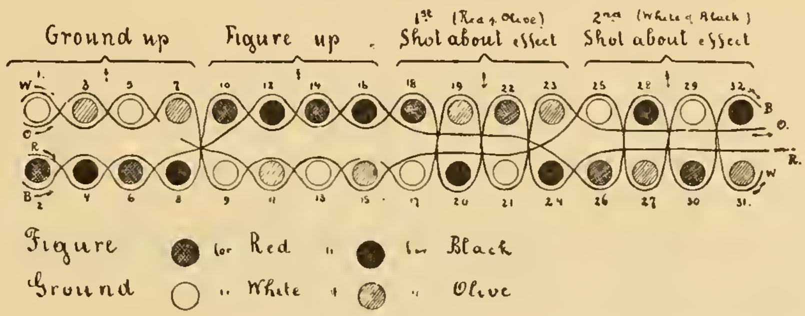


FIG. 921.

Diagram Fig. 921 shows the section of the effect commonly used in ingrain carpet.

Suppose the filling-threads for the figure to be:

Red, indicated by heavy shaded circles; picks 2, 6, 10, 14, 18, 22, 26, 30.

Black, indicated by full black circles; picks 4, 8, 12, 16, 20, 24, 28, 32.

And the filling-threads for the ground to be:

White, indicated by empty circles; picks 1, 5, 9, 13, 17. 21, 25, 29.

Olive, indicated by light shaded circles; picks 3, 7, 11, 15, 19, 23, 27, 31.

A careful examination of the drawing shows that the white threads mate with the red, and the black threads with the olive, so that when one of these colors shows upon the face the mating color will show upon the back, and *vice versa*.

As a general rule, these warp-threads are of the same color as the filling-threads; hence, every filling pick appearing on face is bound by a warp-thread of the same color, and if appearing on back by the other color of the same system; thus, in the present example, the white filling is covered on the face of the fabric by white warp, and if appearing on the back of the fabric by olive warp; the olive filling is covered by olive warp on the face of the fabric and by white warp on the back of the fabric.

The red filling is covered by its red warp on the face of the fabric and by black warp on the back of the fabric; the black filling being covered by black warp on the face of the fabric and by red warp on the back of the fabric.

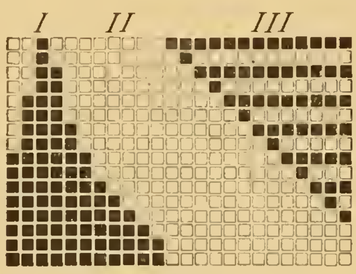


FIG. 922.

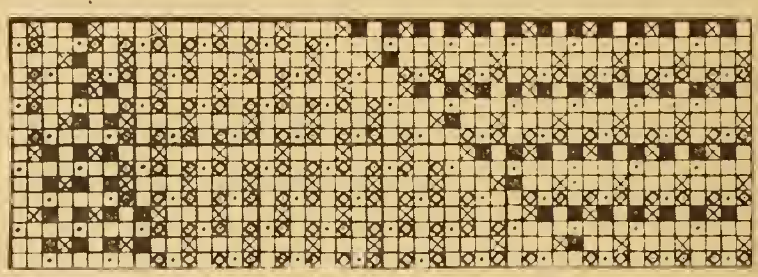


FIG. 923.

In the diagram Fig. 921 the four "standard effects" of the ingrain carpets are illustrated with 32 picks, allowing 8 picks for the illustration of each part.

First effect, picks 1 to 8, is ground up (white and olive).

Second effect, picks 9 to 16, figure up (red and black).

Third effect, picks 17 to 24, is first effect in "shot about" (red and olive up).

Fourth effect, picks 25 to 32, is second effect in "shot about" (white and black up).

Fig. 922 represents a small portion of a design illustrating the three principal combinations required in the manufacture of the two-ply ingrain carpets. *I* = figure up; *II* = ground up; *III* = effect, technically known as "shot about," and derived from "one pick figure up, one pick ground up" (in the design), and repeated.

In Fig. 923 a detailed description or analysis of the interlacing warp and filling of Fig. 922 is given. In the same ■ represents figure up, ▫ represents ground up, produced by the Jacquard machine; ⊠ represents weave for ground, ⊡ represents weave for figures, produced by journals.

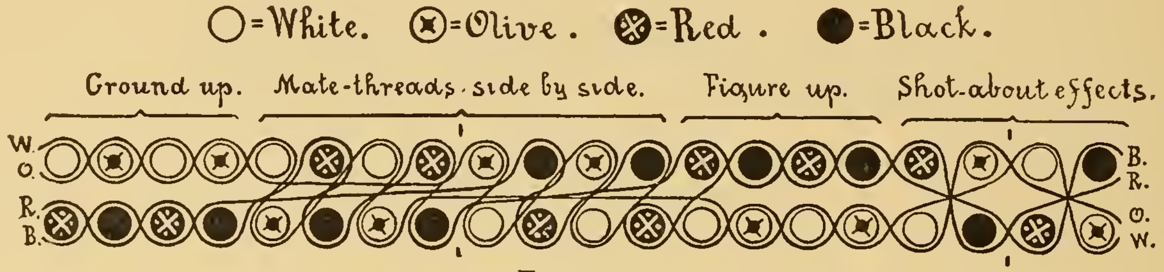


FIG. 924.

In Fig. 923 the weaving of the "shot about" effect calls for two picks face and two picks back. An examination of this part shows that the warp-thread represented by the light pick ^{1}——$_{3}$ is to be raised, or has been raised in the adjoining heavy pick ^{3}——$_{1}$; further, we find the two light picks separated by the raising of a different warp-thread in each pick, which is also effected between the two heavy picks by the lowering of another warp-thread. If these mate threads introduced in succession should be required to show side by side (as may be the case in some special effects) either on the face or the back of the fabric, these changes must be indicated on the design by different colors. If such effects are to be introduced when using the common ingrain Jacquard machine, the needles of the latter must be operated on at each pick. This requires twice as many cards as are used in designs where the mate threads are always placed below or above their respective corresponding threads.

In diagram Fig. 924 a section cut of an ingrain carpet, also containing the previously explained effects of "mate threads side by side on face of the fabric," is shown in connection with the regular effects, "ground-up, figure-up, and both combinations of shot about."

Diagram Fig. 925 indicates the rotation of inserting picks in each ply corresponding to the section of the fabric shown in Fig. 924.

	Ground-up.				Mate threads side by side.								Figure up.				Shot about.				
					1st effect.				2nd effect.								1st effect.		2nd effect.		
Face-ply.	1	3	5	7	9	10	13	14	19	20	23	24	26	28	30	32	34	35	37	40	Face-ply.
Back-ply.	2	4	6	8	11	12	15	16	17	18	21	22	25	27	29	31	33	36	38	39	Back ply.

Fig. 925. Diagram illustrating the rotation of inserting the picks in each ply, corresponding to section of two-ply ingrain carpet, Fig. 924.

Other effects (combination of colors) in ingrain carpets are produced by using three different colors of filling in each of the two single-cloth fabrics, and also by throwing them singly and in a definite order or succession in each ply. For example, the three colors for the one cloth are black, blue and brown. They must be interwoven as follows: Black—blue, brown—blue, black—blue, brown—blue, and so on.

Suppose the colors required to be used for the other cloth are white, olive and drab. They must be interwoven as follows: White—olive, drab—olive, white—olive, drab—olive, etc.

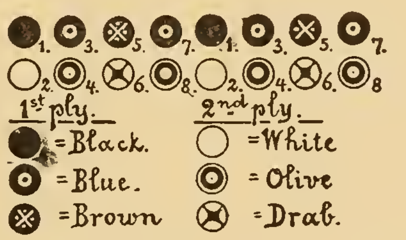


Fig. 926.

As the loom weaves both ply at the same time, throwing a shot in each ply alternately, the actual order of weaving in the present example would be as follows: 1st pick, black; 2d pick, *white;* 3d pick, blue; 4th pick, *olive;* 5th pick, brown; 6th pick, *drab;* 7th pick, blue; 8th pick, *olive*, and so on, eight picks in the repeat of one combination. The colors printed in *italics* representing the colors of one ply, and the colors printed in roman represent the colors of the other ply.

Fig. 926 illustrates a diagram representing the previously explained method of placing colors in an ingrain carpet.

Rules for Selecting the Squared Designing Paper for Ingrain Carpets.

In selecting the squared designing paper for a two-ply ingrain carpet, always observe the proportion existing between the number of warp and filling-threads. For instance, take a carpet having 1072 ends warp (536 ground and 536 figure) per yard, with 30 picks per inch (1 pick ground and 1 pick figure, or 15 pairs). Then, $1072 \div 36 = 29\frac{28}{36}$ ends of warp per inch. The proportion is as $29\frac{28}{36} : 30$; or, what is practically the same, $30 : 30$, showing that the paper must be equally divided, and 8 x 8 the squared designing paper to be used.

Again, take a carpet having 832 ends warp (416 ground and 416 figure) per yard, with 20 picks per inch (1 pick ground and 1 pick figure, or 10 pairs). Then, $832 \div 36 = 23\frac{4}{36}$, and the proportion is as $23\frac{1}{9} : 20$, or as $7\frac{19}{27} : 6\frac{2}{3}$, practically $8 : 7$; and 8 x 7 paper may be used.

Gauze Fabrics.

Principle of Construction.

Gauze fabrics form the second main division of textile fabrics, and are characterized by not having their warp-threads resting parallel near each other, as observed in previously explained weaves and fabrics. In gauze fabrics they are more or less twisted around each other, forming through the different ways of twisting as well as of stopping to do so, different designs.

In gauze we find two distinct divisions of warp-threads: The regular warp called the "ground-warp," and the "douping-warp," or the warp used for twisting around the former. The "douping-warp" threads are also known as "whip-threads."

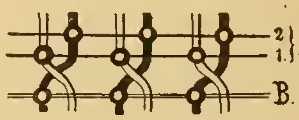


Fig. 929.

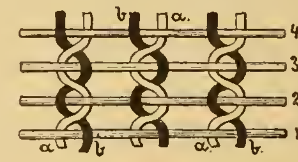


Fig. 927.

In diagram Fig. 927, the structure of a "plain gauze fabric," is shown. Threads indicated by *a* and shown in outlines represent the "ground-warp;" whereas, threads marked *b* and shown in black illustrate the "whip-threads."

Gauze weaving is done upon a system wholly apart from ordinary and pile weaving. For the reason that we find two systems of warp-threads in the gauze fabrics we must use two systems, or sets of harness, for operating the warp at the weaving. One set of the harness is known as the "*Ground-harness set*" (which we will indicate in our following illustrations of drawing-in drafts for gauze weaving by *A*) and the other harness set is technically known as the "*douping harness set*" (which we will indicate through the lecture by *B*). Before proceeding with the weaving and construction of gauze fabrics we will give an explanation of the douping-harness set, and use for explanation the arrangement necessary to produce fabric, Fig. 927, or a single one-sided doup.

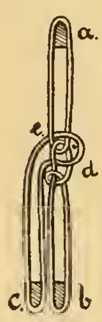


Fig. 928.

In diagram Fig. 928 a specimen of a complete doup is shown. In the same we find a heddle similar to heddles used in regular weaving (see *a*, *b* in diagram) and which is known in the present kind of weaving as the "standard heddle." To this standard heddle we find the actual doup adjusted (see *d*, *c* in diagram). The doup consists of a smooth and strong linen or silk thread which is fastened to the lower part of a common harness frame (see *c* in diagram), passes then through the upper opening of the standard heddle (see *e* in diagram Fig. 928), returning to its starting point by passing through the eye of the standard heddle, and thus connecting the upper part of the doup to the standard heddle. Through the part of the doup extending outside of the upper part of the standard heddle to its eye, the whip-thread is passed, (see black dot at place indicated by *d* in diagram 928 representing its section). Two movements of the doup and the standard heddle contain the entire secret of gauze weaving When these are clearly understood by the student well up in designing and weaving the first main division of textile fabrics, the method of constructing the present system will readily explain itself to him.

In gauze-weaving, every warp-thread (ground as well as whip-thread) must be drawn, the same as for common weaving, in the ground harness set; see *A*, Fig. 929. Next, the whip-thread is passed below the ground-thread through the doup (see *B* in Fig. 929, illustrating the plan of this method of operation), and with its mate (the ground-thread), through *one dent* of the reed.

Now let us examine the first movement of the doup and its standard heddle, and also with reference to the ground harness set.

Suppose we lift the harness frame containing the doup adjusted to its lower shaft, technically known as the "skeleton harness," and so permit the doup to get loose, and consequently allow the whip-thread to be operated on, as in common weaving, by means of the ground harness.

The whip-thread will in this instance return to its regular position near one side of the ground-warp, as regulated by the drawing-in of the warp in the ground harness set (to the right hand side in the present example). Suppose, again, we raise this ground harness and insert a pick in the shed thus formed. During this process the doup will raise, but out of action, behind the reed. Having thus inserted pick number one let us next raise the standard heddle and the skeleton harness, leaving the ground harness set undisturbed. This movement of the harness compels the whip-thread to raise, close to the eye of the standard heddle, drawing the whip-thread below the ground-thread and raising the former on the *opposite* side of the ground warp-thread, as done in the previous pick. This time the doup will be in position parallel to the standard heddle, whereas the whip-thread will be crossed behind the reed, between the sets of douping and ground-harness. This crossing and raising of the thread to full height of shed in such a short distance will consequently put a great amount of tension on the whip-thread and therefore necessitate *two points* in the method of operation which we will mention briefly. We must have sufficient space between both sets of harness, *i. e.*, the heddle of the ground harness set in which the whip-thread is drawn and the standard heddle and doup-head through which this whip-thread is passed in rotation. We also must arrange in rear of harness set near the whip-roll an arrangement technically known as "*Slackener.*" All the whip-threads required to doup are passed over this slackener, which is situated above the regular warp-line after leaving the "whip-roll" of the loom and in their running towards the ground harness set.

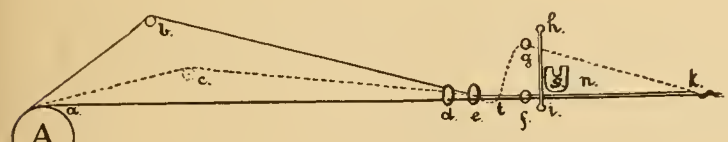


FIG. 930.

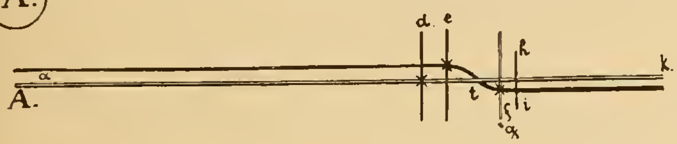


FIG. 931.

On the first pick previously explained, this slackener will remain undisturbed, as no strain is required on the whip-thread, whereas on the second pick explained, this slackener is automatically lowered to bring the whip-thread nearly in the regular warp line in rear of harness. This in turn allows the whip-thread to ease up in front, where required, to cross around the ground warp-thread and is raised a short distance by the doup on the opposite side of the ground warp-thread, as compared with the first pick. This slackener for gauze weaving is also technically known as "easer" (by reason of easing the whip-thread when douping). We will later on return to a more detailed illustration and explanation of the same and its arrangement for plain as well as figured work.

In diagram Fig. 930, *A* represents the whip-roll of the loom, *b* the section of the slackener, *d* ground heddle for ground warp-thread, *e* ground heddle for whip-thread, *f* doup, *h–i* reed, *k* last end of woven fabric. Thus the line shown in full black, *a, d, k*, represents the ground-thread, and line in full black, *a, b, e, k*, represents the whip-thread; both threads "at rest." The object of the present illustration is to explain the principle of the slackener, and therefore we want the doup (standard and skeleton harness) raised (see *f* to *g*) as represented by *g*. To counteract the strain thus put on the whip-thread, we lower at the same time the slackener (see *b* to *c*), giving it position *c*, at the same time the doup is raised to position *g*. Hence the dotted line *a, c, e, g, k* represents the whip-thread when douping. After inserting the filling by means of shuttle (*s*), the shed (*n*) closes and the slackener returns automatically to its point of starting, *b*.

In Fig. 931 we illustrate a corresponding ground plan to diagram Fig. 930, representing a clear idea of the drawing in of the warp and threading of the doup. Outlined warp-thread *a, d, k* represents ground warp-thread, thread shown in full black, *a, e, f, k*, the whip-thread, *d* and *e* the ground harness set, *t* the passing of the whip-thread below the ground warp-thread and *h, i* the reed.

This illustration explains the threading of a whip-thread in a doup situated at the left of the ground warp-thread, but the student will readily apply the same arrangement to the opposite kind of doup by simply reversing the illustration.

We will next turn our attention to the designing of various gauze fabrics, and commence with the plain gauze, as illustrated in Fig. 927. In plain gauze all the warp-threads work in pairs—1 end "whip" and 1 end "ground." The entire warp is drawn on harness similar to any other warp. Afterwards the whip-threads are passed below the standard heddles and threaded in the doup (see Fig. 929), which are passed through the standard heddles (see Fig. 928).

Fig. 932 represents a different method for threading the doup, occasionally used, but which is not as practical as the arrangement of the doup illustrated in Fig. 928.

Fig. 932.

In diagram Fig. 929 we illustrate the plan of drawing-in ground harness and threading the doup for producing a piece of plain gauze, as shown in Fig. 927.

A represents the set of ground-harness (2-harness).

B represents the douping set. (Standard and skeleton.)

Standard warp-threads are illustrated in outline.

Whip-thread is shown in full black.

We find, as previously mentioned, every warp-thread threaded first in the ground harness set; next, the whip-threads passed below the ground-warp and threaded to the doup. Examining the plan of the fabric, we find pick 1 requiring the whip warp-thread raised in its proper position as placed by the ground harness (to the right of the ground warp-thread); therefore this pick will require the raising of ground harness 2 and the skeleton harness, hence loosening the doup for common weaving. Pick 2 calls for the raising of the whip-thread on the opposite position of pick 1 (to the left side of the ground warp-threads); therefore we must doup on this pick by raising only the standard and the skeleton harness, or, in the present example, the entire douping set. Pick 3 = pick 1, pick 4 = pick 2, thus 2 picks repeat.

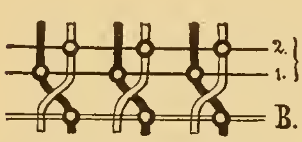


Fig. 933.

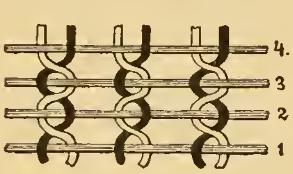


Fig. 934.

In the present example, Fig. 927, we find every pair of warp-threads (1 ground and 1 whip) twist in the same direction and having the crossing in the corresponding drawing-in draft arranged from right to left. This crossing can also be arranged in the other direction, see Fig. 933, but will, in the present fabric, be of no advantage to its general appearance, as shown in Fig. 934.

We will next explain and illustrate the combination of both styles of crossing in the same fabric. For example see Fig. 935. the drawing in of ground harness and arrangement for threading doup: 1st pair, whip-threads

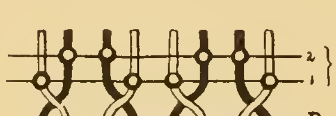


Fig. 935.

Fig. 936.

Skeleton.	Standard.	1st Ground.	2nd "	
✕	◆			4th pick
✕			✕	3rd "
✕	◆			2nd "
✕			✕	1st "

Fig. 937.

Harness-chain for plain guaze fabric, Figs. 927, 936.

Skeleton.	Standard.	1st Ground.	2nd "	
✕	◆			4th pick
✕		✕		3rd "
✕	◆			2nd "
✕		✕		1st "

Fig. 938.

Harness-chain for plain gauze fabric, Fig. 934.

threaded to the left-hand side of ground warp-thread; 2d pair, whip-threads threaded to the right-hand side of ground warp-thread.

Fig. 936 is the plan of the woven fabric. Harness chain is similar to the one required and explained for fabric Fig. 927 and illustrated in Fig. 937.

The drawing-in drafts, Figs. 929, 933 and 935, are illustrated for 2 ground harness and 1 doup. This is done to simplify the principle of construction. The same way that we can illustrate the common plain weave drawn in 2-harness straight, for the clear understanding of the beginner and use in practice, 4, 6, 8, etc., harnesses as required and guided by the height in texture of the fabric (number of warp-threads per inch), we may also, in practice, have to increase in gauze-weaving the number of ground harness, or the number of doups (standard and skeleton), or both at the same time.

Peculiar Character of Gauze Fabrics.

Comparing a plain gauze fabric, as shown in Figs. 927, 934 or 936, to any other woven textile fabric results in not finding one as firm in its method of interlacing nor as light in texture.

The principle of gauze-weaving—the twisting of warp-threads around each other and holding at the same time the filling securely fastened between—will necessarily result in producing a very strong fabric; again, the twisting of the warp-threads between each pick, in plain gauze, will not allow the picks to come close together in the fabric, thus resulting in the production of a fabric containing large perforations.

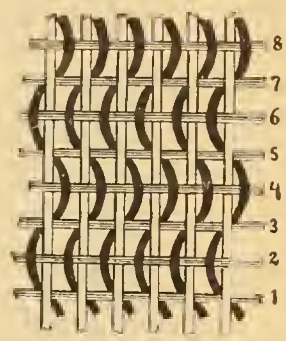


Fig 939.

In diagram Fig. 939 we illustrate the plan of a fabric which is actually a combination of plain and gauze and is technically known as leno, or half-gauze. Pulling out from the present fabric sample every uneven numbered pick (1, 3, 5, 7) will result in transforming the half-gauze in the fabric to a regular plain gauze effect.

Combination of Plain and Gauze Weaving, Technically Known as Fancy Gauze.

In Fig. 940 a combination of plain weaving and gauze is shown in the plan of a fabric. An analysis of this plan will show 3 picks interlacing on ordinary weaving to exchange with one

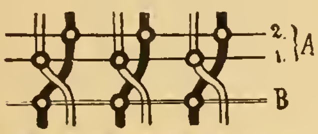


Fig. 941.

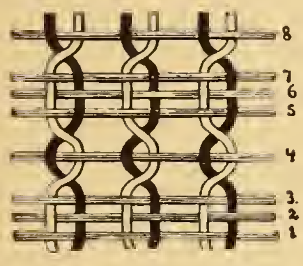


Fig. 940.

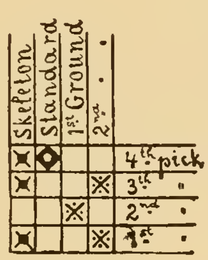


Fig. 942.

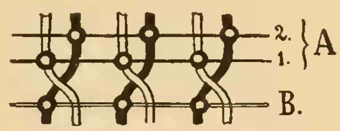


Fig. 944.

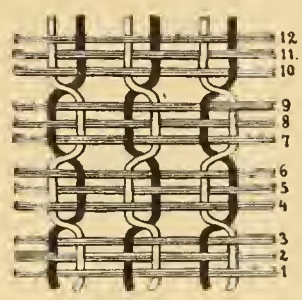


Fig. 943.

gauze pick. Thus four picks in repeat. Drawing in of ground harness and the threading of the doups is shown in Fig. 941. *A* represents the ground harness set, (2 harness), *B* represents the doup (standard harness and skeleton harness).

Fig. 942 illustrates the harness-chain executed correspondingly to Figs. 940 and 941, and so will readily explain itself.

In Fig. 943 another plan of a gauze fabric, combining the common plain cloth with gauze structure, is shown. Liberating picks, 2, 3 and 8, 9, of the present structure would result in changing the same to the fabric shown in its plan in Fig. 940. The drawing in of ground harness set, and the threading of doups to fabric, Fig. 943, is shown in Fig. 944.

In Fig. 945 we illustrate the plan of a gauze fabric similar to the one shown in Fig. 943, the only difference being the using, alternately, left and right-hand threading of the doups. Repeat: four warp-threads, "two pairs," and 6 picks. Drawing in of ground harness set and the threading of doups for producing the present fabric is shown in Fig. 946. In the same we used four-harness for ground-warp, but we can also use the drafting and threading shown in Fig. 935, which only calls for two ground harness in set *A* and will produce the same effect.

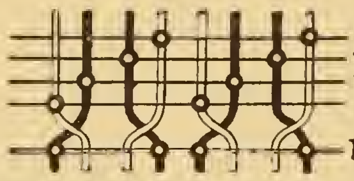


FIG. 946.

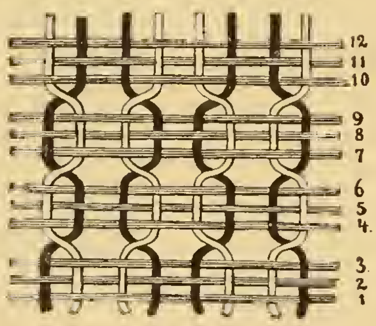


FIG. 945.

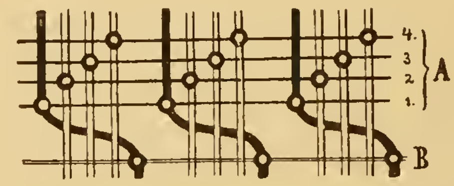


FIG. 948.

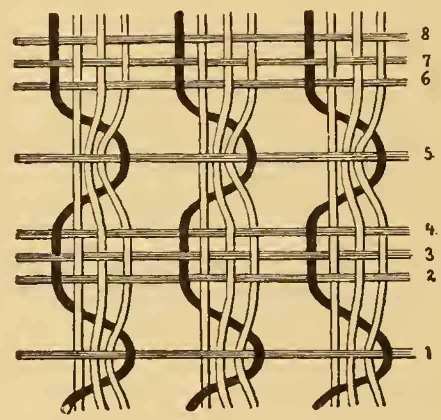


FIG. 947.

Another plan for producing fancy gauze-effects is found in arranging the whip-thread to cross over two or three ground warp-threads; for example, as shown in the plan of a fancy gauze fabric, Fig. 947. In the same we find the whip-thread, after interlacing in connection with three ground-threads into three successive picks, on regular plain cloth, cross below the mate (3) ground-threads for forming at the fourth pick gauze. Repeat: 4 warp-threads, (1 whip, 3 ground), one set drawn in one dent, 4 picks, 3 ordinary plain weaving, 1 douping.

The method of drawing in both systems of warp in the ground harness set, and the method of threading the whip-threads in the doups is shown arranged for three successive sets (correspondingly to fabric sample) in diagram Fig. 948. The same reason which compelled us, in plain gauze, to draw each pair of threads (1 ground, 1 whip) in one dent, leaving as many dents empty between the threading of each pair of warp-threads as required by the size of the perforations in the fabric, requires in the present example of fancy gauze, Figs. 947 and 948, to thread each set of 1 whip-thread and 3 ground-threads in one dent, leaving as many dents empty between the threading of each set as required by the size of perforations wanted in the fabric.

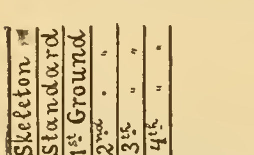


FIG. 949.

Fig. 949 illustrates the harness-chain necessary for weaving the present explained fabric of fancy gauze (Fig. 947.)

The next plan for constructing fancy gauze fabrics is to use two doups in connection with four or more ground harness. In this manner fabric sample, Fig. 950, is constructed. Fig. 951 represents the drawing in of ground harness and the threading of the doups. In the same we find two sections ground harnesses 1 and 2, with doup 1′, forming section 1; ground harnesses 3 and 4, with doup 2′, forming section 2.

In drawing in and threading doups we arranged two repeats for each section, thus 8 warp-threads in repeat of arrangement of pattern. This method of drawing in ground harness as well as threading of doups will, as shown in the fabric sample, allow us to operate each section

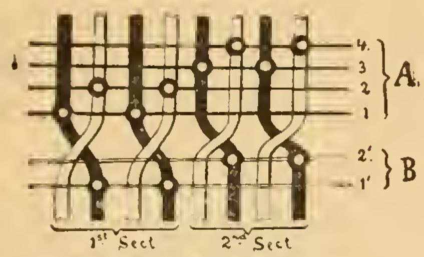


Fig. 951.

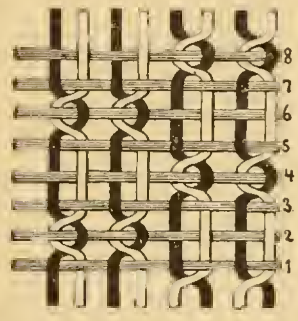


Fig. 950.

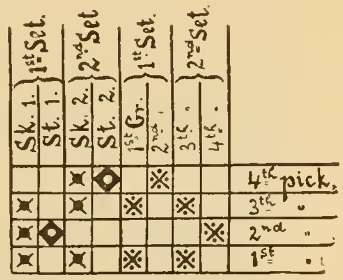


Fig. 952.

independent of the other, thus forming, by arranging the douping for each set for different picks, additional figures in the fabric.

Fig. 952 illustrates the harness-chain for fabric and drawing-in draft, just explained.

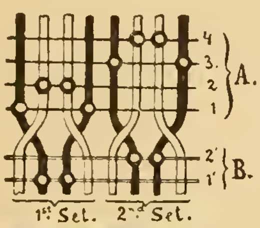


Fig. 954.

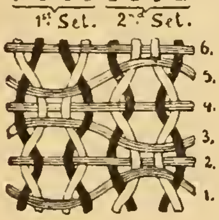


Fig. 953.

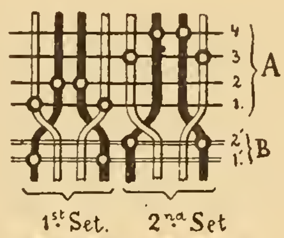


Fig. 956.

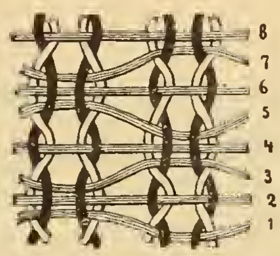


Fig. 955.

In diagram Fig. 953 the plan of another fancy gauze fabric, produced with two doups, is shown. Fig. 954 illustrates the method of drawing in the ground-harness and the threading of the doups, which in the present example is a right-handed and a left-handed doup for each set.

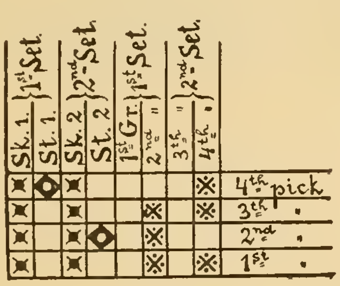


Fig. 957.

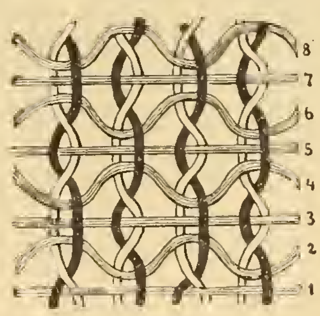


Fig. 958.

Four ground-harness are used in connection with the two doups. Ground-harness 1 and 2 (*A*) and doup 1′ (*B*) equal 1st set; ground-harness 3 and 4 (*A*) and doup 2′ (*B*) equal 2d set.

Fig. 955 illustrates another fancy gauze fabric, produced with two sets of doups and upon a general arrangement in two sections.

Fig. 956 shows the general arrangement for drawing in ground-harness set as well as the threading of the doups. Four ground-harnesses are used in connection with the two doups. Ground-harness 1 and 2 (*A*) and doup 1′ (*B*) equal 1st set; ground-harness 3 and 4 (*A*) and doup 2′ (*B*) equal 2d set.

Fig. 957 illustrates the harness-chain for the fabric and drawing-in draft just explained.

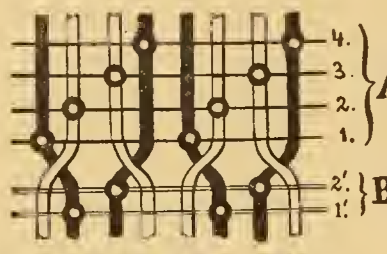


FIG. 960.

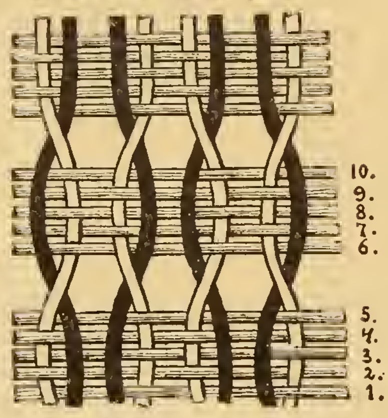


FIG. 959.

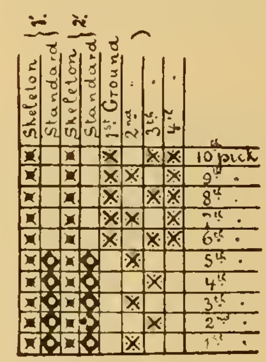


FIG. 961.

Fig. 958 illustrates the plan of another fancy gauze fabric, constructed after the foregoing example, using only warp threads 1, 2, 5 and 6 from the latter (955).

Diagram Fig. 959 illustrates the plan of another fancy gauze fabric.

Fig. 960 illustrates the corresponding drawing in of warp in ground-harness and the threading of the whip-threads in two doups (1′ and 2′),

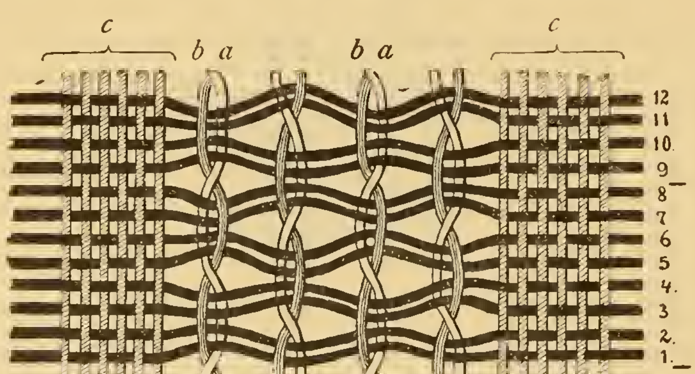


FIG. 962.

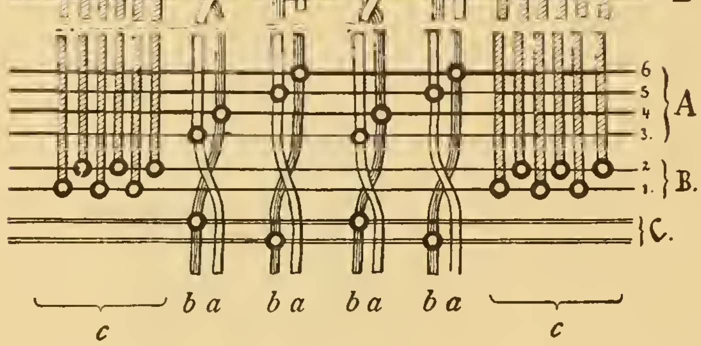


FIG. 963.

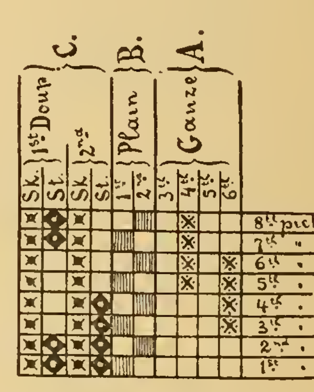


FIG. 964.

Fig. 961 shows the harness-chain required for weaving the fabric shown in Fig. 959.

The "two-section" arrangement, as explained and illustrated, can be extended to three, four or more sections, and in this manner giving fancy effects to an unlimited number of designs.

A further step in producing figured gauze is the combining of gauze and ordinary weaving in the form of stripes. After using a certain number of warp-threads, drawn in its own separate set of harness, for interlacing with the filling either on plain, twill or satin, or in a combination of all three, use similar effects as previously illustrated and explained, either with one, two or more differently working doups, left or right-hand twisting, or all the effects combined. This method of combining stripes of gauze with ordinary woven cloth will also afford great scope for producing figured effects through alternately exchanging both systems of weaving warp and filling ways.

Design Fig. 962 illustrates such a stripe effect in a fabric. Fig. 963 shows the corresponding drawing-in draft and threading of the doups. Warp-threads indicated by *a* (light) are the ground-

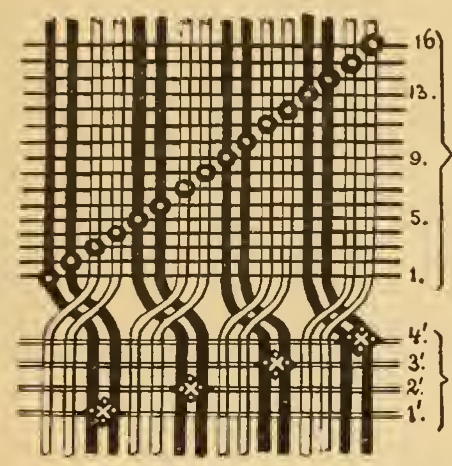


Fig. 965.

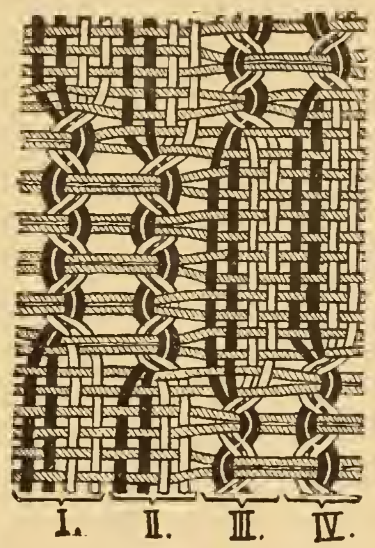


Fig. 966.

threads, and warp-threads indicated by *b* (shaded in vertical direction) are the whip-threads for the gauze; warp-threads indicated by *c* (shaded in diagonal direction) are the threads for producing the ordinary cloth (plain weave in present example). The drawing-in draft shows three different sets of harness used.

The set indicated by *A* represents the ground-harness set for the gauze part; the set indicated by *B* represents the harness for raising warp-threads interlacing in the ordinary cloth; the set indicated by *C* represents the douping set of harness for producing the gauze part.

Fig. 964 represents the harness-chain necessary for weaving a fabric as shown in Fig. 962.

As previously mentioned, figured gauze can also be produced by using two whip-threads against two ground-threads, thus using four ground-harness to one doup. In such an example all four threads must be drawn in one dent.

Fig. 967.

Diagram Fig. 965 illustrates a drawing-in draft arranged in this manner, and Fig. 966 shows a corresponding fabric.

The interlacing of the plain for the ordinary interwoven part of the fabric can in this example be extended to any figured weave up to 16-harness. Four independent sets of doups are made use of and so the douping can be correspondingly arranged on each pick at will for each individual doup.

By arranging the present style of drawing in ground harness and threading of doup for a "sectional repeat effect" (repeat the drawing in and threading of doup of each four warp-threads two, three or more times before changing to the next four warp-threads) novel effects for fancy gauze fabrics may readily be obtained (with a correspondingly large figure).

Fig. 967 illustrates the drawing-in draft for a figured gauze on two sets (for illustrating previously mentioned section draws) having four ground harness and one doup for each set (nine repeats in each set). These two sets are also separated by three warp-threads arranged for ordinary weaving, the centre thread of which is indicated as a cord (or a heavy thread, preferably of a different color).

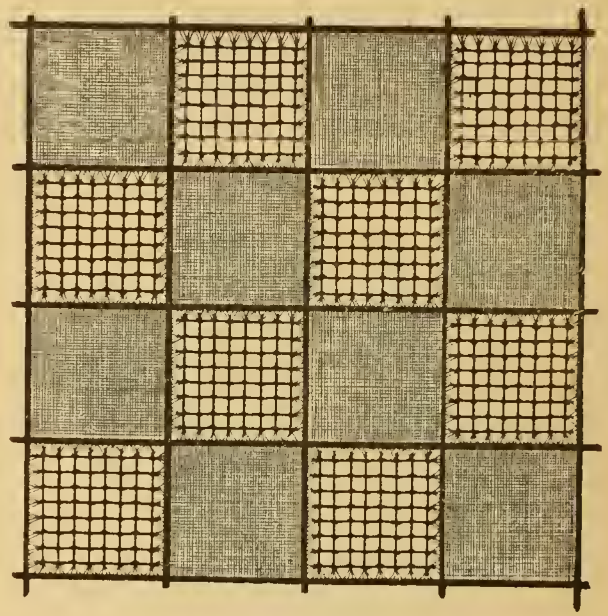
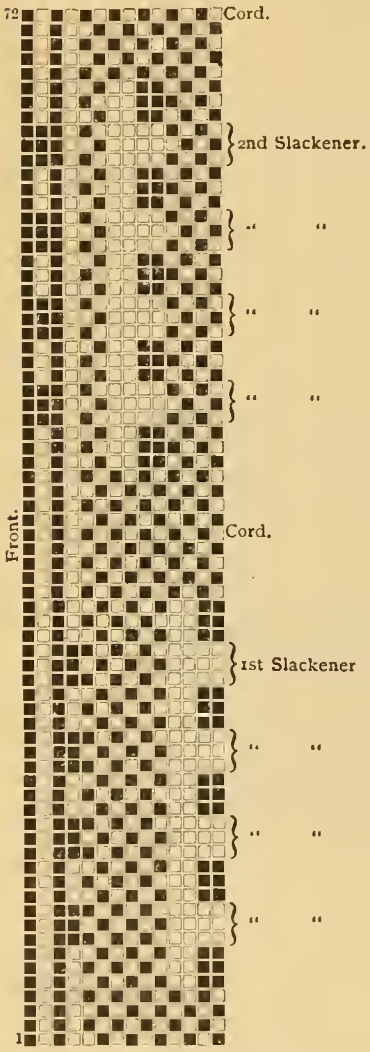


FIG. 968.

If weaving for a certain number of picks ordinary cloth (plain) with set No. 1, and next gauze with set No. 2, changing again afterward, thus arranging for an equal number of picks, set No. 1 for gauze and No. 2 for ordinary cloth (plain), also separating each of these two changes by a few picks ordinary woven cloth, inserting in their centre a heavy filling (similar to cord in warp), we get a checker-board effect for design composed of ordinary and gauze weaving as shown in diagram Fig. 968.



Harness-chain for 14-harness; 72 picks.

FIG. 969.

In reeding the warp for example Fig. 967, leave one, two or more dents empty between each four threads (of two whip and two ground); again, when reaching the three ordinary weaving threads, place the cord in a separate dent and each of the other two ordinary weaving threads in the dent as situated on each side and which is occupied by the set of four threads for gauze weaving. For example, if arranging the reeding of the warp, one dent taken to alternate with one dent left empty all over the regular work, we find the reeding at the part where the cord comes in arranged as follows:

←« 4—0—4—0—5 (4 + 1) —1 (cord) —5 (4 + 1) —0—4—0—4. »→

Fig. 969 illustrates a specimen of a harness chain for weaving the present example of fancy gauze. In the same we find two slackeners used.

1st slackener to lower its whip-threads on picks 8, 9, 10—14, 15, 16—20, 21, 22—26, 27, 28.

2nd slackener to lower its whip-threads on picks 44, 45, 46—50, 51, 52—56, 57, 58—62, 63, 64.

In the beginning of our chapter on gauze we gave the principle of a slackener or easer. We would only state now that for every set of doups which operate the whip-threads at different picks when done on any previous set of doups in the same fabric, we must use a separate slackener; thus in the examples explained as constructed on two sections, we must use two slackeners. This method of using more than one slackener is increased in practical work, when required, up to three but seldom to four.

Diagrams Figs. 970*a* and 970*b* illustrate figured gauze effects as produced by harness work.

Gauze Weaving Mechanism for Open-Shed Looms.

Until lately gauze fabrics, as thus far explained, have been produced only upon looms constructed after the principle known as the "*single-acting*" method, which is characterized by

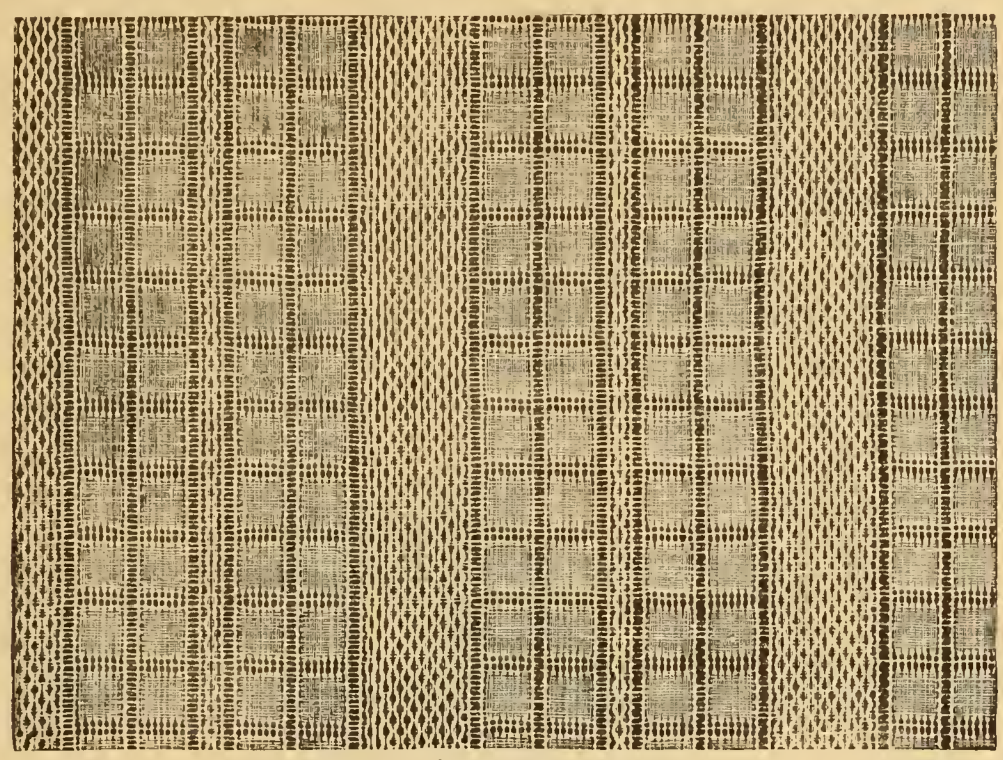


Fig. 970*a*.

leveling the entire warp at every pick, and at this leveling point cross the warps so as to produce the twist. It will be proper to mention that this single-acting method for operating the warp-threads only allows a moderate speed which at the present time is insufficient for the requirements of a loom; hence every manufacturer of this class of fabrics has been anxiously awaiting for

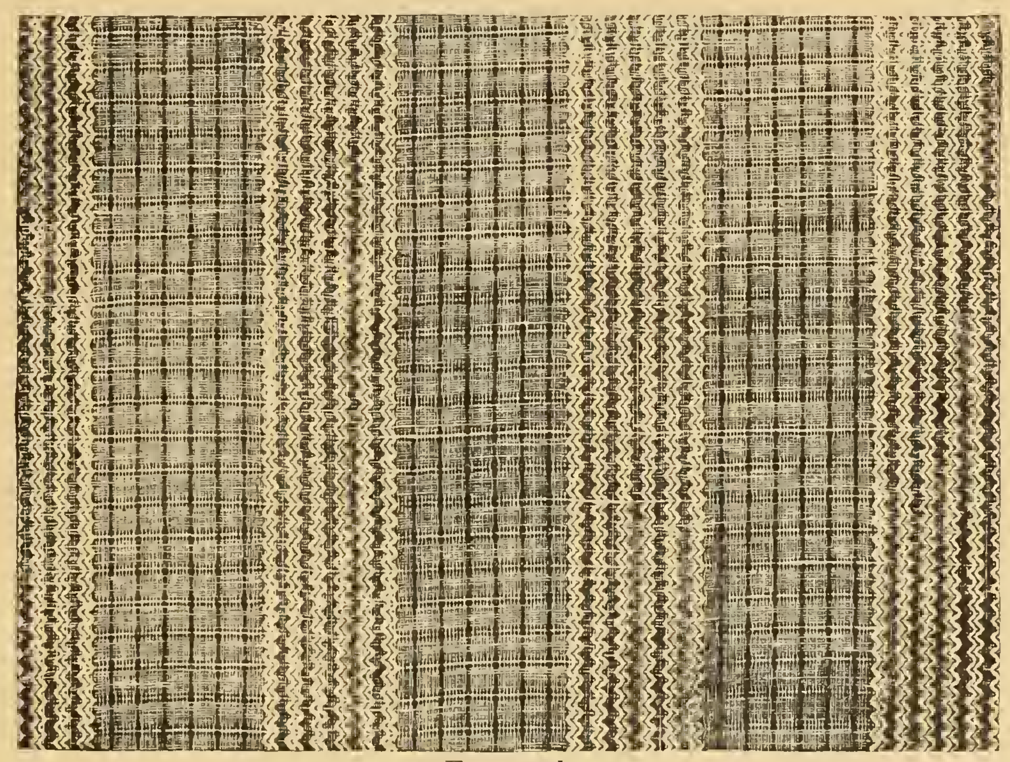


Fig. 970*b*.

a method by which gauze weaving can be successfully executed upon looms built after the principle known as the double-action, giving an increased speed at which the loom can be operated. This gain of speed is owing to the ability of the double-acting loom to select and withhold certain warp-threads for a certain number of succeeding picks of the shuttle, as the pattern being worked may demand.

However, the construction of the *double-acting* loom heretofore employed did not permit of its weaving gauze, because of the inability of the loom to operate a warp-thread so as to raise it for one pick of the shuttle, and then after that pick, lower it and raise it again before the succeeding pick.

The Geo. W. Stafford Manufacturing Co., Providence, R. I., are now building a Double-Action Dobbie which overcomes this defect; hence is capable of weaving gauze with the characteristic high speed of the latter. This is due to the fact that the double-acting loom is adapted to raise a warp for one pick of the shuttle, and then after that pick lower and raise it again before the succeeding pick. The new features of the Dobbie, as thus built by the Stafford Manufacturing Co., are the combining of the ordinary full motions of the recurrent or reciprocating harnesses with a novel and peculiar "*half-and-return*" motion of others of the harnesses when so desired. To gain the "*half-and-return*" motion they use an extra half-stroke lifter (knife), which has half

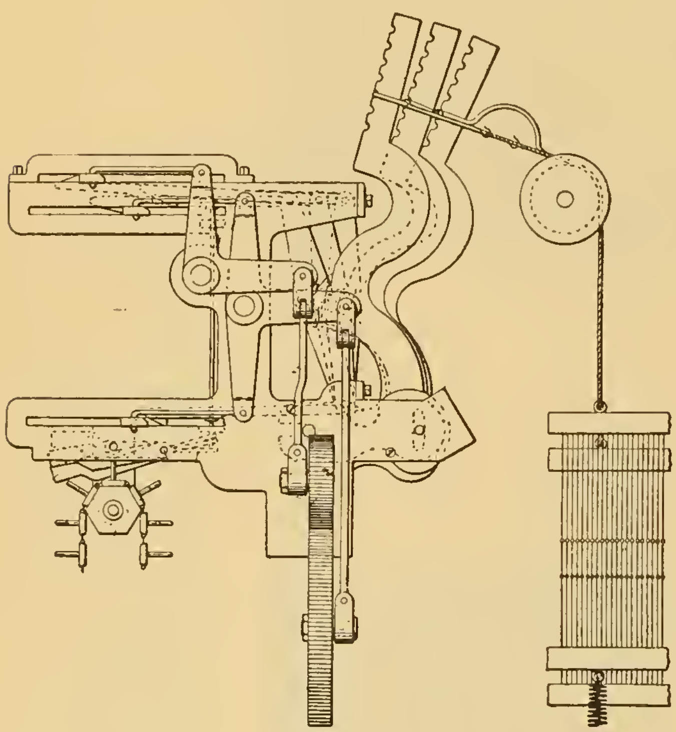


Fig. 971.

Fig. 971*a*.

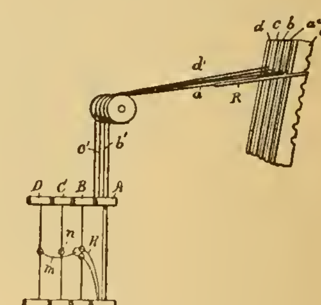


Fig. 971*b*.

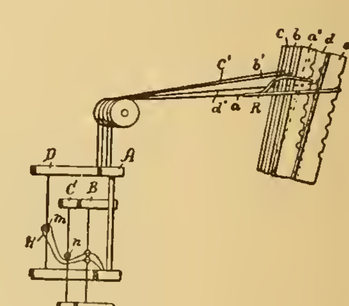


Fig. 971*c*.

the limit of traverse that the ordinary lifters have. The half-stroke lifter has suitable jacks engaging therewith, which are jointed in the common manner with a connecter co-operating with an operating lever.

The half-stroke lifter is reciprocated by a peculiar half-motion device. A second "*half-and-return*" motion for certain other harness is obtained by the arrangement of a pair of ordinary operating levers with connections to a single harness controlled by the levers working simultaneously and oppositely or singly. To give a proper understanding of the subject Figs. 971, 971*a*, 971*b*, 971*c*, 971*d* and 971*e* have been designed.

Fig. 971 represents a rear view of the head or end of the loom containing the harness-operating mechanism. The same also shows the full and half-stroke lifters as at their midway points of travel, and the co-acting jacks and conjoined parts according to their relative positions.

Fig. 971*a* is a view of the double-hooked jack detached.

Figs. 971*b*, 971*c*, 971*d* and 971*e* illustrate four successive relative positions of the harness and harness-operating levers as they occur in the weaving according to the present explained method (plain or gauze).

The parts indicated *D* and *C* are portions of harness-frames provided with single-eyed heddles carrying the warps *m* and *n*, respectively. These frames are connected by the respective cordings d' and c', with their operating-levers *d* and *c*, the former co-acting with full stroke lifters and the latter with the full and half-stroke lifters.

The standard frame *B* is provided with a doup heddle, through which passes one side of the looped cord or doup *k*, the ends of which are attached to the skeleton-harness *A*. Frame *B* is connected with lever *b* by means of cording b', and co-acts with full-stroke lifters. The skeleton-harness *A* (shown in portion) is operated by the half-motion levers a' a^2, to which it is connected by a Y-shaped connecting strap *R*, both forks of which are equal and connected, one with each lever a' a^2, respectively, and its stem is connected with the skeleton *A*. The harness-frames *B* and *D* make full straight-away motions, while the parts *A* and *C* make half-and-return motions, and are also capable of making full straight-away motions. These parts are thus termed, the former "*full-motion*" and the latter "*half-and-return-motion*" harnesses.

Warp-thread indicated by *n* is the standard warp and warp-thread *m* the whip-thread.

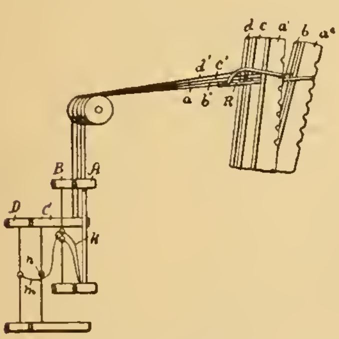


FIG. 971*d*.

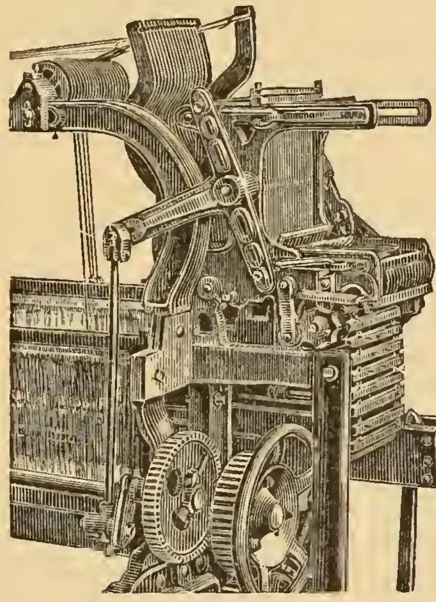


FIG. 971*f*.

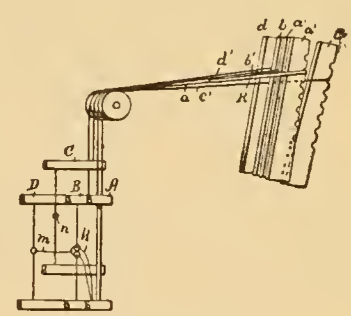


FIG. 971*e*.

The method of operation for producing common gauze weaving is as follows: The harness *C*, carrying the standard warp *n*, is given the half-and-return-motion in order to carry the warp to the middle lift, where the descending whip-thread *m* can be passed under warp *n*, which then descends, while the doup *k* raises warp *m* to form the upper part, while the warp *n* forms the lower part of the shed for the next pick of the shuttle.

Referring to Fig. 971*b* suppose this position is the first position before starting the loom, which may be supposed to have been previously making gauze stitches, and which came to a rest, while the warps were partly turned on themselves for the next twist. In this position all the harnesses *A*, *B*, *C*, *D*, are low and the whip-thread and standard-thread, *m* and *n*, are leveled and crossed one above the other, before being twisted in the formation of the succeeding gauze stitch. The levers a' a^2 *b c d* in this first position are all in line and the branches of the forked connections are both taut. Position of Fig. 971*c* is produced by the levers a' and *d* moving to the outer limit on full-stroke lifters and the levers a^2 *b c* remaining at rest. This serves to raise harness *A* and *D* from lowest to highest limit. By this shedding movement the crossed warps have been tightly twisted on themselves, and the shuttle here makes a pick through the shed and interweaves the filling between the twisted warps. Position Fig. 971*d* is obtained by levers a' and a^2 moving oppositely on full motions—one on a lifter and the other by a retracting-spring, and thereby giving their skeleton-shaft *A* a half-and-return motion; also, by lever *b* moving outwardly on a full-stroke lifter, and accordingly moving the standard harness *B* from low to high limit; also, by lever *c* co-acting with the half-stroke lifter and imparting a half-and-return motion to its frame *C*; also, by the lever *d* moving inwardly a full motion by means of a retracting-spring, and imparting a like motion to its upper warp-frame, *D*, which moves accordingly from high to low limit. During this change of position the warps have been crossed and twisted on themselves, forming a gauze stitch, and then the shuttle picks and lays the filling. The next and fourth position of Fig. 971*e* is arrived at by levers *d* and *a'* remaining at rest, while a^2 and *b* are moved in by virtue of their respective retracting-springs, and *c* is carried out on a full motion by virtue of its jack co-acting with a full-stroke lifter. These movements have caused the doup-frame and harnesses *A* and *B* to descend from high to low limit, frame *C* to rise from low to high limit, and frame *D* to remain at rest at low limit. In this change of position the warps have not been twisted, but merely crossed side by side, as in plain weaving, and in this position of Fig. 971*e* the shuttle picks and interweaves the filling. This position now changes the position of the upper and under warps (standard and warp-threads) reversely relative to the filling.

From the position of Fig. 971*e* the changes may be made, according to the pattern desired, into a series of succeeding similar positions, and thus make more plain weaving-stitches, or it may be changed back to the second position of Fig. 971*c* and repeat the described gauze pattern.

In Fig. 971*f* we show the (upright lever) double action dobbie as built by the Geo. W. Stafford Manufacturing Company, to which the present explained mode of weaving gauze fabrics applies.

Jacquard Gauze.

In gauze fabrics constructed upon the Jacquard loom, in which it is desired to produce large and elaborate designs by the aid of figuring gauze and ordinary weaving, it will be necessary to arrange a slackener for every whip-thread.

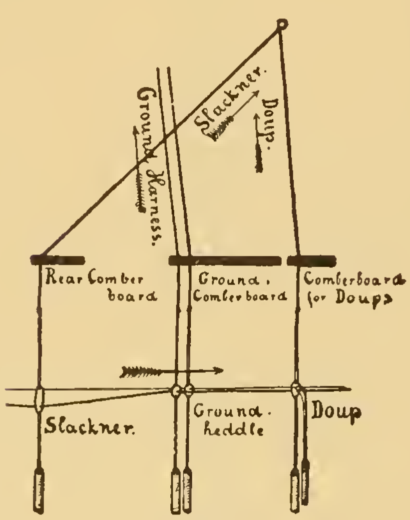


FIG. 972.

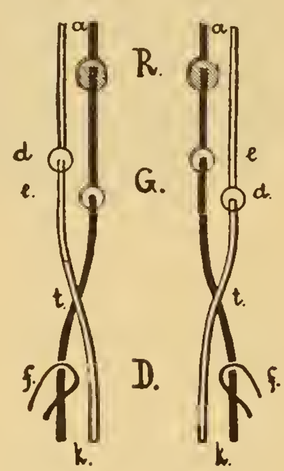


FIG. 973. FIG. 974.

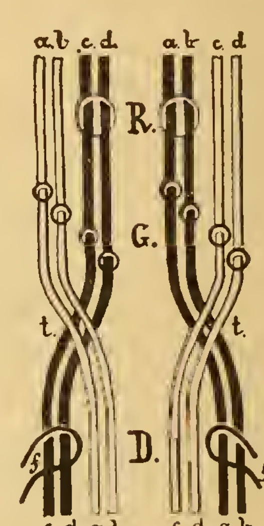


FIG. 977. FIG. 978.

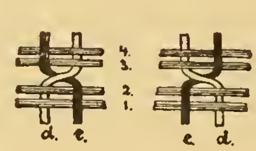


FIG. 975. FIG. 976.

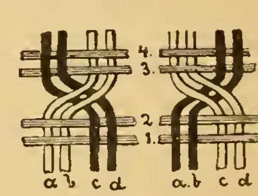


FIG. 979. FIG. 980.

[In my treatise on "The Jacquard Machine, Analyzed and Explained," etc., a chapter is entirely devoted to the method of operation in tying up looms for these fabrics as well as the preparing of designs for the latter fabrics.]

We will next explain the method of operation and adjustment of slackeners in Jacquard fabrics composed of threads working in pairs (one whip-thread douping with one ground-thread).

In such fabrics every whip-thread must be threaded three times; first in a heddle in rear of the regular harness, technically known as the "rear heddle" or "rear harness." These heddles have eyes 1¼ inches high and are fastened from 1¼ to 1½ inches lower than the heddles of the

FIG. 981.

ground-harness and the doup. This rear harness is generally placed at a distance of 8 to 10 inches from the ground-harness. Each rear heddle is connected by means of a harness-cord for operating the corresponding standard heddle of the doup at the place where the latter joins the neck-cords of the Jacquard machine (thus both harness-cords to one hook), and consequently the

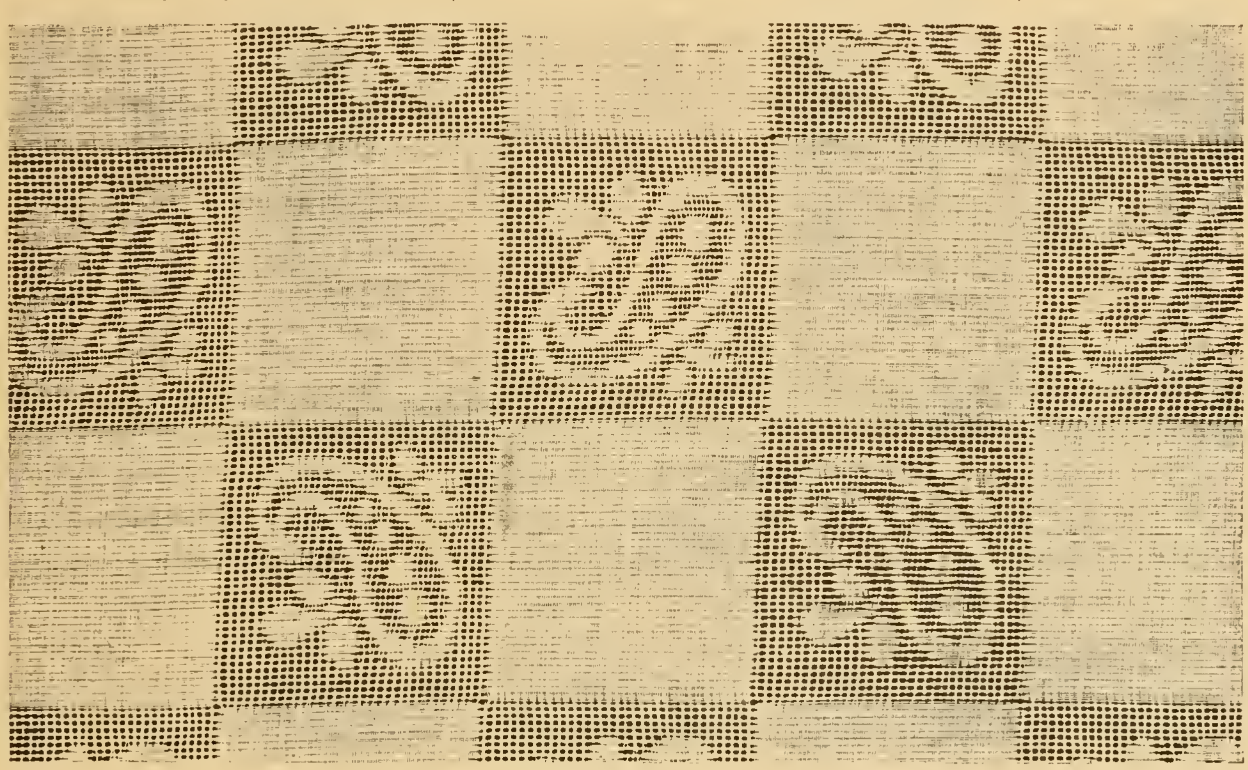


FIG. 982.

rear heddle will lift at the same time when raising the standard, and thus the whip-thread is "slackened" from the rear when required to twist around the ground-warp when douping.

After the whip-thread is drawn in the rear heddle, it is next drawn in its respective heddle of the ground-harness, from where it is threaded to the doup.

In diagram Fig. 972 a plan of the entire procedure as thus far explained is given.

In diagrams Figs. 973 and 974 are shown the ground plans of threading the previously explained Jacquard gauze. Fig. 973 represents the threading of the whip-thread in a doup situated at the left-hand side of the ground-thread (pair). Fig. 974 illustrates a respective threading of the whip-thread to a doup situated at the right-hand side of the ground-thread (pair). Both positions of doups to their respective ground heddle are mentioned as considered by the weaver standing at work in front of the loom. Letters of reference are selected correspondingly: *R* = rear-harness; *G* = ground-harness; *d* = heddle for ground-warp; *e* = heddle for whip-thread; *t* = passing of the whip-threads below ground-warp; *D* = doup-harness; *f* = doup. Whip-threads are shown in full black, ground-threads are shown outlined.

Fig. 975 shows the corresponding crossing as produced in the fabric by using the arrangement illustrated in diagram Fig 973.

Fig. 976 shows the corresponding crossing as produced in the fabric by using the arrangement illustrated in diagram Fig. 974.

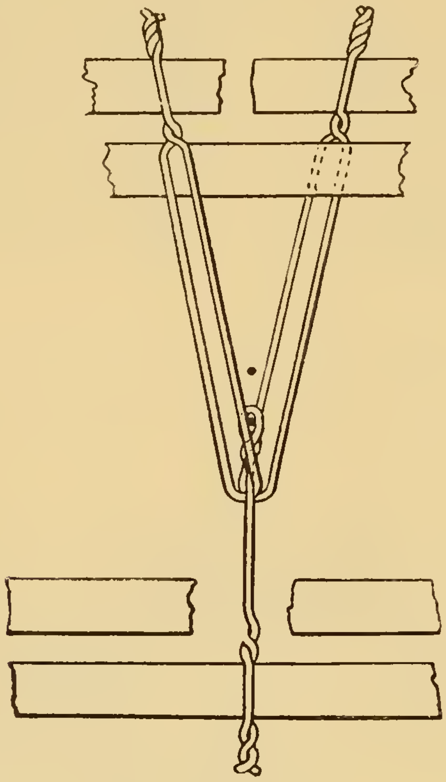


Fig. 983.

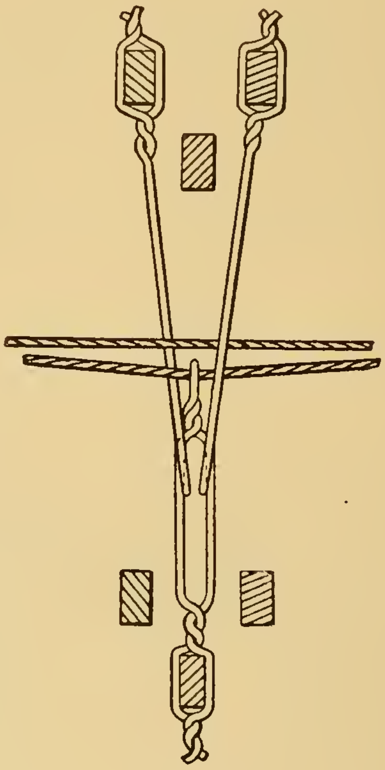


Fig. 984.

Diagrams Figs. 977 and 978 illustrate the ground plans of using two whip-threads for douping against two ground-threads. The following letters of reference are selected correspondingly: *R* = rear harness; *G* = ground-harness; *D* = doup-harness; *t* = passing of the whip-threads below ground-threads; *f* = doup. Threads *a* and *b* in Fig. 977 = ground warp-threads; threads *c* and *d* in Fig. 977 = whip-threads. In diagram Fig. 978 the ground-threads are indicated by letters *c* and *d* and the whip-threads by letters *a* and *b*.

Diagrams Figs. 979 and 980 show the corresponding crossings as produced in the fabric by the respective threadings of whip and ground-warp, illustrated in diagrams Figs. 977 and 978.

Fig. 977 illustrates the threading of the whip-threads to a doup situated at the left-hand side of the ground-threads. Fig. 978 illustrates the threading of the whip-threads to a doup situated at the right-hand side of the ground-threads.

Figs. 981 and 982 illustrate two examples of Jacquard gauze produced upon principles previously explained.

Substitutes for the regular doups have lately been patented by C. A. Littlefield, consisting of a peculiar combination of metallic half-heddles.

Diagrams Figs. 983, 984, 985, 986 and 987 illustrate his invention.

Fig. 983 is a front view of portions of a set of heddle-frame bars with the invention applied.

Fig. 984 illustrates a vertical section of the bars of the heddle frame, and showing the position of the yarns before the crossing takes place.

Fig. 985 is a similar view showing the half-heddles after the crossing takes place.

Figs. 986 and 987 illustrate a modified form of needle, which for some fabrics are preferable.

The present method of cross-weaving requires three common harness-frames for each set of doups. The middle frame is supplied with a specially-shaped half-heddle or needle formed of properly twisted wire or stamped from sheet metal. When the needle or half-heddle is made of wire, the latter is twisted to form an eye at the top end, through which passes the thread or threads required to produce the desired effect in the pattern woven. Below the twist which forms the eye the wires are separated in such a manner as to form a continuous slot or loop from near the eye to a point at or near the lower end, where the half-heddle is formed with an eye or loop adapted to receive the bar upon which the half-heddle is strung. A single bar only is used for the support of this half-heddle. Through the long slot or loop are passed other loop wires, forming half-heddles, there being two of this description to each one of the first named. These

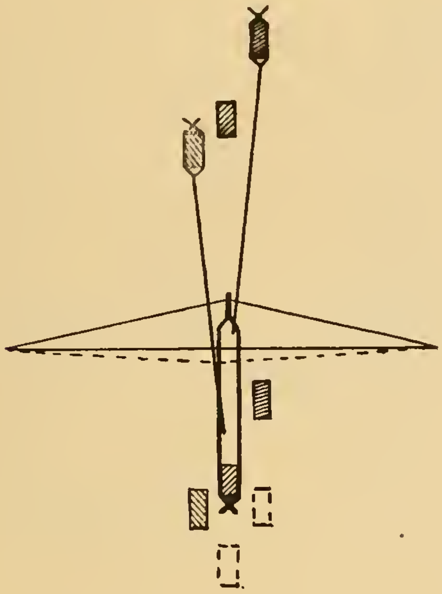


Fig. 985.

Fig. 986.

Fig. 987.

wires are secured, one on the right the other on the left, to the two outside heddle-frames at the top, being strung on the ordinary cross-bars of the harness-frames, the latter passing through suitably-sized loops at the top ends of the looped wires.

To produce the desired pattern, the thread which is to be twisted or crossed about its adjacent thread must be drawn through the eye at the top of the lower half-heddle, and the thread or threads about which it is to cross are to be drawn in between the two upper loops or half-heddles, and in line with the thread passing through the lower heddle-eye. When the harnesses are at rest, the warp-line is established so as to bring the yarn passing through the lower heddle-eye to a position from which it can be drawn up at the forming of the shed upon the desired side of the yarn about which it is to be turned or twisted. The crossing is effected by alternately operating the heddle-frames to which the upper half-heddle or looped wires are secured, the shed being formed by lifting the harness or shaft to the right or left of the frame to which the half-heddles or needles are secured at the bottom. The upper looped wire not lifted slides easily down the long slot or loop in the lower half-heddle, the latter and the upper half-heddle to which the lifting power is applied being drawn into line, thus forming a guide for deflecting the thread about which the crossing or tie is formed to the desired side of the needle or lower half-heddle.

Cross-Weaving for Chenille Fabrics.

A method of cross-weaving other than the one derived by the douping arrangement is largely practised in the manufacture of low-grade Chenille as used for rugs, mosquito-netting and similar fabrics.

In weaving these fabrics the ground-harness set and the douping set of harness are substituted by using two horizontal wooden slats (shafts) of a sufficient strength, which have in a vertical position metal heddles (harness plates or needles) inserted, pointing towards each other. These harness plates are made of thin pieces of metal, each formed with an eye through it for the warp-thread (*r* in Fig. 988*a*) and each beveled at its end near the eye, as shown at *q*, in the same diagram, to form an angle to bring the passing points as near together as possible.

The eyes *q* are formed by making an orifice through the harness-plates and bending the stock on each side of the orifice in opposite directions, so as to permit the warp-threads to pass in a straight line through the eye, and so that there will be but little friction of the warp in the eyes.

In Fig. 988*b* a front elevation of those parts of a loom essential to a clear understanding of the method of operation for these fabrics, is shown. (Warpbeam, lay and shuttle-movement are omitted.)

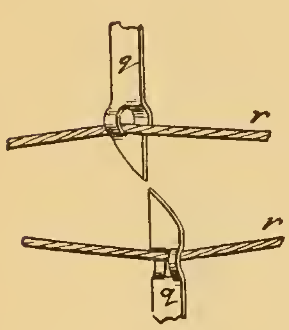


Fig. 988*a*.

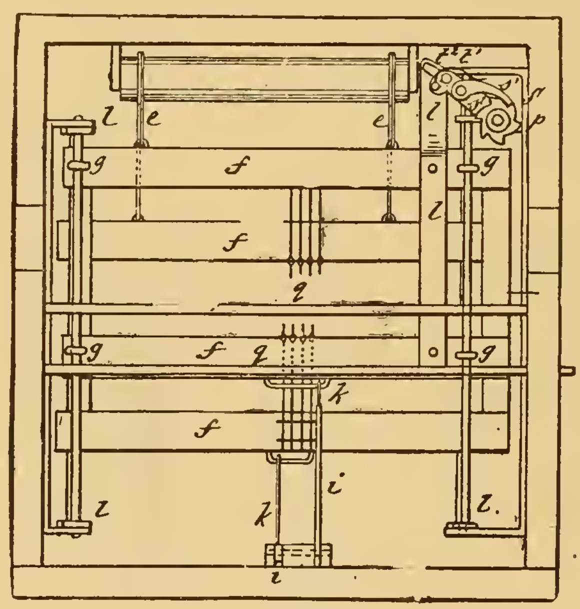


Fig. 988*b*.

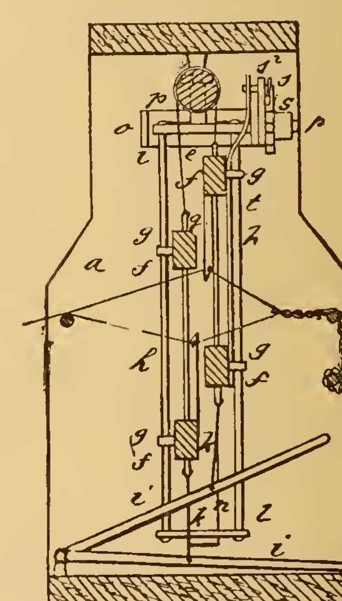


Fig. 988*c*.

Diagram Fig. 988*c* illustrates a transverse sectional view. Letters for indicating the different parts in the diagrams are selected to correspond.

Diagram Figs. 988*a*, 988*b*, 988*c*, illustrate and explain the loom for cross-weaving as patented by Messrs. G. Oldham and Wm. Dixon.

The frame shown is composed of the two side pieces, base, and top cross-piece, on the under surface of which latter are attached brackets for the roller, over which the cords or straps pass, to the ends of which cords or straps the heddle shafts are attached. They are guided at each end by staples *g g*, passing around the upright rods *h h*, and are adapted to be alternately reciprocated by the levers *i i*, pivoted to the base, and connected to the heddles by the connecting-rods *k k*. The upright rods at each end of the heddle-shafts are connected together at their upper and lower ends by plates or cross-pieces *l l*, and these plates or cross-pieces are centrally pivoted to the horizontal supports or arms, forming in this instance a part of the upright plates which are secured to the inner surface of the side pieces of the main frame. In a cross-brace, *o*, is journaled the horizontal shaft *p*, contiguous to one of the plates *l*, which shaft is formed with opposite cams at its ends, so that the shaft when revolved will cause the cams to act alternately against the ends of the plate *l* and vibrate it, and through it and the rods *h h* and other plates, *l*, reciprocate the heddle-shafts *f f* laterally and horizontally at the same time they are reciprocated vertically, which cause the harness-plates to cross the warp-threads *r r* over the filling-threads and to twist them together or cross them between the filling-threads.

The cam-shaft *p* is revolved intermittently by the ratchet-wheel *s*, secured to one end of the shaft, and the pawl s', pivoted to the plate s^2, which is pivoted at one end upon the shaft *p* near the ratchet-wheel *s*, and connected at its other end to the plate *t*, attached to the front heddle-shaft, so the up and down movement of the heddle vibrates the plate s^2 and causes the pawl to turn the shaft *p* at each upward movement of the heddle. The plate s^2 is connected to the plate *t*, in this instance, by the pin t' entering a slot, t^2, made in the plate *t*, to accommodate the lateral movement of the heddle.

Another loom for weaving this chenille as used for rugs and curtains has lately been invented by Messrs. H. & C. Topham. Their improved method of operation is shown in diagrams Figs. 989*a* and 989*b* and 990*a*, 990*b* and 990*c*. (Letters of reference for each diagram are selected to correspond.) Diagram Fig. 989*a* represents the end view of a loom, clearly showing its improvements. Fig. 989*b* is a longitudinal section in the line 1—2, Fig. 989*a*.

Figs. 990*a*, 990*b* and 990*c* are perspective diagrams (as used in the illustrations of their invention), showing the prongs carrying the warp-threads in their different positions.

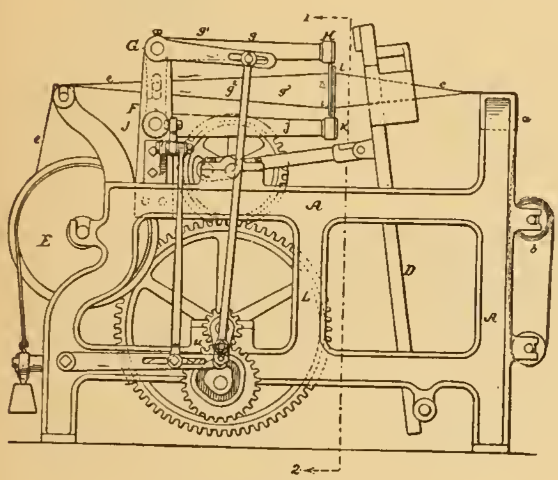


Fig. 989*a*.

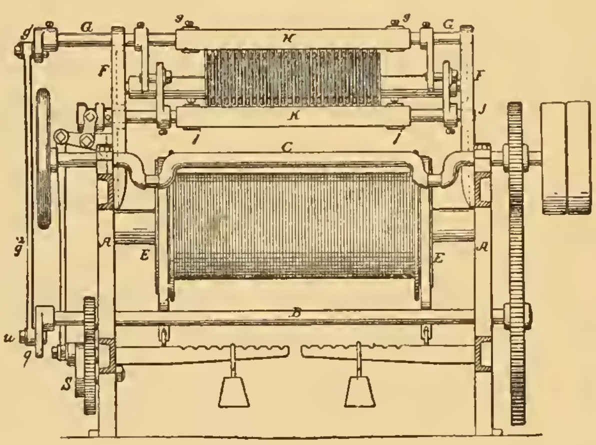


Fig. 989*b*.

Referring to letters of reference: *A A* are the side frames of the loom, *B* is the main shaft and *C* the crank-shaft, *D* is the lathe, *a* is the breastbeam and *b* the cloth-roller, *E* is the warp-beam, *e* the warp-threads.

On the two upright extensions *F* of the side frames is a rock-shaft, *G*, extending from one side of the loom to the other. This rock-shaft carries two arms, *g g*, having at their outer ends a comb *H*, provided with downwardly projecting prongs *h*, which have eyes, *i*, at their outer ends, through which pass one set of warp-threads, *e*. Situated below the rock-shaft before mentioned, but having its bearings in the same upright extensions *F F*, is a rock-shaft, *J*, having two arms, *j j*, which carry a comb, *K*, the prongs *k* of which project upward. These prongs are provided with eyes, *l*, through which the remaining warp-threads pass. Rock-shafts *G* and *J* are connected in such a manner that when the comb *H* is raised the comb *K* is lowered, and *vice versa*.

Rock-shaft *G* derives its motion from main shaft *B*, as clearly shown in diagrams Figs. 989*a* and 989*b*. To regulate the movement of the comb *H* the crank *q* is slotted and carries a crank-pin, *u*, adapted to be adjustably secured therein, so that the rod g^2 can be adjusted either on the crank *q* or arm g'.

The lower rock-shaft *J* has also an independent sidewise movement, so that the prongs of the comb *K* will have a sidewise motion as well as the vertical motion. Motion is given to the shaft *J* by a cam, *S*, driven from the main shaft. When the prongs of the combs are parted the sidewise movement of the lower comb and its shaft takes place

The operation is as follows, reference being made to Figs. 990*a*, 990*b* and 990*c*, as showing the prongs carrying the warp-threads in the different extreme positions during weaving. The eyes in the ends of the prongs of the combs are threaded with the warp-threads *e*, and the filling is thrown across, as shown in Fig. 990*a*, while the combs are in the position shown in that figure. The combs are then parted, as shown in Fig. 990*b*, which will tie in the filling previously inserted. Another pick is then made, as shown in Fig. 990*b*, after which a sidewise movement is given to the lower comb, which causes the warp-threads to twist around each other when the combs come

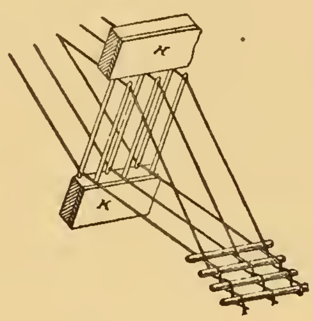


Fig. 990*a*

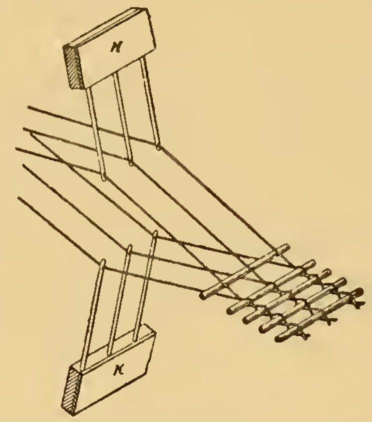


Fig. 990*b*.

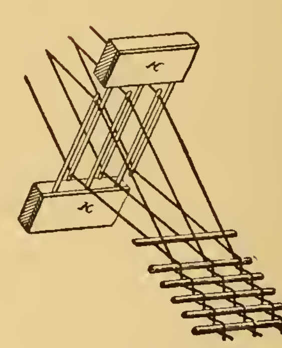


Fig. 990*c*.

together, as shown in Fig. 990*c*. The filling is then pressed towards the woven part of the fabric and another pick is made, throwing another filling across.

Cross-weaving as Used for the Manufacture of Filtering-bags.

Another kind of fabrics (similar to those previously mentioned), which contain the cross-weaving for their principle of construction, are those open-mesh seamless fabrics that are used for filtering-bags for saccharine liquids, etc.

Diagrams Figs. 991, 992 and 993 are given to illustrate the method of operation for producing these fabrics, as patented by B. Muench.

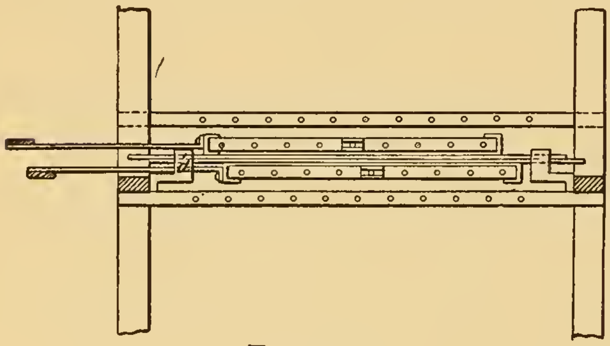


Fig. 991.

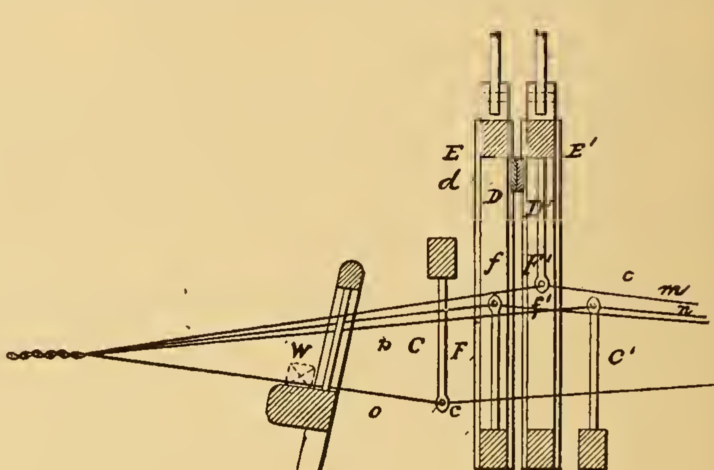


Fig. 992.

Fig. 991 is the top view of part of a loom, showing the fixed and reciprocating frames; one of them has upwardly projecting needles and the other downwardly projecting needles.

Figs. 992 and 993 are cross-sectional views of the harness part of the loom, showing the warps in their different positions. Letters indicating the different parts in the diagrams are used with reference to the following explanations as to construction of these fabrics.

The operation is as follows: Two sets of warps, *o p* and *m n*, are used, one set, *o p*, being used to form the bottom of the seamless fabric in the loom and the set *m n* to form the top of the fabric; the same filling being used for both sets of warps. The warps *o* are passed through the eyes *c* of the front row of fixed needles, *C*, which project downward. The warps *n* are passed through the eyes c' of the rear row of fixed needles C', which project upward. The warps p are passed through the eyes f of the needles F in the front vertically-movable frame D, said needles F projecting upward, and the warps m are passed through the eyes f' of the needles F' in the rear vertically-reciprocating frame D', said needles projecting downward. The warps o and p, which are passed through the eyes of the needles of the front fixed and vertically-reciprocating bar and frame, are the series for making the bottom of the seamless fabric, and the warps m and n, which are passed through the eyes of the needles in the rear fixed and vertically-reciprocating bar and frame, are the series for making the top of the seamless fabric. As shown in Fig. 992, the warps m, n and p are raised and the warps o lowered. The shuttle W is thrown through the space between the warps when those warps are in the positions shown in Fig. 992, and when the shuttle has passed, the filling rests on top of and across the warps o. After the shuttle has thus been thrown, the warps o and p are crossed by the lowering of the frames D and D', and thus the filling is held by warps o and p which form the bottom of the seamless fabric. When the warps are in the position shown in Fig. 993 (and the shuttle thrown), the frames D and D' then raised, the warps m and n are crossed, and the filling is held by warps m and n, forming the top of the seamless fabric, and so on.

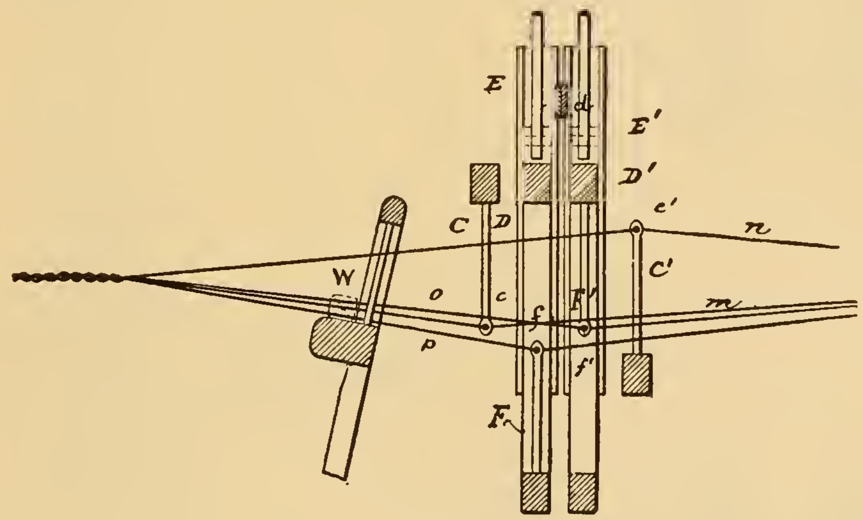


FIG. 993.

In order to hold warps and filling in the position in relation to each other in the fabric, it is necessary that the warps be twisted after each shot. This twisting is obtained by reciprocating the frames E and E' laterally, for as each series of warps has part of its warps passed through laterally-reciprocating needles it is evident that by the shifting of the reciprocating needles such warps will become twisted. The frame D is shifted every time the filling has been shot between the warps o and p, and the frame D' is shifted every time the filling has been shot between the warps m and n.

Cross-Weaving as Used for Producing Fast Centre Selvages.

Cross-weaving is also used in producing fast centre selvages if weaving two or more pieces of a fabric at the same time in the loom. This method of producing such selvages finds extensive use in the manufacture of velvet ribbons, scarfs, and similar fabrics characterized by their narrowness. In dress goods and similar abrics, seldom more than two or three widths are put together to be woven in one width on the loom.

In reeding for fabrics woven with fast centre-selvages, we must be careful to leave one, two or more empty dents in the place where the fabric has to be cut in strips, or separated in pieces after leaving the loom.

In Diagrams 994 and 995, two specimens of such interlacing for headings are shown. In the same threads, B, shown in black, represents the whip-threads. Threads C, illustrated outlined and shaded, represent the ground warp. Threads indicated *A*, and shown outlined, represent the ordinary woven part of the fabric. The filling is shown outlined in a horizontal position (*D*).

Ground warp-threads *C* and corresponding whip-thread *B* must be drawn in one dent.

In Diagrams Figs. 996, 997 and 998, illustrations are given of the weaving of such fast centre selvages in double pile fabrics, woven side by side in a broad loom. The method of operation is patented by Messrs. Lister and Reixach. For forming two adjacent fast inner selvages, both in the upper and lower cloth in double-pile fabrics, and so as to form the upper cloth immediately

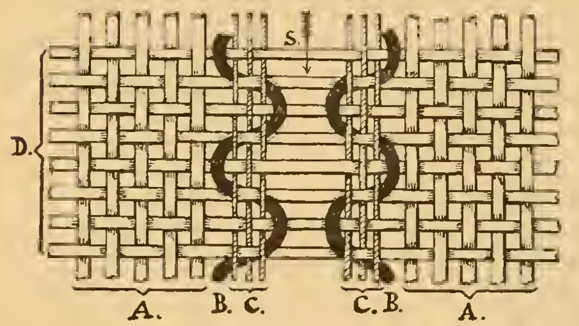


Fig. 994

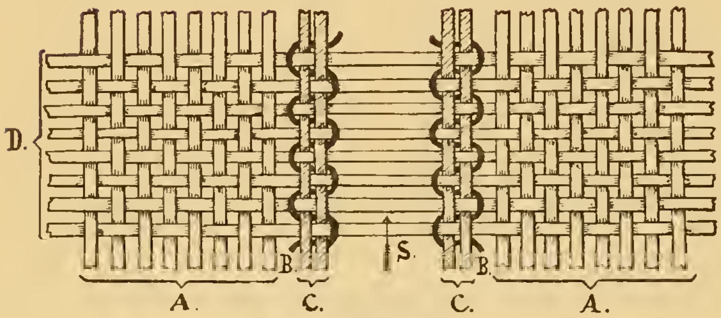


Fig. 995.

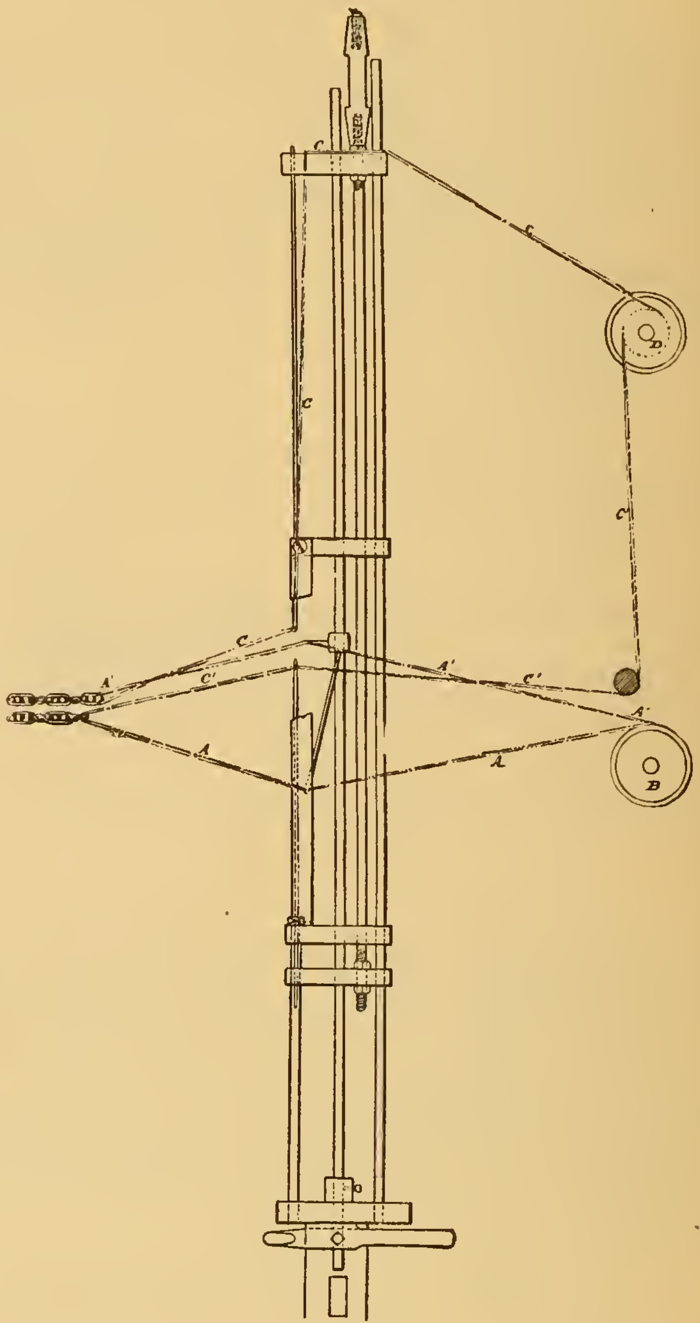


Fig. 996.

above the fast selvages in the lower cloth, two sets of needles of two needles each are required. The needles in the upper set are placed in a line with the needles of the lower set, and made to point downward, while those in the lower set are made to point upward. Both sets of needles are fixed in slides, which can be simultaneously moved up or down in a fixed frame. The needles, near to their points, have eyes formed through them, and through the eyes of the upper pair the binding-threads must be threaded which are to form the fast selvages in the upper cloth, and through the eyes of the lower pair the binding-threads which are to form the fast selvages in the lower cloth must be threaded. With these needles there are also employed two pairs of thread-eyes, to which a lateral movement can be given from the low shaft. Through the upper pair pass two selvage-warps for the upper cloth, and through the lower pair two selvage-warps for the lower cloth. These two pair of eyes are set one above the other at such a distance apart as to leave space enough for a shuttle to pass to and fro between the warps threaded through them. The points of the upper pair of needles are likewise set at a distance from the points of the lower pair of needles. In the upward and downward movement of the needles their points are brought alternately above and below the selvage warp-threads with which the binding-threads, threaded through

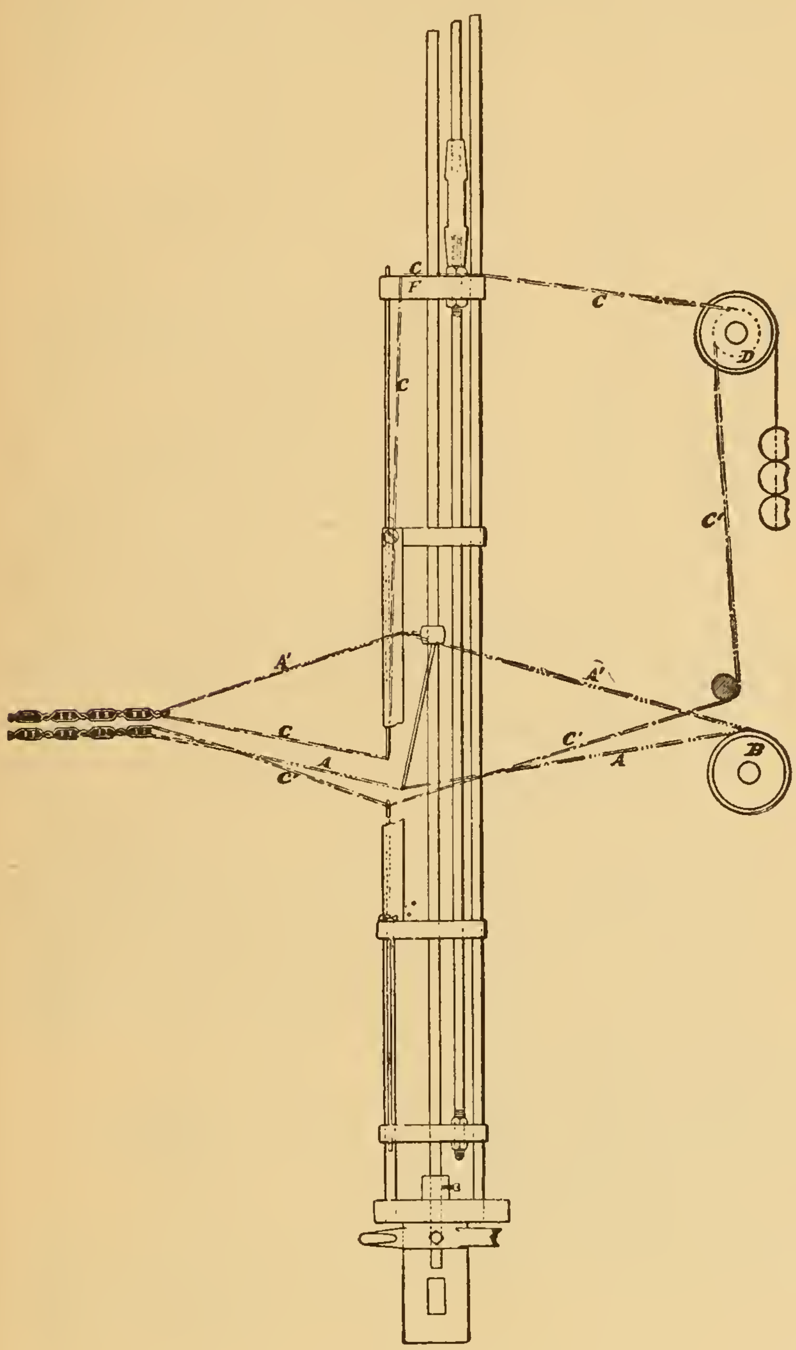


Fig. 997.

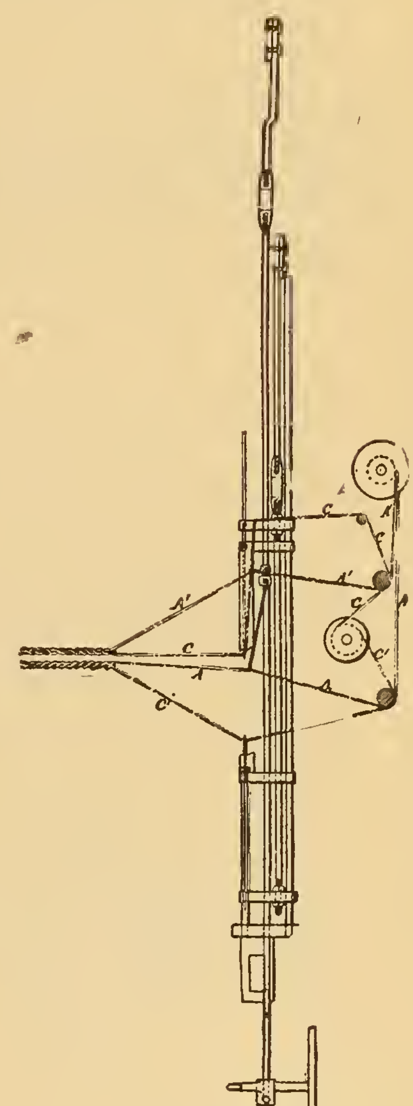


Fig. 998.

the needles, are to be crossed, and when the needles are at one or the other end of their stroke the thread-eyes are made to shog sidewise, so that the warp binding-threads, which receive an up-and-down motion, may be brought to one side and then to the opposite side of the warps, which receive a sidewise movement, and the binding-threads and warps are thus twisted together with a false twist, which, in conjunction with the filling, links them together and forms a fast selvage.

Fig. 996 illustrates a side elevation of mechanism required to be used with a single shuttle-loom for forming the fast inner selvages in the two cloths of a double pile fabric, showing the binding and warp-threads in position while weaving the bottom piece.

Fig. 997 is a side elevation corresponding to the previous one, except that the binding and warp-threads are shown in position while weaving the top piece.

Fig. 998 is a side elevation of the selvage forming mechanism for a two-shuttle loom. Parts of the framework of the loom are illustrated, cut away in the three diagrams to show the needles more clearly.

In Figs. 996 and 997 *A* and A^1 are selvage-warps, which are drawn from a reel or bobbin, *B;* but which also might be taken from the same beam as that upon which the other selvage-warps are carried, or from the main warp-beam. *C* C^1 are the binding-threads, which are drawn from a reel or bobbin, *D*. The warps *A* A^1 are threaded through the thread-eyes, to which a sidewise shogging movement is imparted. The binding-threads *C* C^1 are threaded through the eyes of the needles, to which an up and down movement is imparted.

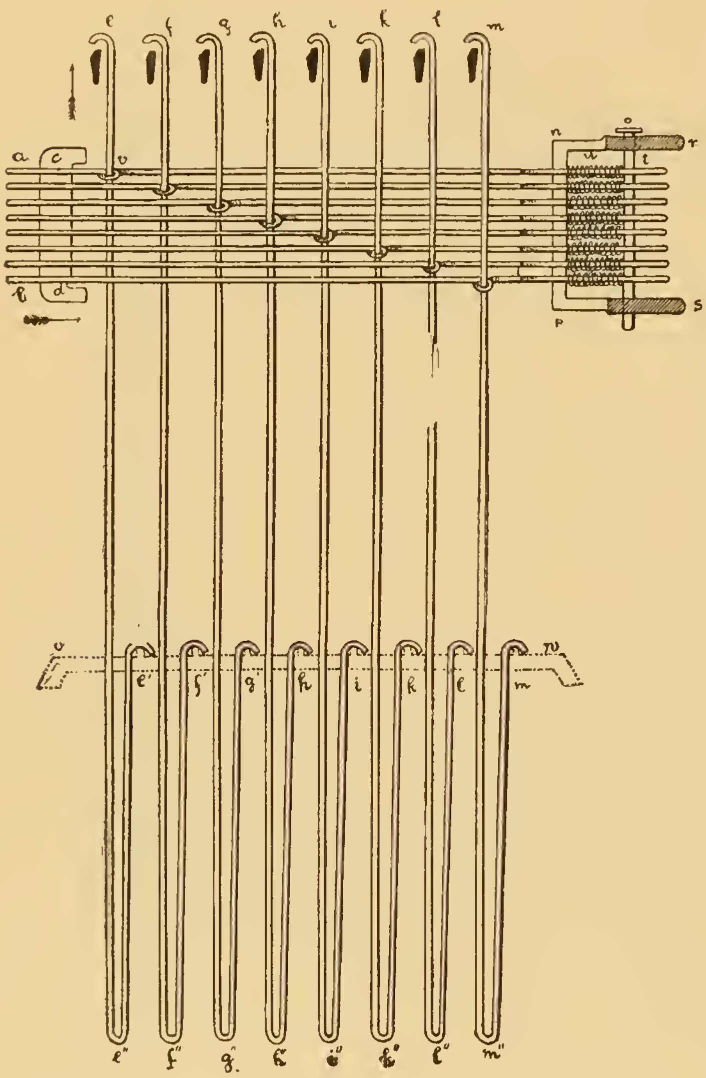


Fig. 999.

The operation is as follows: When the parts are in the position shown in Fig. 996, three picks filling are put into the bottom cloth, and the thread-eyes are during this time shogged sidewise a distance equal to the distance between the needles of each pair. Afterward the needles descend and three picks filling are put into the upper cloth. After this the needles rise and three picks of filling are put into the bottom cloth, and during this time the thread-eyes are shogged back into their former position, and so on continuously. In this way the fast selvage edges are formed in each cloth at a short distance apart from one another, and each cloth can be severed along the small space in between these two selvage edges.

The mechanism shown in Fig. 998 for a two-shuttle loom necessarily differs somewhat from that shown in Figs. 996 and 997, because when two shuttles are thrown simultaneously it is necessary to open two sheds for the shuttles to be passed through.

THE JACQUARD MACHINE.

The Jacquard machine is required for the interlacing of fabrics in which a great number of ends of warps are bound differently in the filling. Every Jacquard machine can be divided into the following parts:

1. The frame and the perforated board through which the neck-cords are passed. 2. The griffe and the necessary attachments for lifting the same. 3. The hooks. 4. The needles. 5. The spring and spring-frame. 6. The needle-board. 7. The cylinder, hammer, and batten. 8. The catches. 9. The cards. 10. The Jacquard harness.

In Fig. 999 we give a clear understanding of the principle of the construction of a Jacquard machine by means of the sectional cut of one cross row in a 200 Jacquard machine, containing 8 hooks, (representing an 8-row-deep machine), illustrating by it the arrangement of hooks, needles, griffebars, springs, frame for holding the latter, and the needle-board. *e*, 1st hook; *f*, 2d hook; *g*, 3d hook; *h*, 4th hook; *i*, 5th hook; *k*, 6th hook; *l*, 7th hook; *m*, 8th hook. These hooks are held in their required places by the eyes of the needles (see place *v* at hook 1) through which the former are passed.

The needles rest with their heads *a* to *b*, in the needle-board, extending outside, towards the cylinder, for about ½ inch. The rear part of the needle—the loop—is passed between two bars of the spring-frame, *n*, *p*, and held by the latter firmly, but with sufficient play for a longitudinal motion for pressing towards their springs. The pin *O*, is inserted for holding the springs in their places, requiring one pin for each vertical row of needles. If the heads of the needles are pushed backwards, in the direction of arrow, the hooks are also moved. If the needles are not pushed, the upper crooks of the hook will remain in position, as in drawing, over the griffebar; and raising the latter, will consequently raise every one of these hooks.

FIG. 1000.

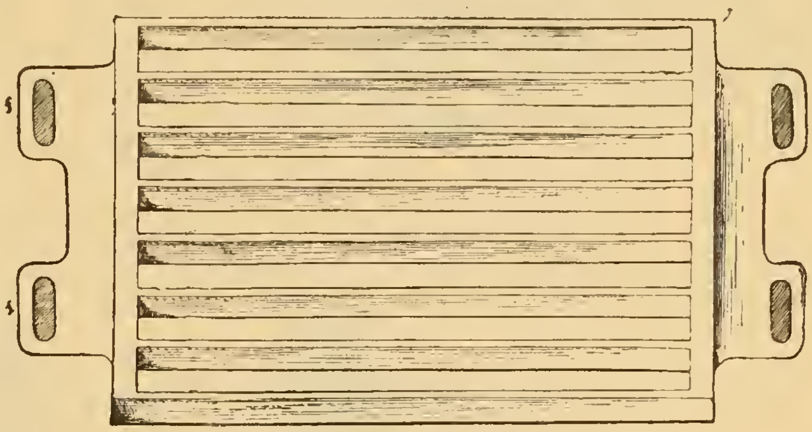


FIG. 1001.

Therefore, if a blank card is pressed against the 208 needles of the machine, used for present illustration, all the needles and hooks will be pushed back out of the way of contact with the griffebars, thus causing an empty lift when they are raised; while by pressing with an empty cylinder, or with a card containing as many holes as the machine has needles, and so placed that the holes are exactly opposite the needles, none of them would be moved, and each hook would remain vertical over its griffebar; and raising the griffe will lift every hook.

The griffe which has its section of the different bars represented in Fig. 1000, is shown in its top view in Fig. 1001. In the drawing, the dark-shaded places, marked *f*, are the hollow places through which the screw is fastened to the plunger.

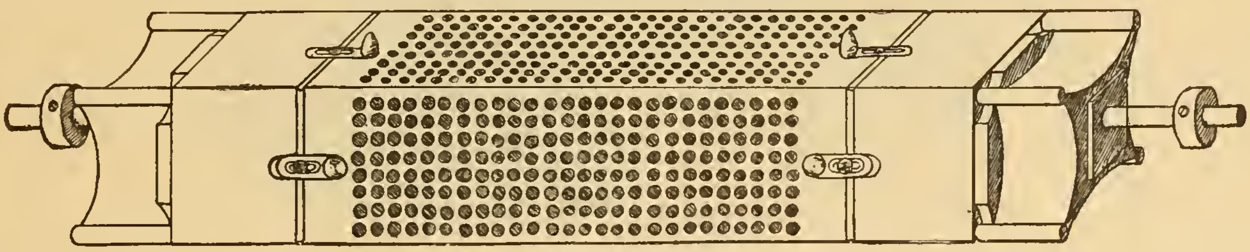


FIG. 1002.

The cylinder around which the cards are working (for operating the needles and these in turn the hooks, neck-cords, leashes and warp-threads) is carried in the batten. This batten has sufficient vibratory motion to enable it to move the required distance away from the needle-board. After coming in contact with the catch, it still moves until the cylinder has performed a complete turn. The cylinder is steadied in the required position by the hammer pressing, by means of a spring, towards the lantern from below. Fig. 1002 represents the cylinder with the lantern for turning the same, by means of the catches mentioned before.

The raising of the "griffe," which in turn also operates the other parts of the Jacquard machine, as previously explained, is generally done by means of a lever arrangement. Fig. 1003 represents the perspective view of a 400 single-acting Jacquard machine (W. P. Uhlinger, Philadelphia, builder).

Fig. 1004 illustrates the "Rise and Fall Shed Jacquard" as built by the Geo. W. Stafford Manufacturing Co., Providence, R. I.

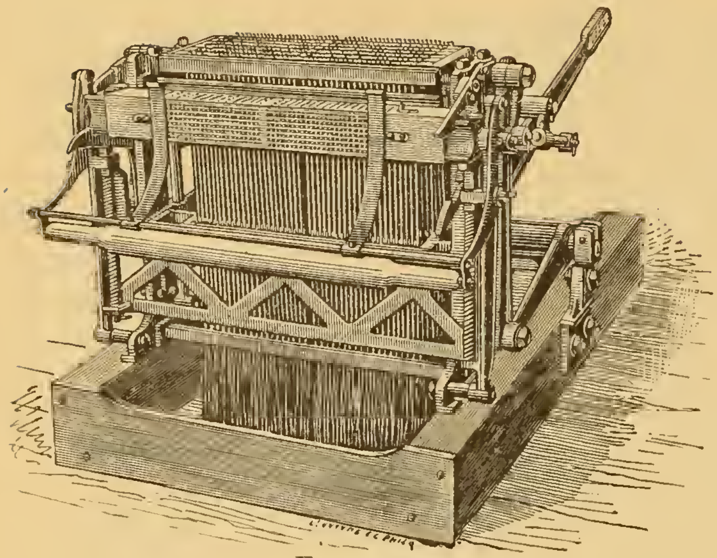


FIG. 1003.

The Jacquard cards have, for regulating the required raising and non-raising of the hooks, holes punched so as to allow their respective needles to penetrate into the cylinder holes and are interlaced in an endless arrangement; hence, one card is brought after the other in rotation towards the needles.

If using a great number of cards in a set, they are made to fold into a "rack." This is done by attaching a wire 1 to 1½ inches longer than the cards, at the junction of say every 12th to 20th card. (See *c*, Fig. 1005, between cards indicated by *a* and *b*.)

Modification of the Single-Lift Jacquard Machine.

During the past few years various modifications in building Jacquard machines have been

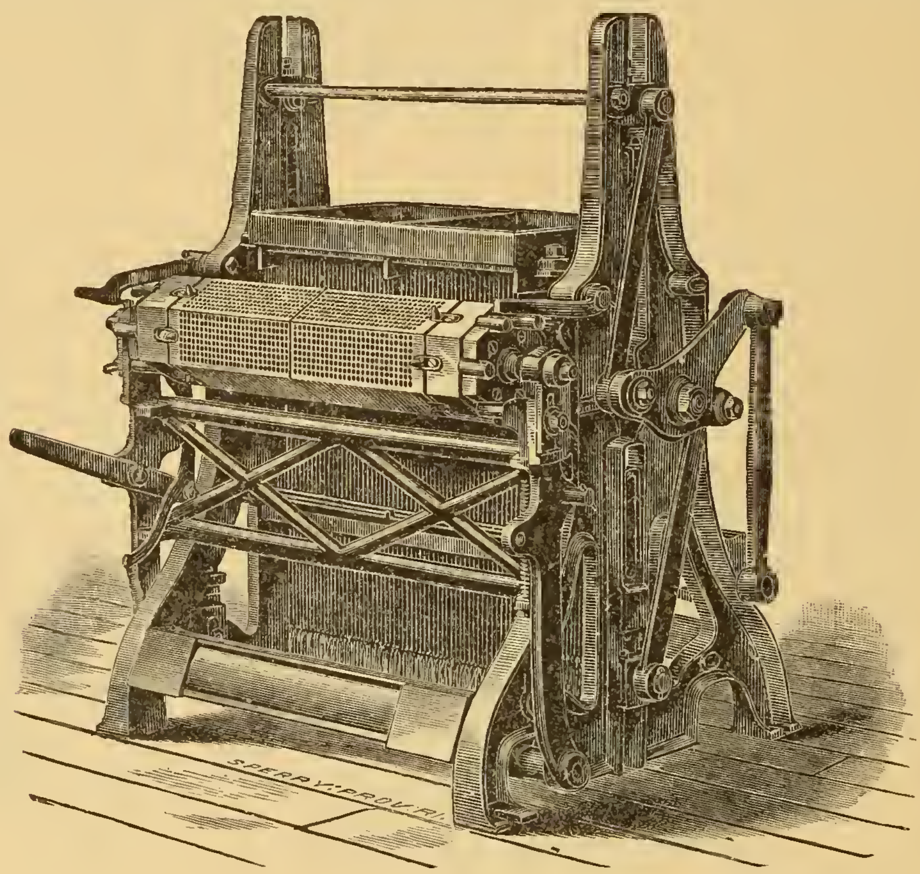


FIG. 1004.

introduced. The object of this has been either the simplifying of designing and card stamping or the saving of card paper and labor for special fabrics, as in the "Ingrain Carpet Machines," the "Brussels Carpet Machines," etc.

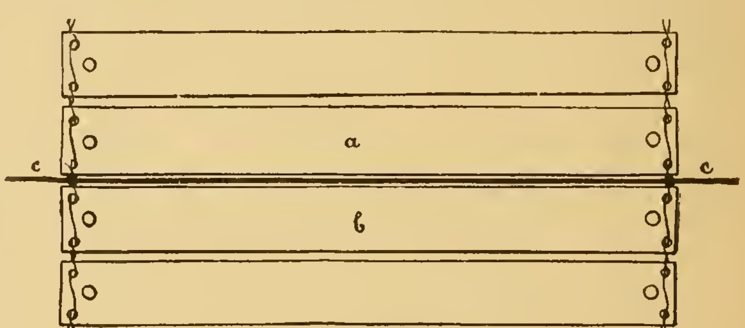


FIG. 1005.

Again, the item of "speed," and consequently more production in cloth for a given time, in damasks and similar fabrics, has been satisfactorily solved by the construction of the "Double-Lift, Double-Cylinder Jacquard Machine." Another principle of a modification over the single-lift Jacquard machine is to be found in the "Double-Lift, Single-Cylinder Jacquard Machine," which has for its object the saving of the warp by operating each individual thread only when required to, by the changes from *up* to *down*, or *vice versa*, in the design or weave, etc. These machines are, in their principle of construction and method of operation, individually explained and illustrated on pages 67 to 72 in my treatise on "The Jacquard Machine."

Card Stamping.*

As mentioned previously, holes are punched in each individual card, according to the design. This is done for each row at one stroke or revolution of the piano card-punching machine.

Fig. 1006 illustrates the perspective view of such a machine (operated by belt-power), while Fig. 1006*a* represents the top view of the "head" (cover taken off).

In the same, the small open spaces for holding the punches for stamping the holes in the cards for the needles, as well as the large opening for holding the punch for stamping the peg holes, are clearly visible.

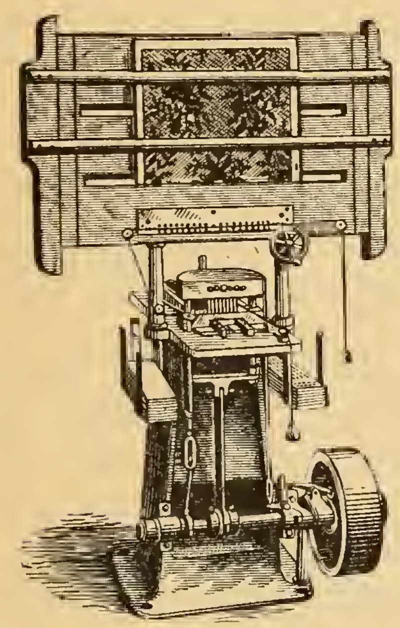


Fig. 1006.

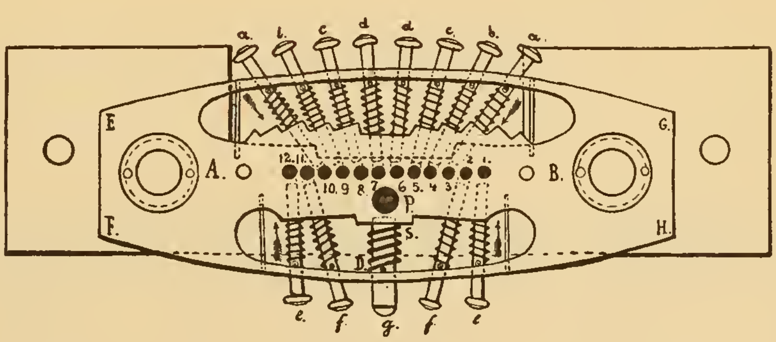


Fig. 1006*a*.

If several sets of cards of one design are required for starting a corresponding number of looms, and the first set has been produced by the piano machine, exact duplicates can be obtained by means of the "Repeating Machine." In this machine the entire card is duplicated at one stroke.

The Jacquard Harness.

To the lower end of the hooks in the Jacquard machine the neck-cords are adjusted. The latter are passed separately through one of the corresponding holes of the perforated bottom board. To these neck-cords are fastened the leashes of the Jacquard-harness, about one-half to one inch above the frame containing the rods which guide the neck-cords vertically, as the hooks are raised and lowered.

The different harness-cords are threaded through the "comber-board," or the "journals," in various ways, and are called "tie-ups." After the harness-cords are threaded the heddles are adjusted.

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*In a chapter on "Preparing and Stamping of Jacquard Cards," comprising pages 85 to 102 of the author's treatise on "The Jacquard Machine," a thorough and complete description, conspicuously illustrated (45 illustrations), of the above subject will be found.

In my treatise, already alluded to, the different methods of "tying-up of Jacquard harness" have been classified as follows:

I.—Straight-through tie-up.
II.—Straight-through tie-up for repeated effects, in one repeat of the design.
III.—Straight-through tie-up of Jacquard loom, having front harness attached.
IV.—Centre tie-up.
V.—Straight-through and point tie-ups combined.
VI.—Straight-through tie-up in two sections.
VII.—Tying-up a Jacquard harness for figuring part of the design with an extra warp.
VIII.—Straight-through tie-up in three sections.
IX.—Point tie-up in three sections.
X.—Combination tie-up in two sections.
XI.—Straight-through tie-up in four sections.
XII.—Tying-up of Jacquard looms with compound harness attached.
XIII.—Tying-up Jacquard looms for gauze fabrics.
XIV.—Tying-up harness for carpets.

Each of these methods of tying-up is treated in a thorough manner and is fully illustrated by over one hundred special illustrations.

The Comber-board and Methods of Figuring for it.

The comber-board is placed in the Jacquard-loom for the purpose of guiding the harness-cords from the neck-cords to their respective position as required by the fabric for operating the heddles (to which they are adjusted on their other extreme end.) There are two kinds of comber-boards in use. *a.* Comber-boards made of a solid piece of material, either wood or porcelain, or constructed by using wires crossing each other and adjusted in a frame (see Fig. 1007). *b.* Comber-boards made in strips of either wood or porcelain and adjusted afterwards in a wooden frame (see Figs. 1007*a* and 1007*b*).

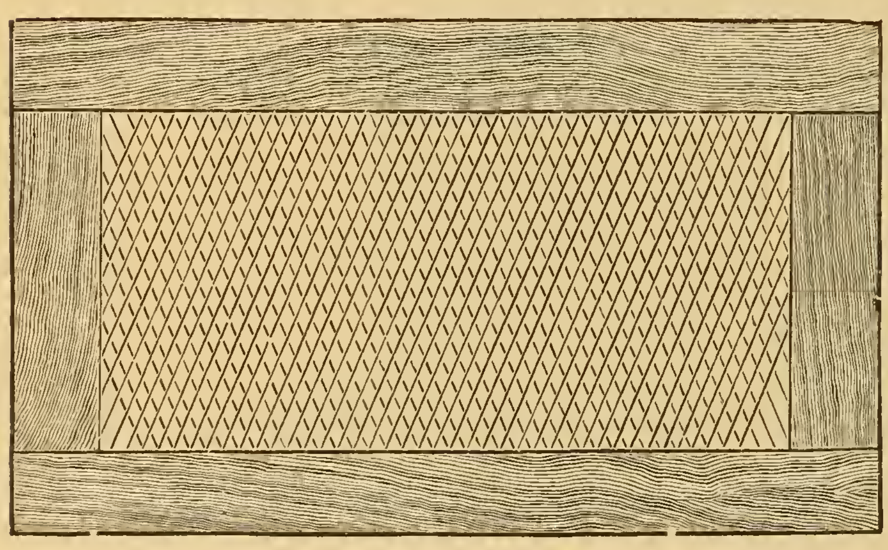


Fig. 1007

Comber-boards Made of a Solid Piece of Material.

Before ordering a comber-board, it is necessary to know the texture of the fabric in the loom, and also the number or size of the machine to be used; for the number of holes per inch in the comber-board is regulated by this. Afterwards, we may, if we choose, arrange the number of holes in depth of the comber-board, according to the number of griffe-bars in the machine (guided by the fabric to be made). We may have eight griffe-bars in the machine, and arrange the comber-board 4, 6, 8, 10, 12 rows deep; or we may have 12 griffe-bars in the machine, and arrange the comber-board 12, 10, 8, 6, 4 rows deep.

Rule: The number of holes to one inch in the comber-board must equal the texture of the fabric to one inch in loom.

The width and depth of the comber-board are regulated by the width of the cloth required and by the design to be used. The greater the number of rows in depth the closer they must be; the same is true of the width. It is necessary to take care not to have the comber-board too deep, as the consequence would be a bad shed; furthermore, we must not have the holes too close together, as in a high texture this would make trouble in the weaving through the catching of the heddles with the warp, and also cause useless chafing of the warp-threads and the heddles.

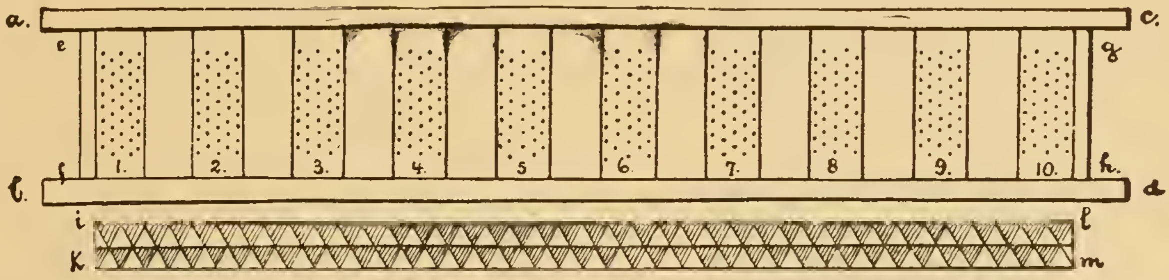
The Changing of Solid Comber-boards for Different Textures.

In Jacquard work we generally use the same texture, or as near as possible, as the loom is tied up for; but changes are unavoidable. If we must reduce the texture of the fabric in a Jacquard loom tied up with a solid comber-board, we must also reduce proportionally the number of hooks and needles used in designing, and hence the number of heddles used per inch. These heddles will thus be left empty when drawing in the warp. To accomplish this, lift the full machine and throw the hooks not to be used from the griffe-bars, lowering in this way every mail which is not to be used. Sometimes there may be only one, two, three, or four hooks to be thrown off, on account of the design. At other times it may be necessary that one-eighth, or one-fourth, or even one-half, of the whole number shall be dropped for this purpose.

Comber-boards Made in Strips and Adjusted Afterwards in a Frame.

By these comber-boards which are used to a great advantage on narrow loom work up to 36-inch fabrics, we can change the texture for the fabric; for the strips composing the comber-

FIG. 1007*a*.



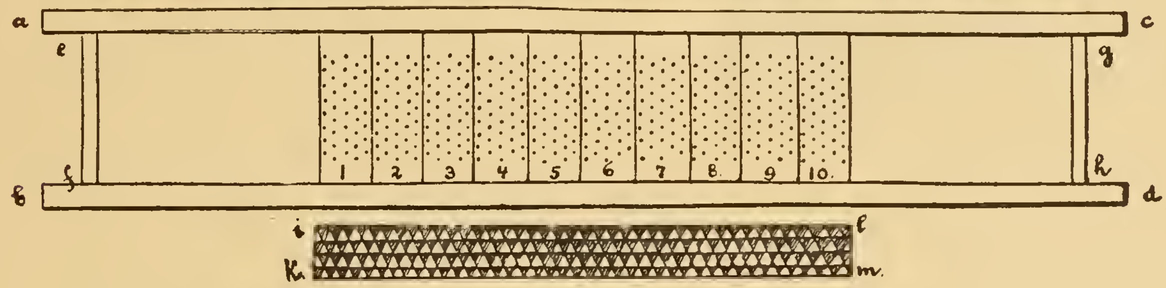


FIG. 1007*b*.

board may be drawn apart, thus changing the high texture to lower. To give a clear understanding, Figs. 1007*a* and 1007*b* are given.

Fig. 1007*b* represents an 8-row deep comber-board, *a*, *b*, *c*, *d*, composed of 10 strips which are set close together. By examining each strip 5 cross-rows of holes will be found, making the whole number of holes 400.

Suppose this comber-board is intended for a texture of 100 ends per inch; this will give for the width of the fabric (shown below, *i*, *k* to *l*, *m*) 4 inches.

In Fig. 1007*a*, the comber-board is arranged for a texture of half as many ends, or 50 holes per inch, and the 10 strips are arranged accordingly; the empty places between the strips are of same size as the strips themselves, and the fabric design below the comber-board is arranged to correspond.

GOBELIN TAPESTRY.

Tapestry is neither real weaving nor true embroidering. Though wrought upon a loom and upon a warp stretched out along its frame, there is no filling thrown across the threads with a shuttle, but the filling is worked with many short threads of various colors, put in with a needle.

Tapestry runs back into remote antiquity. The Greeks and Romans used tapestry for curtains and other hangings; and the use of it for like purposes was common throughout Europe in the succeeding ages. "Arras" was the usual name for hangings of this kind, owing to the excellence of the work produced in that town in England. "French tapestry" has long been famous also. Francis I. brought Flemish workmen to Fontainebleau, and the establishment was kept up by his successors. A hundred years later, Colbert, the celebrated minister to Louis XIV., took under his protection a manufactory which had been set up by two brothers, of the name of "Gobelin," originally dyers; and in a very short time the productions of the "Hotel royal des Gobelins" were universally admired. The well-known tapestry which for many generations hung upon the walls of the House of Lords, London, England, and which were destroyed by the fire of 1834, were Flemish, and executed in the reign of Queen Elizabeth to commemorate the destruction of the Spanish Armada. But the culminating point in the history of tapestry was when Rafaelle was employed to make the designs for a series of Scripture subjects, to be hung upon the walls of the Sistine chapel in Rome.

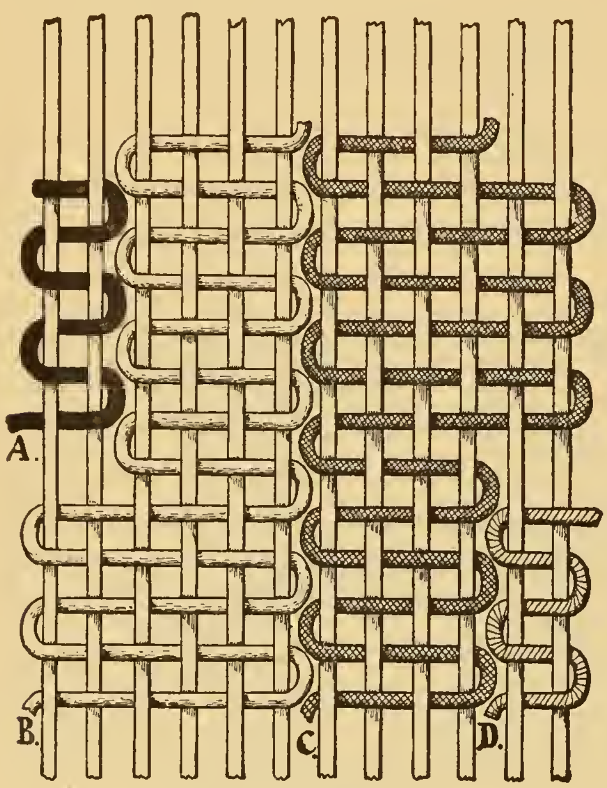


Fig. 1008.

Tapestry work is the most costly and effective of the textile manufacture. We will next explain the method of operation as observed in the manufacture of these fabrics during the last three centuries. (Older kinds of tapestries, for example the well-known "Bayeux tapestry" were wrought by the needle on the surface of the cloth and thus are actually produced by embroidering). As mentioned before, the warp-threads are stretched in a frame (loom) in a vertical position for the weavers. The method of interlacing the filling into the before mentioned warp is done after the principle of the plain weave by means of various numbers of colored filling-threads each guided by a needle. These different colors of filling are arranged after a certain design. For this purpose warp-threads in the required position are pulled by the weaver towards himself with one hand, and with the other hand the required needle (bobbin) block containing the color of filling as called for by the design is inserted. Supposing in the present example the weaver pulls towards himself the uneven numbered warp-threads (1, 3, 5, etc.) with the left hand, and inserts the block containing the required colored thread in the direction from left to right, by means of the right hand. Next he pulls the even numbered warp-threads (2, 4, 6, etc.) and returns the block before mentioned. In this mannei the weaver continues to entwine one color until a certain part of the design requiring this color is finished. He takes next another color as required by the design and finishes, similar to the before explained method, any place where this color is required. In this manner he continues to treat each color as required by the design. The beating up of the filling so inserted is done by means of a comb. Taking the fabric into consideration in its vertical position it will be seen that there is no interlacing from one color effect to the other; therefore these effects must be sewed together after the embroidering is done.

Diagram Fig. 1008 illustrates the method of operation for such a Gobelin.

APPENDIX.

Analysis of the Various Textile Fabrics and Calculations Necessary for their Manufacture.

The analysis of textile fabrics forms a prominent part of the knowledge required in a competent designer and manufacturer. In addition to theory a practical experience in the construction of the various fabrics is likewise called for. Thorough analysis consists not only in "picking out" the arrangement of the interlacing of warp and filling (the weave), but also in ascertaining the materials of which both systems of threads are composed, the process such raw materials must be subjected to before the required yarn or thread is produced, necessary for the construction of the fabric on the loom, as also the various processes commonly designated as finishing.

The analysis of a fabric is not always required for duplicating the fabric, as in some instances it has for its main object only one of the previously mentioned points, as to materials used, amount of twist in yarn, process of finishing necessary, etc. But whichever special point is required to be ascertained, or should a complete reproduction of a given sample be required, it is always best to have a clear understanding (or analysis) of all points. For example: A knowledge of the weave will be the guide for a special analysis as to the materials to use—the amount of twist to put into the yarn—or the finish required, for the harder a weave "takes up" the stronger the warp yarn must be (as to quality of material to use, or amount of twist to be put into the yarn) so as to resist the amount of wear incurred during the weaving. The weave employed in interlacing the warp and filling, and the raw materials used in the manufacture of the yarn, will influence the process of finishing required, etc.

The complete analysis of textile fabrics can thus be classified under the following eight points:

I. Ascertaining the Weight per Yard and Ends per Inch in Warp and Filling for the Finished Fabric from a Given Sample.

II. Ascertaining the Weave.

III. Ascertaining Raw Materials Used in the Construction of Textile Fabrics.

IV. Ascertaining the Texture Required in Loom for a Given Fabric Sample.

V. Ascertaining the Arrangement of Threads in a Sample according to their Color and Counts for the Warp and Filling.

VI. Ascertaining the Sizes of the Yarns, or their Counts, as Necessary to be Produced for the Reproduction of the Given Sample.

VII. Ascertaining the Weight of the Cloth per Yard from the Loom.

VIII. Ascertaining the Process of Finishing Necessary, and Amount of Shrinkage of the Fabric during this Process.

These eight points, when carefully considered, will in most cases produce the required object, "a thorough analysis" or a thorough understanding of the construction of the fabric with which the manufacturer has to deal.

I. Ascertaining the Weight per yard of the Finished Fabric, and its Finished Texture (Ends per inch in Warp and Filling).

Usually the sample given to the designer for analysis is less in length than one yard (of the finished fabric), and generally narrower than the finished width of the cloth; oftentimes only one or two square inches, or even less, being furnished. Should, however, one or more yards of a fabric, having its regular width be given, it is easy for the designer to solve the question by weighing the cloths given and dividing the weight thus ascertained by the number of yards in the sample. The result will be the weight per yard of the finished fabric. But when the size of the sample submitted is small (less than one yard) the weight per yard must be found by figuring in proportions.

Rule for Ascertaining from a Small Sample (finished) the Weight of the Fabric in Ounces for One Yard.

Cut your sample to a known size, and divide the number of square inches thus derived into the number of square inches which one yard of the fabric will contain.

1944 square inches $\frac{6}{4}$ wide fabrics = 54 inches wide.
972 " " $\frac{3}{4}$ " " 27 " "

Multiply the result with the weight in grains of your sample and divide the product by 437½ which will give you the ounces per yard for the fabric in question.

For example: Suppose you have a $\frac{6}{4}$ wide fabric. The sample cut, or stamped, with a die, 3 inches by 3 inches equals 9 square inches. Suppose the weight of these 9 square inches is 25 grains.

Question: Required the weight in ounces of one yard of cloth, being $\frac{6}{4}$ wide?

Answer: $\frac{6}{4}$ or 54 inches wide fabric 54 × 36 or 1944 square inches.

1944 ÷ 9 = 216 × 25 = 5400 ÷ 437.5 = 12.34 oz.; thus the weight of the fabric is 12⅓ oz.

Another example. Take a $\frac{3}{4}$ wide fabric. The sample cut, or stamped with a die 3 inches by 4 inches, equals 12 square inches. Suppose the weight of these 12 square inches is 28 grains.

Question: Required the weight in ounces of one yard of cloth to be 27 inches wide.

Answer: 27 inches wide fabric = 27 × 36 or 972 square inches.

972 ÷ 12 = 81 × 28 = 2268 ÷ 437.5 = 5.18 oz., weight of fabric per yard.

Table for Ascertaining the Number of Square Inches in any Fabric with a Width of 18 Inches to 54 Inches.

Width of Fabric in inches.	Number of square inches in one yard.	Width of Fabric in inches.	Number of square inches in one yard.
18	648	37.	1332
19	684	38.	1368
20	720	39.	1404
21	756	40.	1440
22	792	41.	1476
23	828	42.	1512
24	864	43.	1548
25	900	44.	1584
26	936	45.	1620
27	972	46.	1656
28	1008	47.	1692
29	1044	48.	1728
30	1080	49.	1764
31	1116	50.	1800
32	1152	51.	1836
33	1188	52.	1872
34	1224	53.	1908
35	1260	54.	1944
36	1296	60.	2160

To Ascertain the Finished Texture of the Submitted Sample.

For this purpose unravel a few ends of the warp and filling of each system on one side of the sample, and count the number of threads one inch contains (in each system). In the places from which the filling has been extracted the texture for the warp will be found, and in the places from which the warp-threads have been drawn the filling texture will be found. It is best to ascertain the texture for each system of threads in at least two different places, so that if found to be the same it will serve as a test for correct work. If found not to correspond, it will require a third counting of the respective threads per inch, so as to ascertain which of the two previous countings is correct. Fabrics having a fancy arrangement with regard to their threads frequently require to have the number of threads ascertained in more than one inch. In some fabrics the texture must be found by counting the number of threads in one repeat of the pattern and then dividing this result by the number of inches these threads occupy in the fabric.

EXAMPLE.—180 threads of warp in one repeat of the pattern occupy 3¾ inches space in the finished fabric. *Question:* Find the texture (average). *Answer:* 180 ÷ 3¾ = 48 threads, texture of warp in given sample.

II. Ascertaining the Weave.

This part of the analysis of a fabric is based first of all upon a thorough comprehension of the theory of constructing the various weaves for single cloth, double cloth, etc. It also requires, in dealing with heavy fulled fabrics, or fabrics having the face filling broken during the process of finishing, a considerable amount of patience.

Ascertaining the weave implies to the designer that he is to solve from a sample the manner in which both systems of threads, composing the fabric, interlace each other, and this is technically known as the "picking-out" process. An experienced designer will in most cases ascertain the weave necessary for producing a given sample by a mere glance at it, while in fabrics having fine counts of silk or cotton yarn the microscope will assist him in designating the weave without "picking-out." But as such skill can only be arrived at after years of practice and experience we will define the "picking-out" process for the benefit of the unskilled.

If it is required to ascertain the weave in a fabric having a nap on its surface, the nap must be carefully removed by singeing it off by holding it over a flame, care being taken not to burn the threads. Next carefully remove the burnt refuse adhering to the structure with a sharp knife. (It is well to have a sharp knife or razor always at hand for this purpose.)

Always endeavor to get the samples for "picking-out" sufficiently large, containing at least two or three repeats of the weave, warp and filling-ways, in excess of the amount of cloth necessary for liberating threads in each system, so as to get the proper starting-point for commencing to pick-out. If a sample is submitted for "picking-out" which does not contain a complete repeat of the weave, dissect the amount on hand and finish the complete weave in accordance with the instructions given in the theory of constructing weaves. The experienced designer, when he gets a sample for dissection, readily understands which system of threads are the warp and which the filling, but to the inexperienced this will prove the first difficulty which will have to be mastered. To aid in this the following rules are given, which if carefully considered (with reference to the sample given) must greatly assist the novice in solving the problem.

If the sample submitted for "picking-out" contains a part of the selvage, the latter will readily indicate warp from filling, for the selvage-threads always run in the direction of the warp.

If the threads in one system are "harder" twisted than in the other, the hard-twisted threads are generally the warp system.

If the sample submitted for analyzing has what is technically known as a "face-finish" (kersey, beaver, doeskin, broadcloth, etc.), the direction of the "nap" indicates the warp.

The "counts" of yarn found used in each system will often assist in ascertaining which is the warp and which is the filling, for in most instances the yarn used for warp is of a finer number than the filling.

If the fabric has cotton yarn for one system of threads and woolen for the other (as in union fabrics), the cotton yarn is generally the warp yarn.

If in the sample submitted for analysis the one system of threads is found to have been sized or starched, and not the other, the former is the warp.

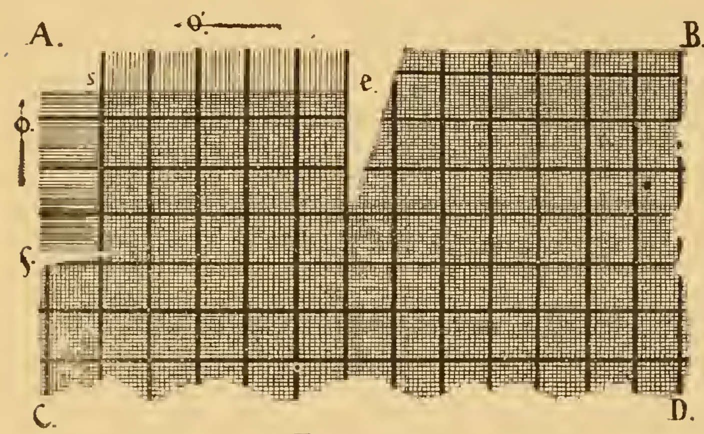


FIG. 1009.

If the sample contains "reed marks" (or imperfections known to the weaver as being caused only by the warp system), such imperfections readily characterize the respective systems of threads.

Another guide for distinguishing the warp from the filling is found in the "style" of the respective fabrics submitted for "picking out." In fabrics having a striped character, or check effects in which the one direction of the lines is prominent compared with the others, the direction of the stripes, or the prominent lines in the check, indicate the warp system.

In fabrics composed of two systems of filling (face filling and backing) and one system of warp, the heavy and soft-spun filling, known as the "backing," indicates itself, and thus the system of threads.

Fabrics are generally dissected by investigating the method of interlacing the filling into the warp; some fabrics require their weaves to be dissected by ascertaining the interlacing of successive warp-threads in the filling, such as the corkscrews, diagonals and similar fabrics. Weaves in pile fabrics, such as velvets, Astrakhans, etc., are ascertained the quickest by analyzing the body structure.

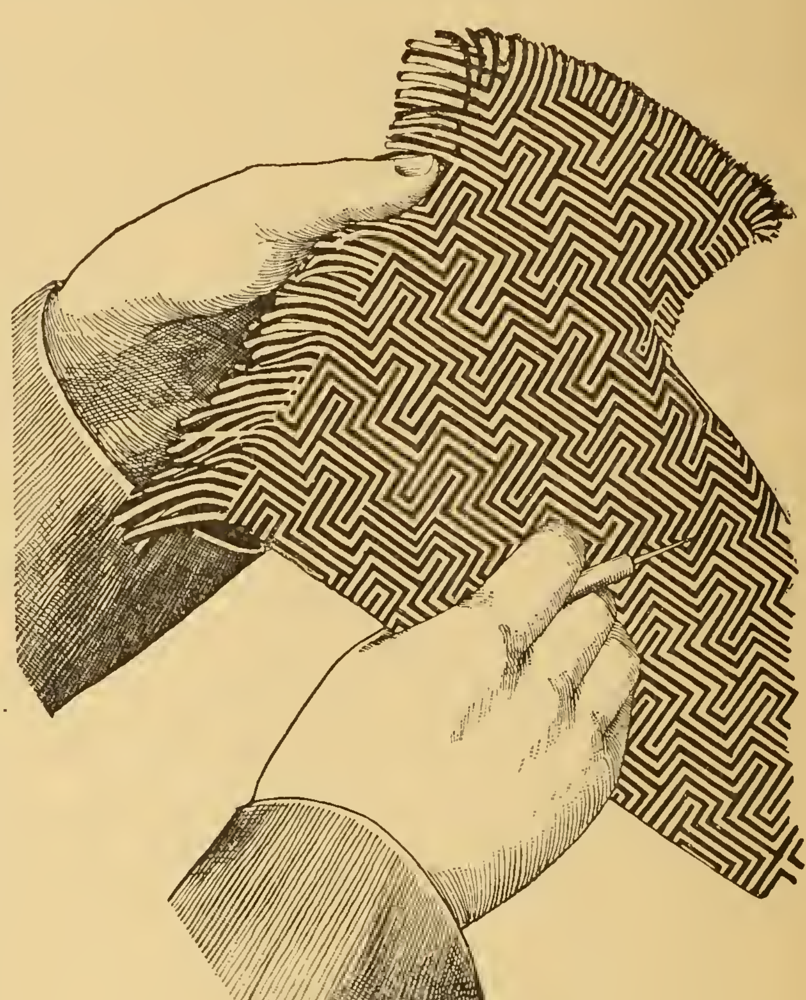


FIG. 1010.

The instrument required for "picking out" is a strong needle with a sharp point. In some instances the microscope is found to be of much service. The work of picking out a sample is most readily accomplished by proceeding as follows :*

Clear off the nap or fibres on the surface of the sample as previously mentioned. In fabrics without a nap this is, of course, not required. Next unravel sufficient filling on top of the fabric, and warp on the left hand side, to produce two fringed edges of say about $\frac{1}{4}$ to $\frac{1}{2}$ inch in length. If you should desire to save, from the sample submitted for analysis, as much as possible, make straight cuts with the scissors at a distance of about $\frac{1}{2}$ to $\frac{3}{4}$ inches from where you want to stop dissecting threads. This procedure is illustrated by diagram Fig. 1009. *A-B-C-D*, sample submitted for "picking out." Arrow *O* direction of warp. Arrow O^1 direction of filling.

*Use picking out of the filling from the structure in the example given for explanation.

The cuts in the fabric are shown at the places indicated by *e* and *f*. Letter *S* indicates the place where the first warp-thread and the first pick meet—the point for commencing to "pick-out."

After the sample is prepared according to the illustration just given, raise the first pick about $\frac{1}{16}$ of an inch with the "picking-out needle." See Fig. 1010.

Place the sample in the left hand as shown in diagram 1011, next ascertain the arrangement of interlacing pick number 1, warp-ways, until repeat is obtained.

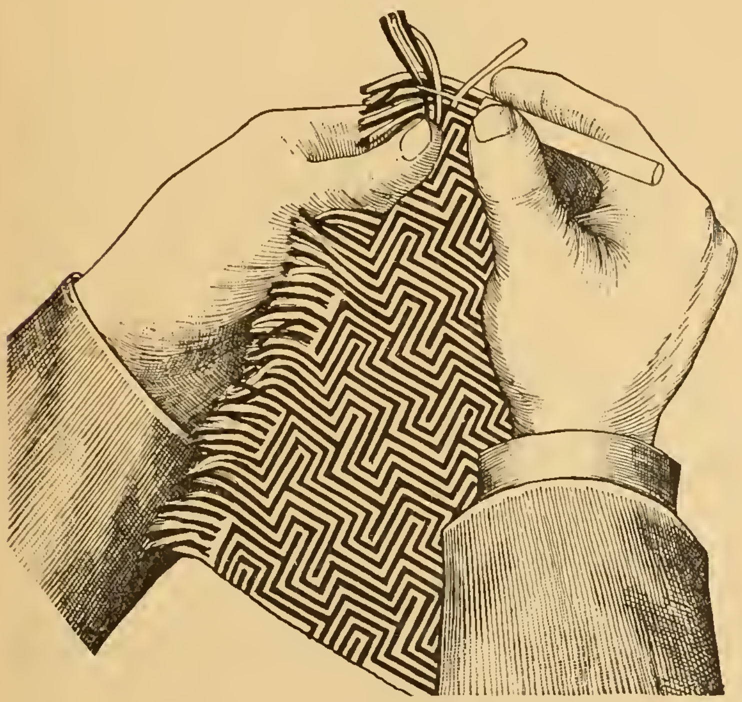


Fig. 1011.

Every time a warp-thread is found situated above the filling, put a corresponding indication on the respective square of the designing paper (with pencil marks or prick holes with the needle), whenever you find the filling covering (floating over) one, two or more successive warp-threads, leave correspondingly one, two or more successive squares empty in the lateral line of small squares upon the designing paper.

After the intersecting of number 1 pick has been clearly ascertained liberate this pick out of the fringed warp edge and duplicate the procedure with pick number 2, to be followed by picks 3, 4, 5, etc., until the repeat is obtained. If dealing with a soft-spun filling yarn be careful in raising it, to avoid breaking the thread; also be careful that after the interlacing of the pick has been ascertained, it is *entirely* removed so that no small pieces of the thread remain in the fringed part of the warp; for if such should be the case it might lead to mistakes in examining the next adjoining pick.

III. Ascertaining Raw Materials Used in the Construction of a Fabric.

In most cases an examination of the threads liberated during "picking-out" with the naked eye will be sufficient to distinguish the material used in the construction of the fabric yet sometimes it is found necessary to use the microscope or a chemical test for their detection. For example: Tests might be required to show whether a certain thread is all wool or whether a certain thread is all silk, etc. For solving such questions, the following methods are given:

A common and ready method for ascertaining the difference between animal and vegetable fibres is to burn some of the threads of yarn in a flame. The vegetable fibre is composed of carbon, hydrogen and oxygen, while the animal fibre, in addition to these, contains nitrogen. By burning, the threads used in testing the first mentioned fibre will result in carbonic acid and water. while those of the latter, or of animal fibre, result in combinations containing nitrogen which element readily makes itself known by its peculiar smell or disagreeable odor similar to burnt feathers. Another point which it is well to note is the rapidity with which the thread composed of vegetable origin burns as compared with the burning of the thread having an animal substance for its basis. In the latter case, only a little bunch of porous carbon forms itself at the end submitted to the flame, and it does not form a flame as in the case of the former. As in some instances these two tests will be found unreliable, a more exact analysis may be required. If so, proceed after one or the other of the following formulas:

To Detect Cotton or other Vegetable Fibre in Woolen or Silk Fabrics.

Boil the sample to be tested in a concentrated solution of caustic soda or potash, and the wool or silk fibre will rapidly dissolve, producing a soapy liquid. The cotton or other vegetable fibre therein will remain undisturbed, even though boiling in weak caustic alkalies for several hours, care being taken to keep the samples below the surface of the solution during the operation. If during this steeping process it is exposed to the air, the cotton fibre becomes rotten, especially when the exposed portions are also at the same time brought under the influence of steam. (Any cotton fibres remaining from the testing, if colored, may be bleached in chlorine water, and afterwards dissolved with cupro-ammonia.)

Prof. E. Kopp gives the following test: "Wool is only soluble in cupro-ammonia by the aid of heat. Concentrated acids, such as sulphuric, nitric, or preferably hydrochloric, act in the cold upon silk, but not on wool. The dissolving properties of cupro-ammonia on all vegetable fibres, make it one of the most reliable of tests. Cupro-ammonia is prepared by suspending strips of copper in concentrated ammonia in a large flask, tightly corked and occasionally shaken, so as to bring the metal in contact with the oxygen of the air. By degrees a tolerably concentrated solution of oxide of copper in ammonia is obtained which dissolves cotton, and other vegetable fibres, leaving animal fibres untouched."

To Detect Silk from Wool or the Vegetable Fibres.

Prof. Hummel gives the following process in his treatise on "The Dyeing of Textile Fabrics:"

"The best solvent for silk is an alkaline solution of copper and glycerine, made up as follows: Dissolve 16 grams copper sulphate in 140–160 c. c. distilled water, and add 8–10 grams pure glycerine (Sp. Gr. 1.24); a solution of caustic soda has to be dropped gradually into the mixture till the precipitate at first formed just re-dissolves; excess of NaOH must be avoided." This solution does not dissolve either wool or the vegetable fibres and thus serves as a distinguishing test.

Still another method is given, as follows: Concentrated zinc chloride, 138° Tw. (Sp. Gr. 1.69) made neutral or basic by boiling with excess of zinc oxide, dissolves silk, slowly if cold, but very rapidly if heated, to a thick gummy liquid. This reagent may serve to separate or distinguish silk from wool and the vegetable fibres, since these are not affected by it. If water be added to the zinc chloride solution of silk, the latter is thrown down as a flocculent precipitate. Dried at 230° to 235° F the precipitate acquires a vitreous aspect, and is no longer soluble in ammonia.

RULES FOR ARRANGING THE FABRIC TO BE TESTED AND METHODS FOR ASCERTAINING THE VARIOUS PERCENTAGES OF EACH FIBRE COMPOSING THE THREAD OR WOVEN CLOTH.

Cut the sample to be tested to a known size with a sharp pair of scissors, or stamp out the desired quantity with a die, of which you know the exact size. Always use the largest sample available and be very accurate in cutting to measure. Next weigh the sample upon a scale (of great accuracy) and make a careful memorandum of its weight; then submit the sample to one of the above mentioned tests (adapted to the material to be tested), and dry the remaining fibre. Weigh the latter after thoroughly dry and deduct the weight from the gross weight previously obtained. The remainder will represent the weight of the fibre dissolved by the test.

"*The amount of each kind of fibre in sample is in proportion to the percentage of each fibre in a full piece of cloth.*"

EXAMPLE: Required to ascertain percentage of cotton and wool fibres in a fabric.

Sample stamped with a die 2 × 4 inches = 8 square inches weighs 24 grains. Suppose the "caustic soda" process for testing is used and the refuse of cotton, dried, weighs 8 grains. Hence:

24 grains gross weight of cloth 8 square inches.
8 " weight of cotton in 8 square inches.
—
16 " " " wool " 8 square inches.

Or, 8 grains cotton in 24 grains gross weight = 33⅓ per cent. of 100.
16 " wool " 24 " " " = 66⅔ " " "

24 "	100

Answer: The cloth given for testing in the present example contains 33⅓ per cent. cotton and 66⅔ per cent. wool, or, one-third of the mixture is cotton fibre and two-thirds wool fibre.

IV. To Ascertain the Texture of Fabrics Required in Loom.

Of all the different points required to be ascertained the present is probably the most difficult to master, in fact, it can only be accomplished after considerable practical experience. To materially aid the novice in this work, it is strongly recommended that he provide himself with a collection of different samples of finished fabrics with the given amount of shrinkage of each during finishing. Such a collection he can afterwards use as a guide for ascertaining the texture of similar fabrics.

The Shrinkage of a Fabric in Width from Loom to Case (or Finished State).

The "setting" of a fabric in the loom, or the reed-space the warp must occupy during the process of weaving, compared to the width of the fabric when finished (ready for the consumer) is regulated by the raw material used, the manner in which the yarn has been produced, and the different processes the fabric is to be subjected to during finishing.

Some kinds of woolen fabrics require a large amount of fulling, hence must be "set" wider in the loom than fabrics having a similar material for their basis but requiring very little or no fulling. For example, billiard-cloth must be "set" nearly twice as wide in the loom as its finished width, while beavers, kerseys, and similar woolen fabrics need to be "set" but about one-half their finished width wider, and fancy cassimeres from one-quarter to one-third. Worsted or worsted and cotton dressgoods mostly require but very little wider "setting" in the loom than the finished width of the fabric calls for. The weave itself has also a considerable influence in regulating the shrinkage.

These general rules are worthy of consideration: The finer the quality, and the softer the filling is spun, the more the cloth will shrink in width. If the filling is hard twisted, and of a coarse nature, the cloth will have but little tendency to shrink. If the weave has a wide stitching, it will produce a narrower fabric than when the texture is more closely intertwined. The less tension put on the warp during weaving ("take-up") the narrower the fabric will be. In comparing woolen and worsted yarn, the former produces fabrics which shrink more in width than fabrics made with worsted yarn. This result, when produced from the same raw material, is based upon the two different processes of "carding" or "combing" the wool fibre. By carding the wool every fibre, through mixing up in every shape and direction, is twisted in itself, and such fibres always endeavor to resume their original position. By worsted combing the wool fibres are separately united, besides being combined in one thread. Each fibre is its own, as placed in position for forming the thread, and thus such a thread remains undisturbed in the fabric. The fabric constructed out of such threads will keep wider than if using a wool-spun yarn of equal size and under equal conditions.

Shrinkage or Take-up of Warp During Weaving.

We must also carefully consider the amount of take-up the warp is subjected to during weaving, and the amount of shrinkage in length the cloth undergoes during the finishing process. The latter point will not come into consideration in the case of fabrics which are ready for the market when leaving the loom. The first mentioned shrinkage, or the "take-up" of the warp during weaving, is different, and varies from fabrics requiring two, three, four or more times the length in dressing than the fabric length woven, to fabrics in which the warp-length dressed equals the fabric length woven or, if any difference, to be very little.

The points given in the previous chapter on the shrinkage in width of a fabric also apply to the shrinkage of the fabric in length. *The weave and the number of picks per inch are the chief object in regulating the take-up of the warp during weaving*, for example, a fabric interlaced with a far stitching satin weave (say 8 to 12 harness) will "take-up" very little if any at all, unless we use an unusually high texture of warp and filling. Thus, the oftener a warp-thread intersects the filling in a given distance the greater the amount of take-up required for the warp. For this reason fabrics which have two systems of weaves combined—suppose 1-inch wide plain weave to alternate with a 2-inch wide 8-harness satin = 3 inches repeat, 10 repeats in width of fabric—require two beams—one beam to carry the warp for weaving the plain, and one beam for carrying the warp for weaving the satin. This also applies to worsted fabrics made with woolen back-warps. The amount of shrinkage in warp pile fabrics for its pile-warp is considerable. It is regulated by the height of pile required and the amount of wires or loops per inch. Such fabrics may often require their pile-warp dressed four to eight times longer than the piece measures woven. To ascertain the exact percentage of "take-up" for a fabric needs experience and can only be mastered after thorough study of the theory of constructing the different weaves, as well as the nature of the different raw materials, with their various methods of preparations for the yarns, and the various processes of finishing.

V. Ascertaining the Arrangement of Threads in a Sample, According to their Color and their Counts, for the Warp and Filling.

During the process of "picking out" a fabric sample, it will be advisable to indicate on the squared designing paper near each filling-thread as picked out, its color or general remarks as to thickness, twist, etc. Also, to indicate the colors and size of the warp-threads as found in the sample dissected. (For illustration see Fig. 1012.) By proceeding in this manner it will be found that after a certain number of successive threads in warp and filling have been picked out, the same arrangement of using threads of various colors or counts, or both combined in the sample, repeats over again. This is classified as the "repeat of the pattern." All repeats of a pattern must be similar to each other; thus, if we place two, three or more repeats of the sample above each other, they must in every instance cover itself in color, size or counts of threads, and method of interlacing.

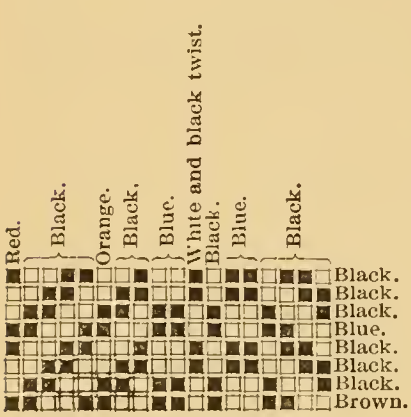


Fig. 1012.

Again, if a number of these repeats are placed near each other in the direction of the warp and filling, they must connect. If patterns are found not to contain this peculiarity, or, in other words, "do not repeat," they must be arranged so as to have this peculiarity, or be made to repeat.

The arrangement of the warp is known as the "dressing," while the arrangement of the filling indicates the building of the "box-chain" in practical work.

VI. Ascertaining the Size of the Yarns (their Counts) Found in Sample, and the Amount and Direction of Twist.

The size or thickness of a thread is ascertained generally by comparing the picked out thread with a collection of yarns of the same material and of a known size. For this purpose prepare a collection of woolen, worsted, cotton and silk yarns most commonly used. In fabrics requiring no fulling, or only a very little, such as worsted dress goods, etc., weigh a small sample of the threads and calculate from their length and weight the size of the yarn; but as a general rule the first given method will be found quick, correct and less troublesome to the designer. Care must be taken to compare threads of which the counts are required to be ascertained with samples of threads of a known size, which have previously been subjected to an equal amount of shrinkage by "fulling" etc.; or, if such a thread cannot be obtained, compare the picked-out thread with the standard threads of a similar material, but take into consideration the process the first mentioned thread has been subjected to during the finishing process of the fabric it was a part of.

VII. Ascertaining the Weight of Cloth per Yard from the Loom.

This subject, based entirely upon results obtained by previous points, forms the most interesting work in the analysis of cloth. Whatever the size of sample may be which is submitted for examination, and whatever the quantity of yards of cloth to be produced, the weight per yard from loom will form the standard upon which future calculations in manufacturing must be based by figuring in proportion. After knowing the number of threads required in the width of a fabric submitted for analysis, the counts of the respective threads, and the dressing and the shrinkage of the warp in weaving, it will be easy to ascertain the weight of warp yarn required.

EXAMPLE A. *Dressing:* 4 threads black, 4 run woolen yarn.
2 " blue, 4 " " "
4 " brown, 4 " " "
—
10 threads in repeat.

3,600 ends in full warp, 6 per cent. shrinkage or take up of warp during weaving.

Required: Find weight of warp yarn of each kind necessary for one yard of the woven fabric.

100 — 6 = 94. Thus 94 : 100 : : 36 : x and 100 × 36 = 3600 ÷ 94 = 38.3.

Each individual thread requires 38.3 inches length dressed to produce 36 inches interwoven. Hence 3,600 × 38.3 = 137,880 inches = 3,830 yards of warp required to produce one yard of the woven fabric (plus amount of filling required).

3,830 yards 4 run yarn equal in weight 9.575 oz, ten threads repeat of the pattern, thus: 9.575 ÷ 10 = 0.9575 oz. weight in proportion for each thread, consequently:

4 threads black = 4 × 0.9575 = 3.830 oz. per yard.
2 " blue = 2 × 0.9575 = 1.915 " "
4 " brown = 4 × 0.9575 = 3.830 " "
—
9.575 oz. total weight.

Answer: The previously given example requires
3.83 oz. 4 run black warp for each yard woven.
1.915 " 4 " blue " " "
3.83 " 4 " brown " " "
—
consequently 9.575 oz. weight of complete warp in one yard woven (3,600 threads 4 run yarn, six per cent. take up of warp).

The threads used are not always of the same counts. Two, three or more different sizes of yarn may be called for in a fabric. If such is the case first ascertain the number of yards required of each kind and next their weight. Suppose the previously given example read as follows: Example *B*. 3,600 ends in warp—6 per cent. shrinkage of warp in weaving.

Dressing: 4 threads brown 2.30s worsted.
2 " blue 2.28s "
4 " black 2.32s "
—
10 threads repeat of pattern.

As explained in previously given example, 36 inches woven equal 38.3 inches dressed by allowing six per cent. take up.

3,600 ends in warp ÷ by 10 threads in one repeat = 360 repeats of each thread; thus,

4 threads	brown	2.30s worsted	= 360 × 4 =	1,440	threads	(*a*).
2 "	blue	2.28s "	= 360 × 2 =	720	"	(*b*).
4 "	black	2.32s "	= 360 × 4 =	1,440	"	(*c*).
10 threads in repeat.				3,600 threads in warp.		

a. Brown, requires 2.30s worsted = 8400 yards to 1 lb.

36 : 38.3 : : 1440 : x

38.3 × 1440 ÷ 36 = 1532 yards of 2.30s brown worsted required.

8400 : 16 : : 1532 : x

1532 × 16 ÷ 8400 = 2.918 oz. of brown 2 30s worsted required for 1 yard cloth woven.

b. Blue, calls for 2.28s worsted = 7840 yards to 1 lb.

36 : 38.3 : : 720 : x

38.3 × 720 ÷ 36 = 766 yards of 2.28s blue worsted required.

7840 : 16 : : 766 : x

766 × 16 ÷ 7840 = 1.563 oz. of blue 2.28s worsted required for 1 yard cloth woven.

c. Black calls for 2.32s worsted = 8960 yards to 1 lb. The number of threads are equal to *a*, thus: 1532 yards of 2.32s black worsted required.

8960 : 16 : : 1532 : x

1532 × 16 ÷ 8960 = 2.735 oz. of black 2.32s worsted required for 1 yard of cloth woven.

Answer: The previously given example requires the following amount of yarns:

Brown, 2.30s worsted = 2.918 oz.
Blue, 2.28s " = 1.563 "
Black, 2.32s " = 2.735 "

7.216 oz. weight of complete warp in 1 yard woven.

TABLE OF RELATIVE LENGTHS

Of Inches Dressed and One Yard Woven, with Reference to a "Take-up" During Weaving, for 1 per cent. to 50 per cent.

Per cent. of take-up during weaving.	Number of inches required dressed to produce one yard or 36 inches woven.	Per cent. of take-up during weaving.	Number of inches required dressed to produce one yard or 36 inches woven.
1	36.36	13	41.38
2	36.73	14	41.86
3	37.11	15	42.35
4	37.50	16	42.85
5	37.89	17	43.37
6	38.30	18	43.90
7	38.71	19	44.44
8	39.13	20	45.00
9	39.56	25	48.00
10	40.00	30	51.43
11	40.45	40	60.00
12	40.91	50	72.00

The next point for ascertaining the weight of cloth per yard from the loom is *to ascertain the amount of filling required for one yard.*

To explain this subject let us continue the example previously given and indicated by *A.* Suppose those 3600 ends require 72 inches wide setting in reed (allowing 1 inch for width of selvage on each side), and suppose the filling found used in sample submitted for analysis calls for 3½ run black woolen yarn and 52 picks per inch in loom.

Question: Find amount of filling required for weaving one yard.

52 (picks) × 72 (width) = 3744 inches filling required for 1 inch of cloth, or 3744 yards of filling required for 1 yard of cloth.

3744 yards of 3½ run filling (3744 ÷ 350) = 10.697 oz.

Answer: 10.697 oz. filling required for weaving 1 yard cloth in the present example.

If two, three or more kinds of threads of various counts of fillings are used, ascertain each kind independent of the other. For illustration let us continue example *B* as previously given for ascertaining the warp.

Suppose the width of fabric (including ½ inch selvage for each side) calls for 64 inches and the arrangement of filling for 6 picks 2.26s black worsted and for 6 picks 2.28s brown worsted = 12 picks in repeat of pattern and 56 picks per inch in fabric.

Question: Find the amount of filling required for weaving 1 yard.

56 (picks) × 64 (width) = 3584 yards of filling required to weave 1 yard of cloth.

Thus: 3584 ÷ 2 = 1792 yards 2.26s worsted black (*a*), and 1792 yards 2.28s worsted brown (*b*), the filling required to weave 1 yard of cloth.

a. 2.26s worsted (= 7280 yards to 1 lb.). Thus: 1792 : x : : 7280 : 16

1792 × 16 ÷ 7280 = 3.938 oz. of 2.26s black worsted required.

b. 2.28s worsted (= 7840 yards to 1 lb.). Thus: 1792 : x : : 7840 : 16

1792 × 16 ÷ 7840 = 3.657 oz. of 2.28s brown worsted required.

Answer: 3.938 oz. of 2.26s black worsted.
3.657 oz. of 2.28s brown worsted.

7.595 oz. the amount of filling required for weaving 1 yard of cloth in the present example.

The next thing to be ascertained will be the amount of selvage threads to be used, and their respective weight.

Suppose example *A* calls for 30 threads 2 run (woolen yarn) for selvage for each side of the fabric, thus 60 threads for complete selvage.

+ 6 per cent. take-up = 63.82 yards of two run selvage, equal to 0.319 oz. of yarn for 1 yard of woven cloth.

For example B. allow 30 threads of 2.20s worsted for selvage on each side of the fabric; thus 60 threads for complete selvage.

+ 6 per cent. take up = 63.82 yards of 2.20s worsted = 0.182 oz. of yarn for 1 yard of woven cloth.

Example A. thus requires:

9.575 oz. warp yarn,
10.697 oz. filling,
0.319 oz. selvage threads.

20.591 oz. the weight of 1 yard of cloth from the loom.

Example B. thus requires:

7.216 oz. warp,
7.595 oz. filling,
0.182 oz. selvage threads.

14.993 oz. the weight of 1 yard of cloth from the loom.

After the weight of 1 yard of the cloth woven is ascertained it is easy to calculate the amount of yarn required for 1 piece of cloth or any number, by simply multiplying the weight per yard with the number of yards required.

For example: Suppose previously given example *A* to be applied to a fabric 40 yards "from loom." Thus:

9.575 oz. × 40 =	383 oz. =	23 lbs.	15 oz.	warp yarn,	
10.697 oz. × 40 =	427.88 oz. =	26 lbs.	11.88 oz.	filling yarn,	
0.319 oz. × 40 =	12.76 oz. =	——	12.76 oz.	selvage.	
20.591 oz.	total,	51 lbs.	7.64 oz.	weight for 1 piece 40 yards long.	

Proof: 20.591 oz., weight of cloth per yard, × 40, number of yards of cloth required, equals 823.64 oz., ÷ 16 = 51 lbs. 7.64 oz.

Suppose the previously given example under *B* applied to the following—

Question: Find the amount of yarn required for producing 20 pieces, each 50 yards long from loom, thus:

20 pieces × 50 yards each cut = 1000 yards of cloth required, hence

7.216 oz. × 1000 =	7216 oz. =	451 lbs.		
7.595 " × 1000 =	7595 " =	474 "	11 oz.	
0.182 " × 1000 =	182 " =	11 "	6 "	
14.993		937 lbs.	1 oz.	weight required for 20 pieces,

each 50 yards long, or 1000 yards of cloth woven.

Proof: 14.993 oz. weight per yard of cloth × 1000 (number of yards of cloth woven) 14993 oz. ÷ 16 = 937 lbs. 1 oz.

VIII. Ascertaining the Process of Finishing Necessary and the Amount of Shrinkage of the Fabric.

The shrinkage of a fabric during finishing is regulated by the amount of fulling required. Woolen fabrics, and especially such as are constructed out of soft spun yarn, shrink more than any other textile fabric.

In arranging the width of a fabric for weaving ("setting" in reed) we must calculate the amount of shrinkage of the fabric on the loom as well as during the process of finishing. The shrinkage in length of the fabric can more readily be regulated during the finishing process (fulling). Worsted fabrics, which require no fulling—only scouring—shrink very little, while cotton goods, which require only calendering or pressing, etc., do not lose any, and may possibly rather gain, in length.

During the process of carding and spinning, oil, water, etc., are taken up by the wool, and during dyeing some of the dye-stuff will remain loosely in the yarn. These substances must be removed in the scouring of the cloth; therefore we must allow for a corresponding loss in weight for such fabrics from their relative weight in the loom until the fabric is scoured.

The subsequent processes, such as gigging and shearing, will also reduce the previous loom weight of the fabric. Fabrics requiring none of these processes consequently need none of these considerations, while fabrics requiring a starching, calendering or flocking may even gain in weight during such an operation.

The shrinkage of fabrics in finishing requires, similar to the two different widths (width of fabric when finished, and its width in reed), to figure in two different lengths during calculations. *a* the length of the cloth from loom, *b* its finished length. It will be easily understood that when orders are given for a certain number of yards from a buyer or the commission house, they consider the number of yards given as the "finished yards"; therefore the percentage that the fabric shrinks during the finishing process must be added for ascertaining the number of yards required "*from loom,*" or woven. Take-up during weaving added, will give us a third length, or the length of warps dressed, while the shrinkage of a fabric in finishing regulates, as previously mentioned, the width of the fabric in loom, in addition to the width of the finished fabric.

GRADING OF THE VARIOUS YARNS USED IN THE MANUFACTURE OF TEXTILE FABRICS ACCORDING TO SIZE OR COUNTS.

The sizes of the yarns, technically known as their counts or numbers, are based for each different raw material upon the number of yards necessary to balance 1 lb. (avoirdupois), consequently the higher the count or number the finer the yarn according to its diameter. The number of yards thus necessary to balance 1 lb. is known as the "Standard" and varies accordingly for each material.

I. Cotton Yarns.

Cotton yarns have for the standard 840 yards (equal to 1 hank) and are graded by the number of hanks 1 lb. contains. Consequently if two hanks, or 2 × 840 yards = 1680 yards, are necessary to balance 1 lb., we classify the same as number 2 cotton yarn. If three hanks, or 3 × 840 yards = 2520 yards, are necessary to balance 1 lb., the thread is known and classified as number 3 cotton yarn. Continuing in this manner, always adding 840 for each successive number, it gives us the number of yards the various counts of yarn contain for 1 lb.

Table for Lengths of Cotton Yarns.

(From number 1 to 240s.)

No.	Yds. to 1 lb.	No.	Yds. to 1 lb.	No.	Yds. to 1 lb.	No.	Yds. to 1 lb.
1	840	25	21,000	49	41,160	73	61,320
2	1,680	26	21,840	50	42,000	74	62,160
3	2,520	27	22,680	51	42,840	75	63,000
4	3,360	28	23,520	52	43,680	76	63,840
5	4,200	29	24,360	53	44,520	77	64,680
6	5,040	30	25,200	54	45,360	78	65,520
7	5,880	31	26,040	55	46,200	79	66,360
8	6,720	32	26,880	56	47,040	80	67,200
9	7,560	33	27,720	57	47,880	85	71,400
10	8,400	34	28,560	58	48,720	90	75,600
11	9,240	35	29,400	59	49,560	95	79,800
12	10,080	36	30,240	60	50,400	100	84,000
13	10,920	37	31,080	61	51,240	110	92,400
14	11,760	38	31,920	62	52,080	120	100,800
15	12,600	39	32,760	63	52,920	130	109,200
16	13.440	40	33,600	64	53,760	140	117,600
17	14,280	41	34,440	65	54.600	150	126,000
18	15,120	42	35,280	66	55,440	160	134,400
19	15,960	43	36,120	67	56,280	170	142,800
20	16,800	44	36,960	68	57,120	180	151,200
21	17,640	45	37,800	69	57,960	190	159,600
22	18,480	46	38,640	70	58,800	200	168,000
23	19,320	47	39,480	71	59,640	220	184,800
24	20,160	48	40,320	72	60,480	240	201,600

Cotton yarns are frequently manufactured into 2-ply. In such cases the number of yards required for 1 lb. is one-half the amount called for in the single thread.

For example: 20s cotton yarn (single) equals 16,800 yards per pound, while a 2-ply thread of 20s cotton, technically indicated as 2.20s cotton, requires only 8,400 yards, or equal to the amount called for in single 10s cotton (technically represented as 10s cotton).

If the yarn be more than 2-ply, divide the number of yards of single yarn in the required number by the number of ply.

Rule for Finding the Weight in Pounds of a Given Number of Yards of Cotton Yarn of a Known Count.

Divide the given yards by the number of yards of the known count required to balance 1 lb.

Example (single yarn).—Find weight of 1,260,000 yards of 30s cotton yarn.

30s cotton yarn = 25,200 yards to 1 lb. Thus 1,260,000 ÷ 25,200 = 50.

Answer: 1,260,000 yards of 30s cotton yarn weigh 50 lbs.

Example (2-ply yarn).—Find weight of 1,260,000 yards of 2.30s cotton yarn.

2.30s cotton yarn = 12,600 yards to 1 lb. Thus 1,260,000 ÷ 12,600 = 100.

Answer: 1,260,000 yards of 2.30s cotton yarn weigh 100 lbs.

Rule for Finding the Weight in Ounces of a Given Number of Yards of Cotton Yarn of a Known Count.

Multiply the given yards by 16 and divide result by the number of yards of the known count required to balance 1 lb.

Example (single yarn).—Find weight of 12,600 yards of 30s cotton yarn.

12,600 × 16 = 201,600. 1 lb. 30s cotton yarn = 25,200 yards. Thus 201,600 ÷ 25,200 = 8.

Answer: 12,600 yards of 30s cotton yarn weigh 8 oz.

Example (2-ply yarn).—Find weight of 12,600 yards of 2.30s cotton yarn.

12,600 × 16 = 201,600. 1 lb. 2.30s cotton yarn = 12,600 yards. Thus 201,600 ÷ 12,600 = 16.

Answer: 12,600 yards of 2.30s cotton yarn weigh 16 oz.

II. Woolen Yarns—"Run" System.

Woolen yarn is, with the exception of the mills in Philadelphia and vicinity, graded by the "runs," which have for their standard 1600 yards. Consequently 1 run yarn requires 1600 yards to 1 lb.; 2 run yarn, 3200 yards to 1 lb.; 3 run yarn, 4800 yards to 1 lb., etc., always adding 1600 yards for each successive run. In addition to using whole numbers only as in the case of cotton and worsted yarn, the run is divided into halves, quarters and occasionally into eighths, hence

200	yards	equal	1/8	run.
400	"	"	1/4	"
600	"	"	3/8	"
800	"	"	1/2	"
1000	"	"	5/8	"
1200	"	"	3/4	"
1400	"	"	7/8	"
1600	"	"	1	" etc.

The run basis is very convenient for textile calculations by reason of the standard number equalling 100 times the number of ounces that one lb. contains. By simply multiplying the size of a yarn given in "run" counts by 100 and dividing the result into the number of yards given (for which we have to find the weight) gives us as the result the weight expressed in ounces.

Example: Find the weight of 7,200 yards of 4 run yarn.

4 × 100 = 400.

7,200 ÷ 400 = 18.

Answer: 7,200 yards 4-run yarn weigh 18 oz.

Question: Find weight of 3,750 yards of 3¾ run yarn.

Answer: 3,750 ÷ 375 = 10 oz.

If the weight of a given number of yards and of a given size of woolen yarn, run system, is required to be calculated in pounds, transfer the result obtained in ounces into pounds or fractions thereof.

Table for Lengths of Woolen Yarns (Run basis) from One-fourth Run to Fifteen Run.

Run.	Yds. to 1 lb.	Run.	Yds. to 1 lb.	Run.	Yds. to 1 lb.
¼	400	4	6400	7¾	12400
½	800	4¼	6800	8	12800
¾	1200	4½	7200	8¼	13200
1	1600	4¾	7600	8½	13600
1¼	2000	5	8000	8¾	14000
1½	2400	5¼	8400	9	14400
1¾	2800	5½	8800	9½	15200
2	3200	5¾	9200	10	16000
2¼	3600	6	9600	10½	16800
2½	4000	6¼	10000	11	17600
2¾	4400	6½	10400	11½	18400
3	4800	6¾	10800	12	19200
3¼	5200	7	11200	13	20800
3½	5600	7¼	11600	14	22400
3¾	6000	7½	12000	15	24000

III. Woolen Yarn—"Cut" System.

As previously mentioned, woolen yarn is also graded by the "cut" system.

300 yards is the basis or standard, consequently if

300 yards of a given woolen yarn weigh 1 lb., we classify it as 1 cut yarn;
600 " " " " " " 1 " " " " 2 " "
900 " " " " " " 1 " " " " 3 " "

and so on, hence the count of the woolen yarn expressed in the "cut," multiplied by 300, gives as the result the number of yards of respective yarn that 1 lb. contains.

Table for Lengths of Woolen Yarns (Cut System).

(From 1 Cut to 50 Cut Yarn.)

Cut.	Yards to lb.	Cut.	Yards to lb.	Cut.	Yards to lb.	Cut.	Yards to lb.
1	300	13	3,900	25	7,500	37	11,100
2	600	14	4,200	26	7,800	38	11,400
3	900	15	4,500	27	8,100	39	11,700
4	1,200	16	4,800	28	8,400	40	12,000
5	1,500	17	5,100	29	8,700	41	12,300
6	1,800	18	5,400	30	9,000	42	12,600
7	2,100	19	5,700	31	9,300	43	12,900
8	2,400	20	6,000	32	9,600	44	13,200
9	2,700	21	6,300	33	9,900	45	13,500
10	3,000	22	6,600	34	10,200	46	13,800
11	3,300	23	6,900	35	10,500	48	14,400
12	3,600	24	7,200	36	10,800	50	15,000

Rule for Finding the Weight in Ounces for a Given Number of Yards of Woolen Yarn, Figured by the "Cut" Basis.

This rule is similar to the one given for cotton yarn. Multiply the given yards by 16 and divide the result by the original number of yards for the given "count" of cotton yarn that 1 lb. contains.

Example.—Find weight for 12,600 yards of 40-cut woolen yarn.

12,600 × 16 = 201,600. 1 lb. of 40-cut woolen yarn = 12,000 yards. Thus 201,600 ÷ 12,000 = 16.8.

Answer: 12,600 yards of 40-cut woolen yarn weigh 16.8 oz.

Rule for Finding the Weight in Pounds of a Given Number of Yards of Woolen Yarn, Graded by the "Cut" Basis.

This rule is also similar to the one previously given for cotton yarn. Divide the given yards by the original number of yards for the given "count" of woolen yarn (cut basis) in 1 lb. The result expresses the weight in pounds or fractions thereof.

Example.—Find weight of 1,260,000 yards of 40-cut woolen yarn.

40-cut woolen yarn = 12,000 yards to 1 lb. Thus 1,260,000 ÷ 12,000 = 105.

Answer: 1,260,000 yards of 40-cut woolen yarn weigh 105 lbs.

IV. Worsted Yarns.

Worsted yarns have for their standard measure 560 yards to the hank. The number of hanks that one pound requires for balancing indicate the number or count by which it is graded. Hence, if 40 hanks, each 560 yards long, are required to equal one pound in weight, such a yarn is known as 40s worsted. If 48 hanks are required, it is known as 48s worsted, etc. In this manner is found the number of yards for any size or count of worsted yarns by simply multiplying the number by 560.

Worsted yarn is, like cotton yarn, produced very frequently in 2-ply. If such is the case, only one-half the number of yards are required to balance the pound. Hence, 40s worsted (technically for single 40s worsted) requires 22,400 yards per pound, and 2.80s worsted (technically for two-ply 80s worsted) requires also 22,400 yards per pound.

If the yarn be more than 2-ply, divide the number of yards of single yarn in the required number by the number of ply.

Table showing the Number of Yards of Worsted Yarn to the Pound, either Single or Two-ply, in any Count not exceeding 200.

No.	Yds. Single Thread.	Or,	Yds. Two-Ply.	No.	Yds. Single Thread.	Or,	Yds. Two-Ply.
1	560	"	280	54	30,240	"	15,120
2	1,120	"	560	56	31,360	"	15,680
4	2,240	"	1,120	58	32,480	"	16,240
6	3,360	"	1,680	60	33,600	"	16,800
8	4,480	"	2,240	62	34,720	"	17,360
10	5,600	"	2,800	64	35,840	"	17,920
12	6,720	"	3,360	66	36,960	"	18,480
14	7,840	"	3,920	68	38,080	"	19,040
16	8,960	"	4,480	70	39,200	"	19,600
18	10,080	"	5,040	72	40,320	"	20,160
20	11,200	"	5,600	74	41,440	"	20,720
22	12,320	"	6,160	76	42,560	"	21,280
24	13,440	"	6,720	78	43,680	"	21,840
26	14,560	"	7,280	80	44,800	"	22,400
28	15,680	"	7,840	82	45,920	"	22,960
30	16,800	"	8,400	84	47,040	"	23,520
32	17,920	"	8,960	86	48,160	"	24,080
34	19,040	"	9,520	88	49,280	"	24,640
36	20,160	"	10,080	90	50,400	"	25,200
38	21,280	"	10,640	92	51,520	"	25,760
40	22,400	"	11,200	94	52,640	"	26,320
42	23.520	"	11,760	96	53,760	"	26,880
44	24,640	"	12,320	98	54,880	"	27,440
46	25,760	"	12,880	100	56,000	"	28,000
48	26,880	"	13,440	150	84,000	"	42,000
50	28,000	"	14 000	200	112,000	"	56,000
52	29,120	"	14,560				

Rule for Finding the Weight in Ounces of a Given Number of Yards of Worsted Yarn.

Multiply the given yards by 16, and divide the result by the number of yards the given "count" of worsted yarn contains balancing 1 pound.

Example: (Single worsted).

Find weight for 12,600 yards of 40s worsted.

12,600 × 16 = 201,600.

1 lb. of 40s worsted = 22,400 yards, thus:

201,600 ÷ 22,400 = 9.

Answer:—12,600 yards of 40s worsted weigh 9 ounces.

Question: (2-ply worsted).—Find weight for 12,600 yards of 2.40s worsted.

12,600 × 16 = 201,600.

lb. of 2.40s worsted = 11,200 yards. Hence, 201,600 ÷ 11,200 = 18.

Answer—12,600 yards of 2-40s worsted weigh 18 ounces.

Rule for Finding the Weight in Pounds of a Given Number of Yards of Worsted Yarn of a Known Count.

Divide the given yards by the number of yarns of the known count required to balance 1 pound.

Example. (Single yarn).

Question:—Find the weight of 1,260,000 yards of 40s worsted yarn.

40s worsted = 22,400 yds. to 1 lb. Thus, 1,260,000 ÷ 22,400 = 56¼ lbs.

Answer:—1,260,000 yds. of 40s worsted yarn weigh 56¼ lbs.

Question: (2-ply yarn).—Find the weight of 1,260,000 yds. of 2.40s worsted yarn.

2.40s worsted = 11,200 yds. to 1 lb. Thus, 1,260,000 ÷ 11,200 = 112½.

Answer:—1,260,000 yds. of 2.40s worsted yarn weigh 112½ lbs.

V. Silk.

A. Spun Silks.—Spun silks are calculated as to the size of the thread, on the same basis as cotton (840 yards to one hank, and the number of hanks one pound requires indicate the counts).

In the calculation of cotton, woolen or worsted, double and twist yarn, the custom is to consider it the same as twice as heavy as single; thus double and twisted 40s worsted (technically 2.40s worsted) equals single 20s worsted for calculations. In the calculation of spun silk the single yarn equals the two-fold; thus single 40s and two-fold 40s (40.2s) require the same number of hanks (40) = 33,600 yards. The technical expression of two-fold in spun silk is also correspondingly reversed if compared to cotton, wool and worsted yarn.. In cotton, wool and worsted yarn the 2 indicating the two-fold is put in front of the counts indicating the size of the thread (2.40s), while in indicating spun silk this point is reversed (40.2s), or in present example single 80s doubled to 40s.

B. Raw Silks.—The adopted custom of specifying the size of silk yarns is in giving the weight of the 1000 yards hank in drams avoirdupois; thus if one hank weighs 5 drams it is technically known as "5 dram silk," and if it should weigh 8½ drams it is termed "8½ dram silk." As already mentioned the length of the skeins is 1000 yards, except in fuller sizes where 1000 yard skeins would be rather bulky, and apt to cause waste in winding. Such are made into skeins of 500 and 250 yards length, and their weight taken in proportion to the 1000 yards; thus, if the skein made up into 500 yards weighs 8½ drams, the silk would be 17 dram silk; if a skein made up into 250 yards weighs 4 drams, the silk would be 16 dram silk. The size of yarns is always given for their "gum" weight; that is, in their condition before dyeing.

Previous to being dyed silk yarns are subjected to "boiling off," a process taking out the gum or saliva which the silk worm spins into the single thread. In this "boiling off" yarns lose from 24 to 30 per cent according to the class of raw silk used; China silks losing the most, European and Japan silks the least.

The following table shows the number of yards to the pound and ounce from 1 dram silk to 30 dram silk. The number of yards given per pound in the table is based on a pound of gum silk.

Length of Gum Silk Yarn per Pound and per Ounce.

Drams per 1000 yards.	Yards per lb.	Yards per oz.	Drams per 1000 yards.	Yards per lb.	Yards per oz.	Drams per 1000 yards.	Yards per lb.	Yards per oz.
1	256,000	16,000	5	51,200	3,200	16	16,000	1,000
1¼	204,800	12,800	5½	46,545	2,909	17	15,058	941
1½	170,666	10,667	6	42,667	2,667	18	14,222	889
1¾	146,286	9,143	6½	39,385	2,462	19	13,474	842
2	128,000	8,000	7	36,571	2,286	20	12,800	800
2¼	113,777	7,111	7½	34,133	2,133	21	12,190	762
2½	102,400	6,400	8	32,000	2,000	22	11,636	727
2¾	93,091	5,818	8½	30,118	1,882	23	11,130	696
3	85,333	5,333	9	28,444	1,778	24	10,667	666
3¼	78,769	4,923	9½	26,947	1,684	25	10,240	640
3½	73,143	4,571	10	25,600	1,600	26	9,846	615
3¾	68,267	4,267	11	23,273	1,455	27	9,481	592
4	64,000	4,000	12	21,333	1,333	28	9,143	571
4¼	60,235	3,765	13	19,692	1,231	29	8,827	551
4½	56,889	3,556	14	18,286	1,143	30	8,533	533
4¾	53,368	3,368	15	17,067	1,067			

RULES FOR FINDING THE EQUIVALENT COUNTS OF A GIVEN THREAD IN ANOTHER SYSTEM.

A. Cotton, Woolen and Worsted Yarn.

RULE: The counts of a given thread are to the counts of an equal thread (in size) of a different material, or a thread of the same material but figured after a different "*standard*," in the same proportion as the "standard number" of the one to be found is to the "standard number" of the one given.

EXAMPLE 1. Cotton—Worsted. Find equal size in worsted yarn to 21s cotton.

Cotton standard : Worsted standard.

$$840 : 560 = 3 : 2.$$

Thus, $3 : 2 :: x : 21.$

$$3 \times 21 = 63 \div 2 = 31\tfrac{1}{2}.$$

Answer: A thread of 21s cotton equals (in size) a thread of 31½s worsted.

EXAMPLE 2. Cotton—Wool (run system). Find equal size in woolen yarn (runs) to 10s cotton.

Cotton standard : Run standard.

$$840 : 1600 = 21 : 40.$$

Thus, $21 : 40 :: x : 10.$

$$21 \times 10 = 210 \div 40 = 5\tfrac{1}{4}.$$

Answer: A thread of 10s cotton equals (in size) a thread of 5¼-run (wool).

Example 3. Cotton—Wool (cut system). Find equal size in woolen yarn (cut basis) to 10s cotton.

Cotton standard : Cut standard.

$$840 : 300 = 14 : 5.$$

$$\text{Thus, } 14 : 5 :: x : 10.$$

$$14 \times 10 = 140 \div 5 = 28.$$

Answer: A thread of 10s cotton equals (in size) a thread of 28 cut (wool).

Example 4. Worsted—Wool (run system). Find equal size in woolen yarn (run basis) to 20s worsted.

Worsted standard : Run standard.

$$560 : 1600 = 7 : 20.$$

$$\text{Thus, } 7 : 20 :: x : 20.$$

$$7 \times 20 = 140 \div 20 = 7.$$

Answer: A thread of 20s worsted equals (in size) a thread of 7 run (wool).

Example 5. Worsted—Wool (cut system). Find equal size in woolen yarn (cut basis) to 15s worsted.

Worsted standard : Cut standard.

$$560 : 300 = 28 : 15.$$

$$\text{Thus, } 28 : 15 :: x : 15.$$

$$28 \times 15 = 420 \div 15 \doteq 28.$$

Answer: A thread of 15s worsted equals (in size) a thread of 28 cut (wool).

Example 6. Worsted—Cotton. Find equal size in cotton to 30s worsted.

$$2 : 3 :: x : 30 = 60 \div 3 = 20.$$

Answer:—A thread of 30s worsted equals (in size) a thread of 20s cotton.

Example 7. Woolen Yarn. Run System—Cut System. Find equal size in the cut basis of a 6-run thread.

$$16 : 3 :: x : 6 = 96 \div 3 = 32.$$

Answer:—A 6-run woolen thread equals (in size) a 32 cut thread of the same material.

Example 8. Woolen Yarn. Cut System—Run System. Find equal size in the run basis of a 32-cut woolen thread.

$$3 : 16 :: x : 32 = 96 \div 16 = 6$$

Answer:—A 32-cut woolen thread has for its equal in size a 6-run thread of the same material.

B^1. Spun Silk Compared to Cotton, Woolen, or Worsted Yarn.

The basis of spun silk is the same as that of cotton. Therefore, the rules and examples given under the heading of "Cotton" refer at the same time to spun silk.

B^2. Raw Silk Compared to Spun Silk, Cotton, Woolen, or Worsted Yarn.

Rule.—Find the number of yards per pound (on table previously given) in raw silk, and divide the same by the standard size of the yarn basis to be compared with.

Example 9. Raw Silk—Cotton. Find equal size in cotton yarn to 9 dram raw silk.

9 dram raw silk = 28,444 yds. per lb. Thus, 28,444 ÷ 840 (cotton standard) = $33\frac{6}{7}$.

Answer:—9 dram raw silk equals nearly 34s cotton.

Example 10. Spun Silk or Cotton—Raw Silk. Find equal size in raw silk to 38s cotton.

38s cotton = 31,920 yds. per lb. (38 × 840).

Refer to table for raw silk, where you will find 8 dram per 1000 yards gives 32,000 per lb.

Answer:—A 38s-cotton thread equals (nearly) an 8 dram raw silk thread.

TABLE OF RELATIVE LENGTHS.

Of Cotton Yarns by Numbers and Woolen Yarns by Runs.

Taking the Number as a Basis.
840 yards single Cotton Yarn = 1 Number.
1,600 " " Woolen " = 1 Run.

No.	Single Cotton Yarn		Run Single Woolen.
No. 1	Single Cotton Yarn	=	21/40 Run Single Woolen.
2	" " "	=	1 1/20 " " "
3	" " "	=	1 23/40 " " "
4	" " "	=	2 1/10 " " "
5	" " "	=	2 5/8 " " "
6	" " "	=	3 3/20 " " "
7	" " "	=	3 27/40 " " "
8	" " "	=	4 1/5 " " "
9	" " "	=	4 29/40 " " "
10	" " "	=	5 1/4 " " "
11	" " "	=	5 31/40 " " "
12	" " "	=	6 3/10 " " "
13	" " "	=	6 33/40 " " "
14	" " "	=	7 7/20 " " "
No. 15	Single Cotton Yarn	=	7 7/8 Run Single Woolen.
16	" " "	=	8 2/5 " " "
17	" " "	=	8 37/40 " " "
18	" " "	=	9 9/20 " " "
19	" " "	=	9 39/40 " " "
20	" " "	=	10 1/2 " " "
21	" " "	=	11 1/40 " " "
22	" " "	=	11 11/20 " " "
23	" " "	=	12 3/40 " " "
24	" " "	=	12 3/5 " " "
25	" " "	=	13 1/8 " " "
26	" " "	=	13 13/20 " " "
28	" " "	=	14 7/10 " " "
30	" " "	=	15 3/4 " " "

TABLE OF RELATIVE LENGTHS

Of Cotton Yarns by Numbers and Woolen Yarns by Cuts.

Taking the Number as a Basis.
840 yards single Cotton Yarn = 1 Number.
300 " " Woolen Yarn = 1 Cut.

No.	Single Cotton Yarn		Cut Single Woolen.
No. 1	Single Cotton Yarn	=	2 4/5 Cut Single Woolen.
2	" " "	=	5 3/5 " " "
3	" " "	=	8 2/5 " " "
4	" " "	=	11 1/5 " " "
5	" " "	=	14 " " "
6	" " "	=	16 4/5 " " "
7	" " "	=	19 3/5 " " "
8	" " "	=	22 2/5 " " "
9	" " "	=	25 1/5 " " "
10	" " "	=	28 " " "
11	" " "	=	30 4/5 " " "
12	" " "	=	33 3/5 " " "
13	" " "	=	36 2/5 " " "
14	" " "	=	39 1/5 " " "
No. 15	Single Cotton Yarn	=	42 Cut Single Woolen.
16	" " "	=	44 4/5 " " "
17	" " "	=	47 3/5 " " "
18	" " "	=	50 2/5 " " "
19	" " "	=	53 1/5 " " "
20	" " "	=	56 " " "
21	" " "	=	58 4/5 " " "
22	" " "	=	61 3/5 " " "
23	" " "	=	64 2/5 " " "
24	" " "	=	67 1/5 " " "
25	" " "	=	70 " " "
26	" " "	=	72 4/5 " " "
28	" " "	=	78 2/5 " " "
30	" " "	=	84 " " "

TABLE OF RELATIVE LENGTHS.

Of Cotton Yarn by Numbers and Worsted Yarn by Numbers.

Taking the Cotton Number as a Basis.
840 yards Single Cotton Yarn = 1 Number.
560 " " Worsted " = 1 Number.

No.	Single Cotton Yarn		No.	Single Worsted.
No. 1	Single Cotton Yarn	=	No. 1½	Single Worsted.
2	" " "	=	3	" "
4	" " "	=	6	" "
6	" " "	=	9	" "
8	" " "	=	12	" "
10	" " "	=	15	" "
12	" " "	=	18	" "
14	" " "	=	21	" "
16	" " "	=	24	" "
18	" " "	=	27	" "
20	" " "	=	30	" "
No. 22	Single Cotton Yarn	=	No. 33	Single Worsted.
24	" " "	=	36	" "
26	" " "	=	39	" "
28	" " "	=	42	" "
30	" " "	=	45	" "
32	" " "	=	48	" "
34	" " "	=	51	" "
36	" " "	=	54	" "
38	" " "	=	57	" "
40	" " "	=	60	" "
42	" " "	=	63	" "

No. 44	Single	Cotton	Yarn	=	No. 66	Single	Worsted.	
46	"	"	"	=	69	"	"	
48	"	"	"	=	72	"	"	
50	"	"	"	=	75	"	"	
52	"	"	"	=	78	"	"	
54	"	"	"	=	81	"	"	
56	"	"	"	=	84	"	"	
58	"	"	"	=	87	"	"	
60	"	"	"	=	90	"	"	
62	"	"	"	=	93	"	"	

No. 64	Single	Cotton	Yarn	=	No. 96	Single	Worsted.
66	"	"	"	=	99	"	"
68	"	"	"	=	102	"	"
70	"	"	"	=	105	"	"
72	"	"	"	=	108	"	"
74	"	"	"	=	111	"	"
76	"	"	"	=	114	"	"
78	"	"	"	=	117	"	"
80	"	"	"	=	120	"	"
100	"	"	"	=	150	"	"

TABLE OF RELATIVE LENGTHS.

Of Woolen Yarn by Runs and Cotton Yarn by Numbers.

Taking the Run as a Basis.
1600 Yards Single Woolen Yarn = 1 Run.
840 " " Cotton Yarn = 1 Number.

1	Run	Single	Woolen	Yarn	=	No. $1\frac{19}{21}$	Single	Cotton	Yarn.
$1\frac{1}{4}$	"	"	"	"	=	$2\frac{8}{21}$	"	"	"
$1\frac{1}{2}$	"	"	"	"	=	$2\frac{6}{7}$	"	"	"
$1\frac{3}{4}$	"	"	"	"	=	$3\frac{1}{3}$	"	"	"
2	"	"	"	"	=	$3\frac{17}{21}$	"	"	"
$2\frac{1}{4}$	"	"	"	"	=	$4\frac{2}{7}$	"	"	"
$2\frac{1}{2}$	"	"	"	"	=	$4\frac{16}{21}$	"	"	"
$2\frac{3}{4}$	"	"	"	"	=	$5\frac{5}{21}$	"	"	"
3	"	"	"	"	=	$5\frac{5}{7}$	"	"	"
$3\frac{1}{4}$	"	"	"	"	=	$6\frac{4}{21}$	"	"	"
$3\frac{1}{2}$	"	"	"	"	=	$6\frac{14}{21}$	"	"	"
$3\frac{3}{4}$	"	"	"	"	=	$7\frac{1}{7}$	"	"	"
4	"	"	"	"	=	$7\frac{13}{21}$	"	"	"
$4\frac{1}{4}$	"	"	"	"	=	$8\frac{2}{21}$	"	"	"
$4\frac{1}{2}$	"	"	"	"	=	$8\frac{4}{7}$	"	"	"
$4\frac{3}{4}$	"	"	"	"	=	$9\frac{1}{21}$	"	"	"
5	"	"	"	"	=	$9\frac{11}{21}$	"	"	"
$5\frac{1}{4}$	"	"	"	"	=	10	"	"	"
$5\frac{1}{2}$	"	"	"	"	=	$10\frac{10}{21}$	"	"	"
$5\frac{3}{4}$	"	"	"	"	=	$10\frac{20}{21}$	"	"	"
6	"	"	"	"	=	$11\frac{3}{7}$	"	"	"
$6\frac{1}{4}$	"	"	"	"	=	$11\frac{19}{21}$	"	"	"
$6\frac{1}{2}$	"	"	"	"	=	$12\frac{8}{21}$	"	"	"
$6\frac{3}{4}$	"	"	"	"	=	$12\frac{6}{7}$	"	"	"
7	"	"	"	"	=	$13\frac{1}{3}$	"	"	"
$7\frac{1}{4}$	"	"	"	"	=	$13\frac{17}{21}$	"	"	"
$7\frac{1}{2}$	"	"	"	"	=	$14\frac{2}{7}$	"	"	"
$7\frac{3}{4}$	"	"	"	"	=	$14\frac{16}{21}$	"	"	"
8	"	"	"	"	=	$15\frac{5}{21}$	"	"	"
$8\frac{1}{4}$	"	"	"	"	=	$15\frac{5}{7}$	"	"	"
$8\frac{1}{2}$	"	"	"	"	=	$16\frac{4}{21}$	"	"	"
$8\frac{3}{4}$	"	"	"	"	=	$16\frac{14}{21}$	"	"	"
9	"	"	"	"	=	$17\frac{1}{7}$	"	"	"
$9\frac{1}{4}$	"	"	"	"	=	$17\frac{13}{21}$	"	"	"
$9\frac{1}{2}$	"	"	"	"	=	$18\frac{2}{21}$	"	"	"
$9\frac{3}{4}$	"	"	"	"	=	$18\frac{4}{7}$	"	"	"
10	"	"	"	"	=	$19\frac{1}{21}$	"	"	"
$10\frac{1}{4}$	"	"	"	"	=	$19\frac{11}{21}$	"	"	"
$10\frac{1}{2}$	"	"	"	"	=	20	"	"	"
$10\frac{3}{4}$	"	"	"	"	=	$20\frac{10}{21}$	"	"	"
11	"	"	"	"	=	$20\frac{20}{21}$	"	"	"
$11\frac{1}{2}$	"	"	"	"	=	$21\frac{19}{21}$	"	"	"
12	"	"	"	"	=	$22\frac{6}{7}$	"	"	"

TABLE OF RELATIVE LENGTHS

Of Woolen Yarn by Runs with Woolen Yarn by Cuts.

Taking the Run as a Basis.
1600 yards Single Woolen Yarn=1 Run.
300 " " " =1 Cut.

1	Run Woolen Yarn	= 5⅓	Cut.
1¼	" " "	= 6⅔	"
1½	" " "	= 8	"
1¾	" " "	= 9⅓	"
2	" " "	= 10⅔	"
2¼	" " "	= 12	"
2½	" " "	= 13⅓	"
2¾	" " "	= 14⅔	"
3	" " "	= 16	"
3¼	" " "	= 17⅓	"
3½	" " "	= 18⅔	"
3¾	" " "	= 20	"
4	" " "	= 21⅓	"
4¼	" " "	= 22⅔	"
4½	" " "	= 24	"
4¾	" " "	= 25⅓	"
5	" " "	= 26⅔	"
5¼	" " "	= 28	"
5½	" " "	= 29⅓	"
5¾	" " "	= 30⅔	"
6	" " "	= 32	"
6¼	" " "	= 33⅓	"
6½	" " "	= 34⅔	"
6¾	Run Woolen Yarn	= 36	Cut.
7	" " "	= 37⅓	"
7¼	" " "	= 38⅔	"
7½	" " "	= 40	"
7¾	" " "	= 41⅓	"
8	" " "	= 42⅔	"
8¼	" " "	= 44	"
8½	" " "	= 45⅓	"
8¾	" " "	= 46⅔	"
9	" " "	= 48	"
9¼	" " "	= 49⅓	"
9½	" " "	= 50⅔	"
9¾	" " "	= 52	"
10	" " "	= 53⅓	"
10¼	" " "	= 54⅔	"
10½	" " "	= 56	"
10¾	" " "	= 57⅓	"
11	" " "	= 58⅔	"
11¼	" " "	= 60	"
11½	" " "	= 61⅓	"
11¾	" " "	= 62⅔	"
12	" " "	= 64	"

TABLE OF RELATIVE LENGTHS.

Of Woolen Yarn by Runs and Worsted Yarn by Numbers.

Taking the Run as a Basis.
1,600 yards Single Woolen Yarn = 1 Run.
560 " " Worsted Yarn = 1 Number.

RUN				
1	Single Woolen Yarn	= No.	$2\frac{6}{7}$	Single Worsted.
2	" " "	=	$5\frac{5}{7}$	" "
3	" " "	=	$8\frac{4}{7}$	" "
4	" " "	=	$11\frac{3}{7}$	" "
4½	" " "	=	$12\frac{6}{7}$	" "
5	" " "	=	$14\frac{2}{7}$	" "
5¼	" " "	=	15	" "
5½	" " "	=	$15\frac{5}{7}$	" "
5¾	" " "	=	$16\frac{3}{7}$	" "
6	" " "	=	$17\frac{1}{7}$	" "
6¼	" " "	=	$17\frac{6}{7}$	" "
6½	" " "	=	$18\frac{4}{7}$	" "
6¾	" " "	=	$19\frac{2}{7}$	" "
7	" " "	=	20	" "
7¼	" " "	=	$20\frac{5}{7}$	" "
7½	" " "	=	$21\frac{3}{7}$	" "
7¾	" " "	=	$22\frac{1}{7}$	" "
8	" " "	=	$22\frac{6}{7}$	" "
8¼	" " "	=	$23\frac{4}{7}$	" "
8½	" " "	=	$24\frac{2}{7}$	" "
8¾	" " "	=	25	" "
RUN.				
9	Single Woolen Yarn	= No.	$25\frac{5}{7}$	Single Worsted.
9¼	" " "	=	$26\frac{3}{7}$	" "
9½	" " "	=	$27\frac{1}{7}$	" "
9¾	" " "	=	$27\frac{6}{7}$	" "
10	" " "	=	$28\frac{4}{7}$	" "
10¼	" " "	=	$29\frac{2}{7}$	" "
10½	" " "	=	30	" "
10¾	" " "	=	$30\frac{5}{7}$	" "
11	" " "	=	$31\frac{3}{7}$	" "
11¼	" " "	=	$32\frac{1}{7}$	" "
11½	" " "	=	$32\frac{6}{7}$	" "
11¾	" " "	=	$33\frac{4}{7}$	" "
12	" " "	=	$34\frac{2}{7}$	" "
12¼	" " "	=	35	" "
12½	" " "	=	$35\frac{5}{7}$	" "
12¾	" " "	=	$36\frac{3}{7}$	" "
13	" " "	=	$37\frac{1}{7}$	" "
13¼	" " "	=	$37\frac{6}{7}$	" "
13½	" " "	=	$38\frac{4}{7}$	" "
13¾	" " "	=	$39\frac{2}{7}$	" "
14	" " "	=	40	" "

TABLE OF RELATIVE LENGTHS

Of Woolen Yarn Cuts and Cotton Yarn by Numbers.

Taking the "Cut" as a Basis.
300 yards Single Woolen Yarn = 1 Cut.
840 " " Cotton " = 1 Number.

1 Cut	Single	Woolen	Yarn	=	No. $\frac{5}{14}$	Single	Cotton	Yarn.
2 "	"	"	"	=	$\frac{5}{7}$	"	"	"
3 "	"	"	"	=	$1\frac{1}{14}$	"	"	"
4 "	"	"	"	=	$1\frac{3}{7}$	"	"	"
5 "	"	"	"	=	$1\frac{11}{14}$	"	"	"
6 "	"	"	"	=	$2\frac{1}{7}$	"	"	"
7 "	"	"	"	=	$2\frac{1}{2}$	"	"	"
8 "	"	"	"	=	$2\frac{6}{7}$	"	"	"
9 "	"	"	"	=	$3\frac{3}{14}$	"	"	"
10 "	"	"	"	=	$3\frac{4}{7}$	"	"	"
11 "	"	"	"	=	$3\frac{13}{14}$	"	"	"
12 "	"	"	"	=	$4\frac{2}{7}$	"	"	"
13 "	"	"	"	=	$4\frac{9}{14}$	"	"	"
14 "	"	"	"	=	5	"	"	"
15 "	"	"	"	=	$5\frac{5}{14}$	"	"	"
16 "	"	"	"	=	$5\frac{5}{7}$	"	"	"
17 "	"	"	"	=	$6\frac{1}{14}$	"	"	"
18 "	"	"	"	=	$6\frac{3}{7}$	"	"	"
19 "	"	"	"	=	$6\frac{11}{14}$	"	"	"
20 "	"	"	"	=	$7\frac{1}{7}$	"	"	"
21 "	"	"	"	=	$7\frac{1}{2}$	"	"	"
22 "	"	"	"	=	$7\frac{6}{7}$	"	"	"
23 "	"	"	"	=	$8\frac{3}{14}$	"	"	"
24 "	"	"	"	=	$8\frac{4}{7}$	"	"	"
25 "	"	"	"	=	$8\frac{13}{14}$	"	"	"
26 "	"	"	"	=	$9\frac{2}{7}$	"	"	"
27 "	"	"	"	=	$9\frac{9}{14}$	"	"	"
28 "	"	"	"	=	10	"	"	"
29 "	"	"	"	=	$10\frac{5}{14}$	"	"	"
30 "	"	"	"	=	$10\frac{5}{7}$	"	"	"
31 "	"	"	"	=	$11\frac{1}{14}$	"	"	"
32 "	"	"	"	=	$11\frac{3}{7}$	"	"	"
33 "	"	"	"	=	$11\frac{11}{14}$	"	"	"
34 "	"	"	"	=	$12\frac{1}{7}$	"	"	"
35 "	"	"	"	=	$12\frac{1}{2}$	"	"	"
36 "	"	"	"	=	$12\frac{6}{7}$	"	"	"
37 "	"	"	"	=	$13\frac{3}{14}$	"	"	"
38 "	"	"	"	=	$13\frac{4}{7}$	"	"	"
39 "	"	"	"	=	$13\frac{13}{14}$	"	"	"
40 "	"	"	"	=	$14\frac{2}{7}$	"	"	"
41 "	"	"	"	=	$14\frac{9}{14}$	"	"	"
45 "	"	"	"	=	$16\frac{1}{14}$	"	"	"

TABLE OF RELATIVE LENGTHS

Of Woolen Yarn by Cuts and Woolen Yarn by Runs.

Taking the "Cut" as a Basis.
300 yards Single Woolen = 1 Cut.
1600 " " " = 1 Run.

1 Cut Single Woolen Yarn . . . . . . =	$\frac{3}{16}$ Run.	6 Cut Single Woolen Yarn . . . . . . =	$1\frac{1}{8}$ Run.
2 " " " " . . . . . . =	$\frac{3}{8}$ "	7 " " " " . . . . . . =	$1\frac{5}{16}$ "
3 " " " " . . . . . . =	$\frac{9}{16}$ "	8 " " " " . . . . . . =	$1\frac{1}{2}$ "
4 " " " " . . . . . . =	$\frac{3}{4}$ "	9 " " " " . . . . . . =	$1\frac{11}{16}$ "
5 " " " " . . . . . . =	$\frac{15}{16}$ "	10 " " " " . . . . . . =	$1\frac{7}{8}$ "

11 Cut Single Woolen Yarn	=	$2\frac{1}{16}$ Run.
12 " " " "	=	$2\frac{1}{4}$ "
13 " " " "	=	$2\frac{7}{16}$ "
14 " " " "	=	$2\frac{5}{8}$ "
15 " " " "	=	$2\frac{13}{16}$ "
16 " " " "	=	3 "
17 " " " "	=	$3\frac{3}{16}$ "
18 " " " "	=	$3\frac{3}{8}$ "
19 " " " "	=	$3\frac{9}{16}$ "
20 " " " "	=	$3\frac{3}{4}$ "
21 " " " "	=	$3\frac{15}{16}$ "
22 " " " "	=	$4\frac{1}{8}$ "
23 " " " "	=	$4\frac{5}{16}$ "
24 " " " "	=	$4\frac{1}{2}$ "
25 " " " "	=	$4\frac{11}{16}$ "
26 " " " "	=	$4\frac{7}{8}$ "
27 " " " "	=	$5\frac{1}{16}$ "
28 " " " "	=	$5\frac{1}{4}$ "
29 " " " "	=	$5\frac{7}{16}$ "
30 " " " "	=	$5\frac{5}{8}$ "
31 " " " "	=	$5\frac{13}{16}$ "
32 " " " "	=	6 "
33 " " " "	=	$6\frac{3}{16}$ "
34 " " " "	=	$6\frac{3}{8}$ "
35 " " " "	=	$6\frac{9}{16}$ "
36 Cut Single Woolen Yarn	=	$6\frac{3}{4}$ Run.
37 " " " "	=	$6\frac{15}{16}$ "
38 " " " "	=	$7\frac{1}{8}$ "
39 " " " "	=	$7\frac{5}{16}$ "
40 " " " "	=	$7\frac{1}{2}$ "
41 " " " "	=	$7\frac{11}{16}$ "
42 " " " "	=	$7\frac{7}{8}$ "
43 " " " "	=	$8\frac{1}{16}$ "
44 " " " "	=	$8\frac{1}{4}$ "
45 " " " "	=	$8\frac{7}{16}$ "
46 " " " "	=	$8\frac{5}{8}$ "
47 " " " "	=	$8\frac{13}{16}$ "
48 " " " "	=	9 "
49 " " " "	=	$9\frac{3}{16}$ "
50 " " " "	=	$9\frac{3}{8}$ "
51 " " " "	=	$9\frac{3}{4}$ "
52 " " " "	=	$9\frac{15}{16}$ "
53 " " " "	=	$10\frac{1}{8}$ "
54 " " " "	=	$10\frac{5}{16}$ "
55 " " " "	=	$10\frac{1}{2}$ "
56 " " " "	=	$10\frac{11}{16}$ "
57 " " " "	=	$10\frac{7}{8}$ "
58 " " " "	=	$11\frac{1}{16}$ "
59 " " " "	=	$11\frac{1}{4}$ "
60 " " " "	=	$11\frac{7}{16}$ "

TABLE OF RELATIVE LENGTHS

Of Woolen Yarn by Cuts and Worsted Yarn by Numbers.

Taking the Cut as the Basis.

300 yards Single Woolen Yarn = 1 Cut.

560 " " Worsted " = 1 Number.

1 Cut Single Woolen Yarn=No.		$\frac{15}{28}$ Single Worsted.
2 " " " "	=	$1\frac{2}{28}$ " "
4 " " " "	=	$2\frac{4}{28}$ " "
6 " " " "	=	$3\frac{6}{28}$ " "
8 " " " "	=	$4\frac{8}{28}$ " "
10 " " " "	=	$5\frac{10}{28}$ " "
11 " " " "		$5\frac{25}{28}$ " "
12 " " " "	=	$6\frac{12}{28}$ " "
13 " " " "	=	$6\frac{27}{28}$ " "
14 " " " "	=	$7\frac{14}{28}$ " "
15 " " " "	=	$8\frac{1}{28}$ " "
16 " " " "	=	$8\frac{16}{28}$ " "
17 " " " "	=	$9\frac{3}{28}$ " "
18 " " " "	=	$9\frac{18}{28}$ " "
19 " " " "	=	$10\frac{5}{28}$ " "
20 " " " "	=	$10\frac{20}{28}$ " "
21 " " " "	=	$11\frac{7}{28}$ " "
22 " " " "	=	$11\frac{22}{28}$ " "
23 " " " "	=	$12\frac{9}{28}$ " "
24 " " " "	=	$12\frac{24}{28}$ " "
25 " " " "	=	$13\frac{11}{28}$ " "
26 " " " "	=	$13\frac{26}{28}$ " "
27 " " " "	=	$14\frac{13}{28}$ " "
28 " " " "	=	15 " "
29 " " " "	=	$15\frac{15}{28}$ " "
30 " " " "	=	$16\frac{2}{28}$ " "
31 " " " "	=	$16\frac{17}{28}$ " "
32 " " " "	=	$17\frac{4}{28}$ " "
33 Cut Single Woolen Yarn=No.		$17\frac{19}{28}$ Single Worsted.
34 " " " "	=	$18\frac{6}{28}$ " "
35 " " " "	=	$18\frac{21}{28}$ " "
36 " " " "	=	$19\frac{8}{28}$ " "
37 " " " "	=	$19\frac{23}{28}$ " "
38 " " " "	=	$20\frac{10}{28}$ " "
39 " " " "	=	$20\frac{25}{28}$ " "
40 " " " "	=	$21\frac{12}{28}$ " "
41 " " " "	=	$21\frac{27}{28}$ " "
42 " " " "	=	$22\frac{14}{28}$ " "
43 " " " "	=	$23\frac{1}{28}$ " "
44 " " " "	=	$23\frac{16}{28}$ " "
45 " " " "	=	$24\frac{3}{28}$ " "
46 " " " "	=	$24\frac{18}{28}$ " "
47 " " " "	=	$25\frac{5}{28}$ " "
48 " " " "	=	$25\frac{20}{28}$ " "
49 " " " "	=	$26\frac{7}{28}$ " "
50 " " " "	=	$26\frac{22}{28}$ " "
51 " " " "	=	$27\frac{9}{28}$ " "
52 " " " "	=	$27\frac{24}{28}$ " "
53 " " " "	=	$28\frac{11}{28}$ " "
54 " " " "	=	$28\frac{26}{28}$ " "
55 " " " "	=	$29\frac{13}{28}$ " "
56 " " " "	=	30 " "
57 " " " "	=	$30\frac{15}{28}$ " "
58 " " " "	=	$31\frac{2}{28}$ " "
59 " " " "	=	$31\frac{17}{28}$ " "
60 " " " "	=	$32\frac{4}{28}$ " "

TABLE OF RELATIVE LENGTHS

Of Worsted Yarns by Numbers and Cotton Yarns by Numbers.

Taking the Worsted Number as a Basis.
560 yards Single Worsted Yarn = 1 Number.
840 " " Cotton " = 1 Number.

No. 1	Single	Worsted	Yarn	=	No. ⅔	Single	Cotton	Yarn.
2	"	"	"	=	1⅓	"	"	"
4	"	"	"	=	2⅔	"	"	"
6	"	"	"	=	4	"	"	"
8	"	"	"	=	5⅓	"	"	"
10	"	"	"	=	6⅔	"	"	"
12	"	"	"	=	8	"	"	"
14	"	"	"	=	9⅓	"	"	"
16	"	"	"	=	10⅔	"	"	"
18	"	"	"	=	12	"	"	"
20	"	"	"	=	13⅓	"	"	"
22	"	"	"	=	14⅔	"	"	"
24	"	"	"	=	16	"	"	"
26	"	"	"	=	17⅓	"	"	"
28	"	"	"	=	18⅔	"	"	"
30	"	"	"	=	20	"	"	"
32	"	"	"	=	21⅓	"	"	"
34	"	"	"	=	22⅔	"	"	"
36	"	"	"	=	24	"	"	"
38	"	"	"	=	25⅓	"	"	"
40	"	"	"	=	26⅔	"	"	"
42	"	"	"	=	28	"	"	"
44	"	"	"	=	29⅓	"	"	"
46	"	"	"	=	30⅔	"	"	"
48	"	"	"	=	32	"	"	"
50	"	"	"	=	33⅓	"	"	"
52	"	"	"	=	34⅔	"	"	"
54	"	"	"	=	36	"	"	"
56	"	"	"	=	37⅓	"	"	"
58	"	"	"	=	38⅔	"	"	"
60	"	"	"	=	40	"	"	"
62	"	"	"	=	41⅓	"	"	"
64	"	"	"	=	42⅔	"	"	"
66	"	"	"	=	44	"	"	"
68	"	"	"	=	45⅓	"	"	"
70	"	"	"	=	46⅔	"	"	"
72	"	"	"	=	48	"	"	"
74	"	"	"	=	49⅓	"	"	"
76	"	"	"	=	50⅔	"	"	"
78	"	"	"	=	52	"	"	"
80	"	"	"	=	53⅓	"	"	"
82	"	"	"	=	54⅔	"	"	"
84	"	"	"	=	56	"	"	"
86	"	"	"	=	57⅓	"	"	"
88	"	"	"	=	58⅔	"	"	"
90	"	"	"	=	60	"	"	"
92	"	"	"	=	61⅓	"	"	"
94	"	"	"	=	62⅔	"	"	"
96	"	"	"	=	64	"	"	"
98	"	"	"	=	65⅓	"	"	"
100	"	"	"	=	66⅔	"	"	"
110	"	"	"	=	73⅓	"	"	"
120	"	"	"	=	80	"	"	"
130	"	"	"	=	86⅔	"	"	"

TABLE OF RELATIVE LENGTHS

Of Worsted Yarn by Numbers and Woolen Yarn by Runs.

Taking the Number as a Basis.
560 yards Single Worsted Yarn = 1 Number.
1600 " " Woolen " = 1 Run.

No.								
No. 1	Single	Worsted	Yarn	=	$\frac{7}{20}$	Run	Single	Woolen.
2	"	"	"	=	$\frac{7}{10}$	"	"	"
4	"	"	"	=	$1\frac{4}{10}$	"	"	"
6	"	"	"	=	$2\frac{1}{10}$	"	"	"
8	"	"	"	=	$2\frac{8}{10}$	"	"	"
10	"	"	"	=	$3\frac{5}{10}$	"	"	"
12	"	"	"	=	$4\frac{2}{10}$	"	"	"
14	"	"	"	=	$4\frac{9}{10}$	"	"	"
16	"	"	"	=	$5\frac{6}{10}$	"	"	"
18	"	"	"	=	$6\frac{3}{10}$	"	"	"
20	"	"	"	=	7	"	"	"
22	"	"	"	=	$7\frac{7}{10}$	"	"	"
24	"	"	"	=	$8\frac{4}{10}$	"	"	"
26	"	"	"	=	$9\frac{1}{10}$	"	"	"
28	"	"	"	=	$9\frac{8}{10}$	"	"	"
30	"	"	"	=	$10\frac{5}{10}$	"	"	"
32	"	"	"	=	$11\frac{2}{10}$	"	"	"
34	"	"	"	=	$11\frac{9}{10}$	"	"	"
36	"	"	"	=	$12\frac{6}{10}$	"	"	"
38	"	"	"	=	$13\frac{3}{10}$	"	"	"
40	"	"	"	=	14	"	"	"
42	"	"	"	=	$14\frac{7}{10}$	"	"	"
44	"	"	"	=	$15\frac{4}{10}$	"	"	"
46	"	"	"	=	$16\frac{1}{10}$	"	"	"
48	"	"	"	=	$16\frac{8}{10}$	"	"	"
50	"	"	"	=	$17\frac{5}{10}$	"	"	"

TABLE OF RELATIVE LENGTHS

Of Worsted Yarn by Numbers and Woolen Yarn by Cuts.

Taking the Number as a Basis.
560 Yards Single Worsted Yarn = 1 Number.
300 " " Woolen Yarn = 1 Cut.

No. 1	Single	Worsted	Yarn	=	$1\frac{13}{15}$	Cut	Single	Woolen.
2	"	"	"	=	$3\frac{11}{15}$	"	"	"
4	"	"	"	=	$7\frac{7}{15}$	"	"	"
6	"	"	"	=	$11\frac{3}{15}$	"	"	"
8	"	"	"	=	$14\frac{14}{15}$	"	"	"
10	"	"	"	=	$18\frac{10}{15}$	"	"	"
12	"	"	"	=	$22\frac{6}{15}$	"	"	"
14	"	"	"	=	$26\frac{2}{15}$	"	"	"
16	"	"	"	=	$29\frac{13}{15}$	"	"	"
18	"	"	"	=	$33\frac{9}{15}$	"	"	"
20	"	"	"	=	$37\frac{5}{15}$	"	"	"
22	"	"	"	=	$41\frac{1}{15}$	"	"	"
24	"	"	"	=	$44\frac{12}{15}$	"	"	"
26	"	"	"	=	$48\frac{8}{15}$	"	"	"
28	"	"	"	=	$52\frac{4}{15}$	"	"	"
30	"	"	"	=	56	"	"	"
32	"	"	"	=	$59\frac{11}{15}$	"	"	"
34	"	"	"	=	$63\frac{7}{15}$	"	"	"
36	"	"	"	=	$67\frac{3}{15}$	"	"	"
38	"	"	"	=	$70\frac{14}{15}$	"	"	"
40	"	"	"	=	$74\frac{10}{15}$	"	"	"

YARN CALCULATIONS.

Ascertaining the Counts of Twisted Yarns Composed of Two or more minor Threads of which the Counts are Known.

I. If the compound thread is composed of two minor threads of equal counts and material, the compound thread is one-half the count of the minor.

EXAMPLE: 2.60s cotton = single 30s cotton yarn.
2.40s worsted = " 20s worsted.
Double and twist 4-run woolen yarn = 2-run single woolen yarn.
Double and twist 30-cut woolen yarn = 15-cut single woolen yarn.

II. If the yarn be more than two-ply, divide the given counts by the number of ply.

EXAMPLE: 3.90s cotton = 90 ÷ 3 = single 30s cotton yarn.
3.60s worsted = 60 ÷ 3 = single 20s worsted, etc.

III. If the compound thread is composed of two minor threads of unequal counts but the same material, the rule for finding the equal in a single thread as compared with the compound thread, is as follows:

Divide the product of the counts of the minor threads by their sum.

EXAMPLE A.—Find the equal in single cotton yarn to a two-fold cotton thread composed of single 40s and 60s.

$$40 \times 60 = 2400 \div 100 \; (40 + 60) = 24.$$

Answer: A two-fold cotton thread composed of single 40s and 60s equals a single 24s cotton yarn.

EXAMPLE B.—Find the equal in a single worsted thread to a two-fold worsted thread composed of single 20s and 30s.

$$20 \times 30 = 600 \div 50 \; (20 + 30) = 12.$$

Answer: A two-fold worsted thread composed of single 20s and 30s equals single 12s worsted.

EXAMPLE C.—Find the equal counts in single woolen yarn (run basis) for a double and twist thread composed of single 3-run and 6-run woolen yarn.

$$3 \times 6 = 18 \div 9 \; (3 + 6) = 2.$$

Answer: A 3-run and 6-run woolen thread being twisted equals a single 2-run woolen thread.

EXAMPLE D.—Find the equal counts in single woolen yarn (cut basis) for a double and twist thread composed of single 20-cut and 30-cut yarn.

$$20 \times 30 = 600 \div 50 \; (20 + 30) = 12.$$

Answer: A 20-cut and 30-cut woolen yarn twisted equals single 12-cut woolen yarn.

IV. If the compound thread is composed of two minor threads of different materials, one must be reduced to the relative basis of the other thread, and the resulting count found in this system. (See tables of relative lengths given on page 276 to 282.)

EXAMPLE A.—Find the equal counts in a single worsted thread to a 2-ply thread composed of single 30s worsted and single 40s cotton yarn.

40s cotton = 60s worsted. Thus $30 \times 60 = 1800 \div 90 \; (30 + 60) = 20$.

Answer: Compound thread given in example equals a single 20s worsted thread.

EXAMPLE B.—Find the equal counts in single cotton yarn to a 2-ply thread composed of single 30s worsted and 40s cotton yarn.

30s worsted = 20s cotton. Thus $40 \times 20 = 800 \div 60 \; (40 + 20) = 13\frac{1}{3}$.

Answer: Compound thread given in example equals a single cotton thread of number $13\frac{1}{3}$.

EXAMPLE C.—Find the equal counts in single woolen yarn (run basis) to a 2-ply thread composed of single 20s cotton yarn and 6-run woolen yarn.

20s cotton = $10\frac{1}{2}$-run woolen yarn. Thus $10\frac{1}{2} \times 6 = 63 \div 16\frac{1}{2} \; (10\frac{1}{2} + 6) = 3\frac{9}{11}$.

Answer: Compound thread given in example equals a single woolen thread of $3\frac{9}{11}$ runs.

Example D.—Find the equal counts in single woolen yarn (cut basis) to a 2-ply thread composed of single 40s cotton yarn and 28-cut woolen yarn.

40s cotton = 112 cuts. Thus $28 \times 112 = 3136 \div 140\ (28 + 112) = 22\frac{4}{10}$.

Answer: Compound thread given in example equals a single woolen yarn of $22\frac{4}{10}$ cuts.

V. If the compound thread is composed of three minor threads of unequal counts, but of the same material, compound any two of the minor threads into one and apply previously given Rule III to this so compounded thread and the third (minor) thread not previously used.

Example: A 3-run, 6-run and 8-run thread being twisted together, what are the equal counts in one thread of the compound thread?

$3 \times 6 = 18 \div 9\ (3+6) = 2$. (A 3-run and a 6-run thread compounded equal a 2-run single thread.)

Thus: $2 \times 8 = 16 \div 10\ (2 + 8) = 1\frac{6}{10} = 1\frac{3}{5}$.

Answer: Compound thread given in example equals $1\frac{3}{5}$ run.

Example: A 20s, 30s and 40s worsted being twisted together, what is the size of the three-fold yarn?

$20 \times 30 = 600 \div 50\ (20 + 30) = 12$. (20s and 30s worsted compounded into one thread equal single 12 worsted.)

Thus: $12 \times 40 = 480 \div 52\ (12 + 40) = 9\frac{3}{13}$.

VI. If the compound thread is composed of three minor threads of two or three different materials, they must by means of their relative length (see tables of relative length given on pages 276 to 282) be transferred into equal counts in one basis, and afterwards find the size of the compound thread by Rule V.

Example: Find equal counts in single woolen yarn, "run" basis, for the following compound thread: A 3-run, a 6-run woolen thread, and a single 20s cotton twisted together.

20's cotton equals $10\frac{1}{2}$-run. $3 \times 6 = 18 \div 9\ (3 + 6) = 2$.

(3-run and 6-run threads compounded equal a single 2-run thread.)

Thus, $2 \times 10\frac{1}{2} = 21 \div 12\frac{1}{2}\ (2 + 10\frac{1}{2}) = 1\frac{17}{25}$.

Answer. The three-fold thread given in example equals in counts a single woolen yarn of $1\frac{17}{25}$ (nearly $1\frac{3}{4}$) run.

By means of the rules and explanations given it will be easy to ascertain the equal counts in a single thread for a two or three-ply thread, composed of yarns of the same basis, as well as compound threads constructed of different materials.

VII. Rule for ascertaining the counts of a thread required to produce with a given single thread a two-fold thread of which the compound size is known.

Multiply the counts of the given single thread by the counts of the compound thread and divide the product by the remainder, obtained by substracting the counts of the compound threads from the counts of the given single thread.

Example A.—*Question:* Find size of single yarn required (run basis) to produce with a 4-run woolen yarn a compound thread of 3-run.

$4 \times 3 = 12 \div 1\ (4 - 3) = 12$.

Answer: The minor thread required in the present example is a 12-run thread, or a 4-run and a 12-run woolen thread compounded into a 2-fold yarn, equal in counts to a 3-run single woolen.

Example B.—*Question:* Find size of single yarn required (worsted numbers) to produce with a 48's worsted thread a compound thread the equal of 16s worsted yarn.

$48 \times 16 = 768 \div 32\ (48 - 16) = 24$.

Answer: The minor thread required in the present example is a 24s worsted thread, or a 48s worsted thread and a 24s worsted thread compounded into a 2-fold yarn the equal in counts to 16s worsted yarn.

EXAMPLE C.—*Question:* Find size of single yarn required (cotton numbers) to produce with a 80s cotton thread a 2-fold yarn of a compound size of equal 30s cotton yarn.

$$80 \times 30 = 2400 \div 50\ (80 - 30) = 48.$$

Answer: The minor thread required in the present example is a 48s cotton thread, or 80s and 48s cotton threads compounded into a 2-fold yarn equal in this compound size to a single 30s cotton thread.

VIII. If one of the minor threads is to be found for a 3-ply thread, of which two minor threads are known, use the following

RULE: Compound the two minor threads into their equal in a single thread, and solve the question by Rule VII.

EXAMPLE.—Find minor thread required to produce with single 30s and single 60s worsted a 3-ply yarn to equal single 12s worsted counts.

60s and 30s worsted compound = (60 × 30 = 180 ÷ 90 [60 + 30] = 20) single 20s worsted.

Thus 20 × 12 = 240 ÷ 8 (20 — 12) = 30

{Compound two minor threads of which size is known} × {Known size of ply yarn,} {Compound two minor threads of which size is known} — {Known size of 3 ply yarn.}

Answer: The size of the third minor thread required to be ascertained in the given example is single 30s worsted yarn or a 3-ply thread composed of a single 30s, 60s and 30s worsted yarn equals single 12s worsted counts.

TABLE OF RELATIVE LENGTHS

Between Metric Measure of Length and the Denominations in use in the United States.

Metric Denominations and Values.		Equivalent in Denominations in Use in the U. S.
1 Millimetre =	.001th of a metre.	0.03937 inches.
1 Centimetre =	.01th " "	0.39370 "
1 Decimetre =	.1 " "	3.93708 "
1 Metre =	Unit of Length.	39.3708 " or 3.2809 feet.
1 Decametre =	10 metres.	393.708 " " 10.9363 yds.
1 Hectometre =	100 "	328 feet 1 inch, or 109.3633 "
1 Kilometre =	1,000 "	0.62138 miles.
1 Myriametre =	10,000 "	6.2138 "

The Metre, the Unit of the Metric Measure (in use in Austria, France, Germany, etc.), is the Ten-Millionth part of a Line drawn from the Pole to the Equator.

U. S. Measures.	Metric Measures.
1 Inch =	2.5399 Centimetres.
1 Yard =	0.9143 Metre.
1 Foot =	3.0479 Decimetres.
1 Mile =	1609.32 Metres.

TABLE OF RELATIVE WEIGHTS

Between Metric Denominations and the Denominations in Use in the United States.

Metric Denominations and Values.		Equivalent in Denominations in Use in the U. S.
1 Milligram =	.001th of a gram,	0.0154 troy grains.
1 Centigram =	.01 " "	0 1543 " "
1 Decigram =	.1 " "	1.5432 " "
1 Gram =	Unit of Weight.	15.4323 " "
1 Decagram =	10 grams.	154.3235 " "
1 Hectogram =	100 "	3.5291 oz. avoirdupois.
1 Kilogram, or 1 Kilo, =	1,000 "	2.2046 lbs. "
1 Myriagram =	10,000 "	22.0462 " "

The Gram, the Unit of the Metric Weights, is the Weight of a Cubic Centimetre of Distilled Water at 4° Centigrade.

U. S. Measures.	Metric Measures.
1 ounce avoirdupois =	28.34 grams.
1 pound " =	453.59 "
1 grain troy =	.0648 gram.
1 ounce " =	31.104 grams.
1 pound " =	.3732 kilo.

TABLE OF RELATIVE MEASURES OF CAPACITY, DRY AND LIQUID,

Between Metric Denominations and the Denominations in use in the United States.

1 Millilitre = .001th of a litre, or 1 cubic Centimetre = 15.432 grain measures, or 0.061 cubic inches.
1 Centilitre = .01th of a litre, or 10 cubic Centimetres = 0.61027 cubic inches.
1 Decilitre = .1th of a litre, or 0.1 cubic Decimetre = 6.1027 cubic inches.
1 Litre = unit of the measures = 1 cubic Decimetre = 1.7608 pints.
1 Decalitre = 10 litres = 10 cubic Decimetres = 2.2009 gallons.
1 Hectolitre = 100 litres = .1 cubic Metre = 22.0097 gallons.
1 Kilolitre = 1000 litres = 1 cubic Metre = 220.0967 gallons.

The Litre, the Unit of the Metric Measures of Capacity, Dry and Liquid, is the Volume of a Cubic Decimetre.

INDEX AND GLOSSARY.

Relative Weights of "Avoirdupois" Weights in "Troy" Denomination.

Avoirdupois=		*Lbs.*	*oz.*	*Dwt.*	*Grains.*	
1 Ton	=	2922	2	13	8	Troy Weight.
1 cwt.	=	146	1	6	16	
1 Qt.	=	34	0	6	16	
1 Lb.	=	1	2	11	16	
1 Oz.	=			18	5½	
1 Dr.	=			1	$3\frac{11}{32}$	

Relative Weights of "Avoirdupois" Weights in "Apothecaries" Weight.

Avoirdupois =		*Lbs.*	*oz.*	*Dr.*	*Scr.*	*Gr.*	
1 Lb.	=	1	2	4	2		Apoth. Weight.
1 Oz.	=			7		17½	
1 Dr.	=				1	$7\frac{11}{32}$	

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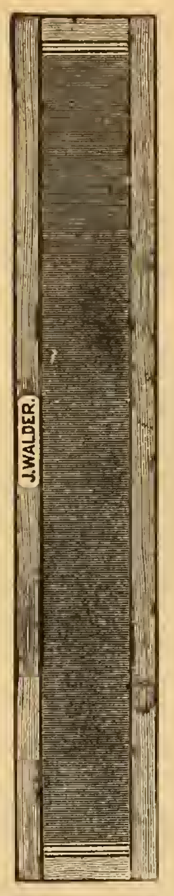
WRINGING ARMS, DYE STICKS,
LOOM JACKS, LOOM TREADLES, LOOM RODS, CRANK ARMS,
PICKING STICKS, BOBBIN WHEELS, Etc.

JACOB WALDER



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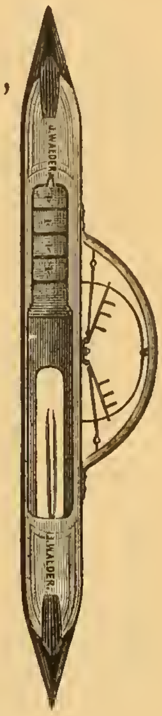

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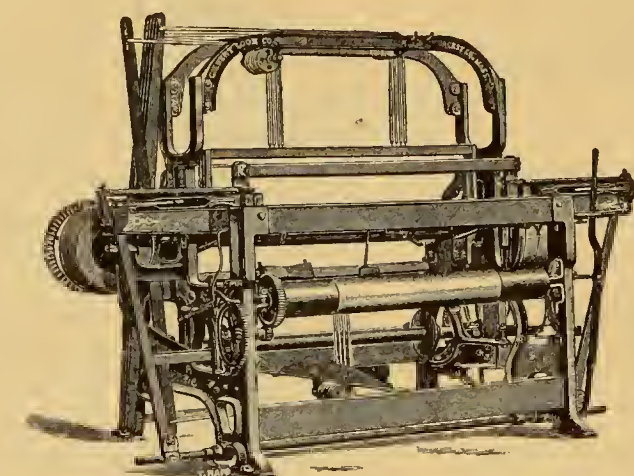
Velvet  and Plush

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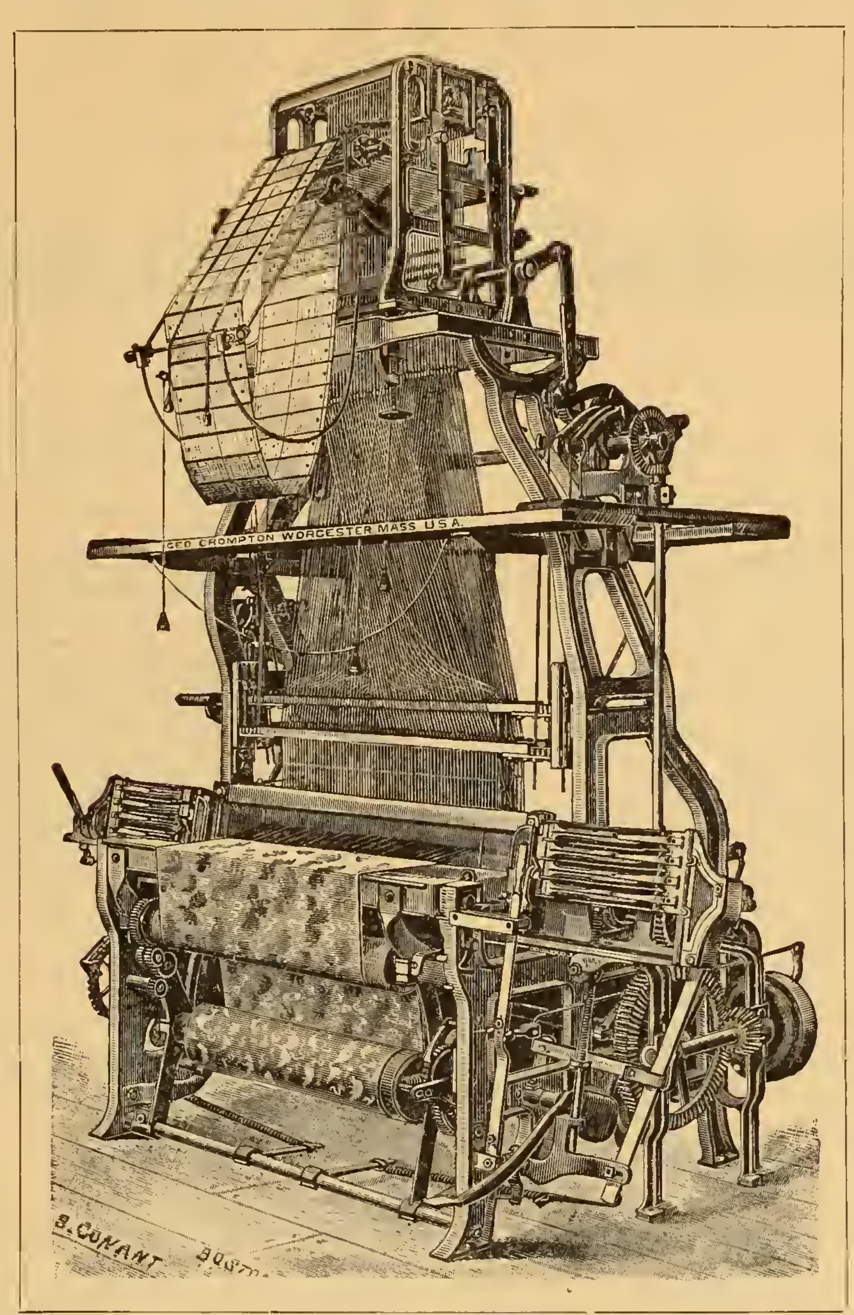

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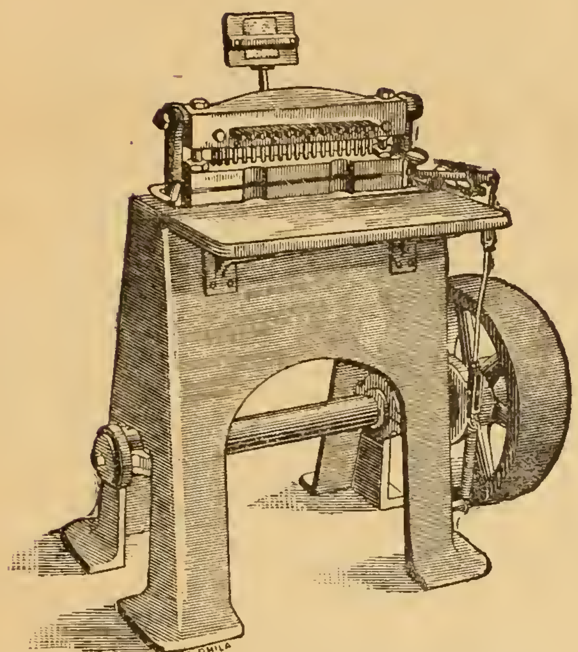

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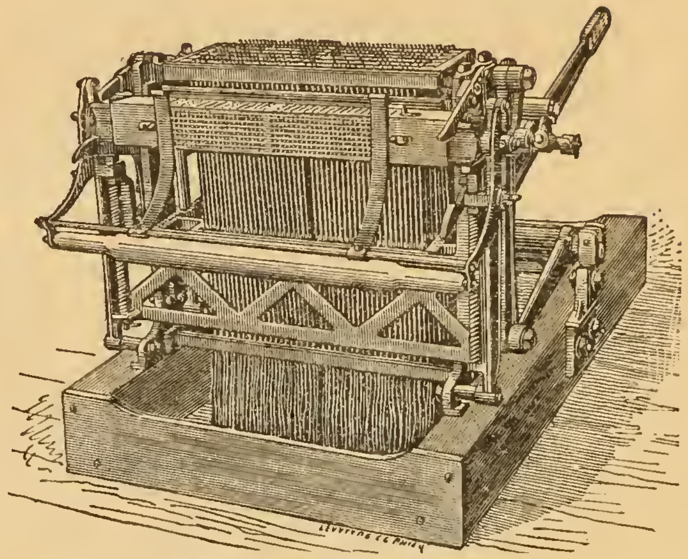

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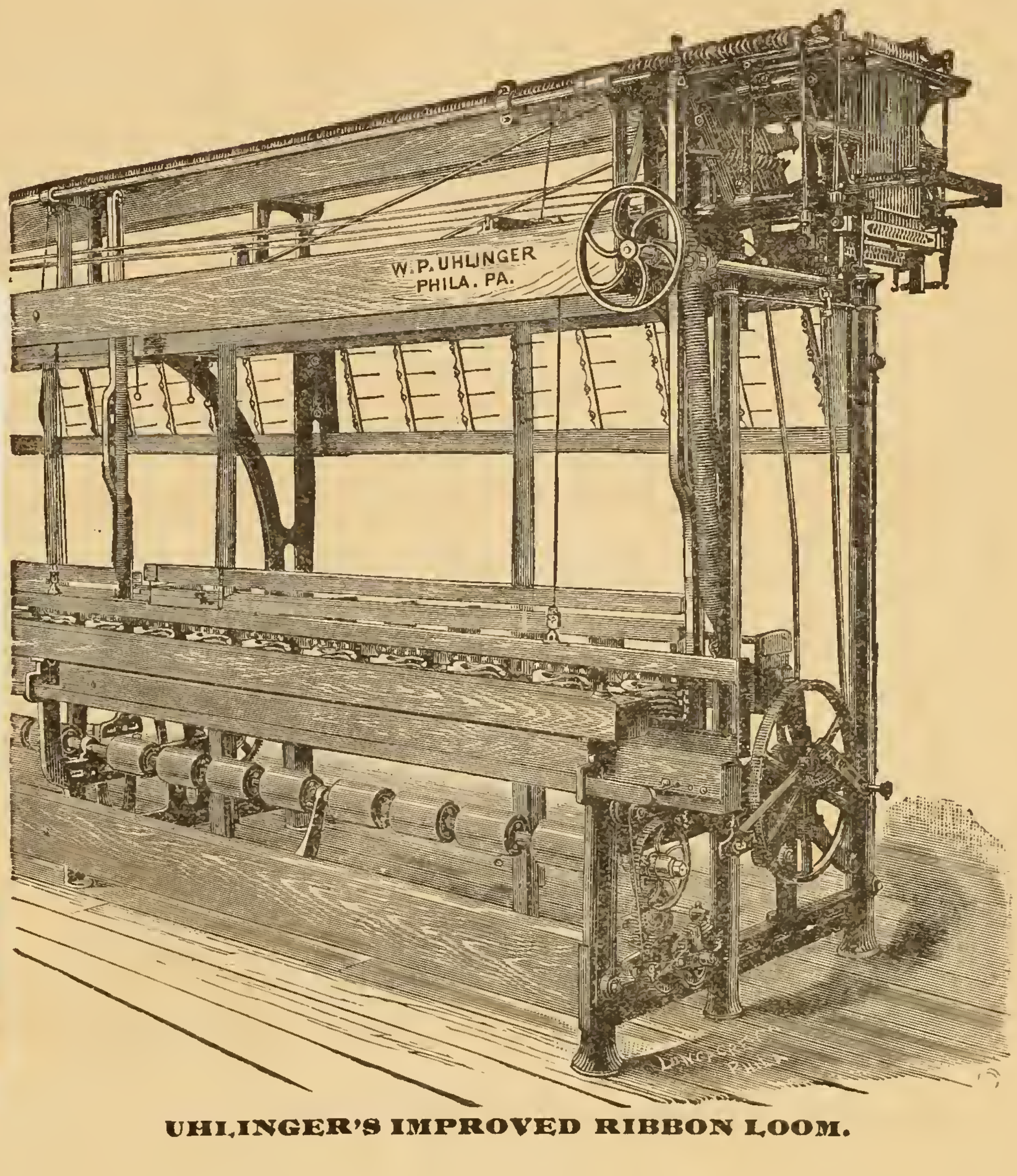

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