


TECHNOLOGY  
OF  
TEXTILE DESIGN  
BY  
E. A. POSSELT  
FOURTH EDITION



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22d & Wood Sts., Philadelphia, Pa.

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Plain Beaming Machines.  
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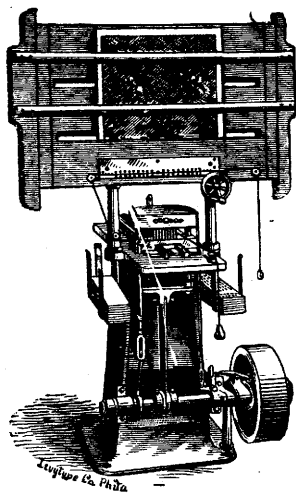
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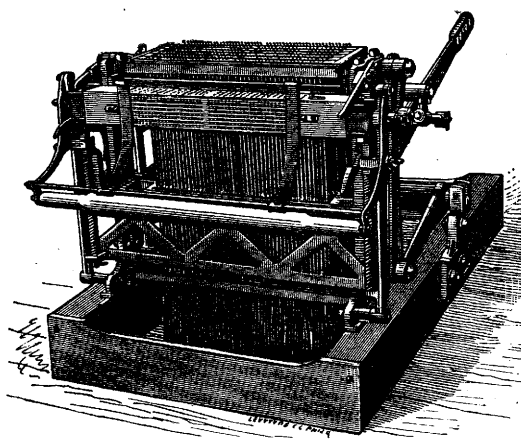
Witch Motions,  
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**PIANO STEAM-POWER CARD-STAMPING MACHINE.**

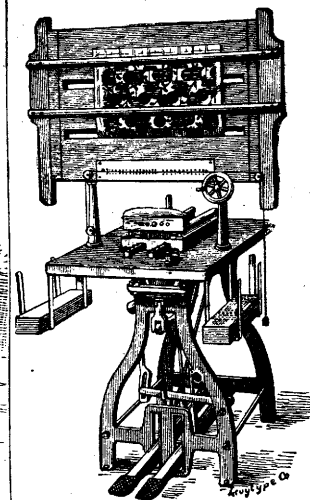
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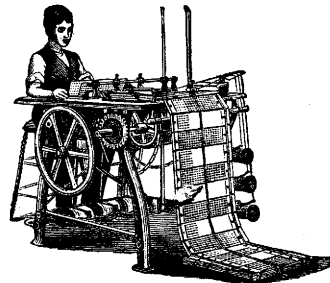
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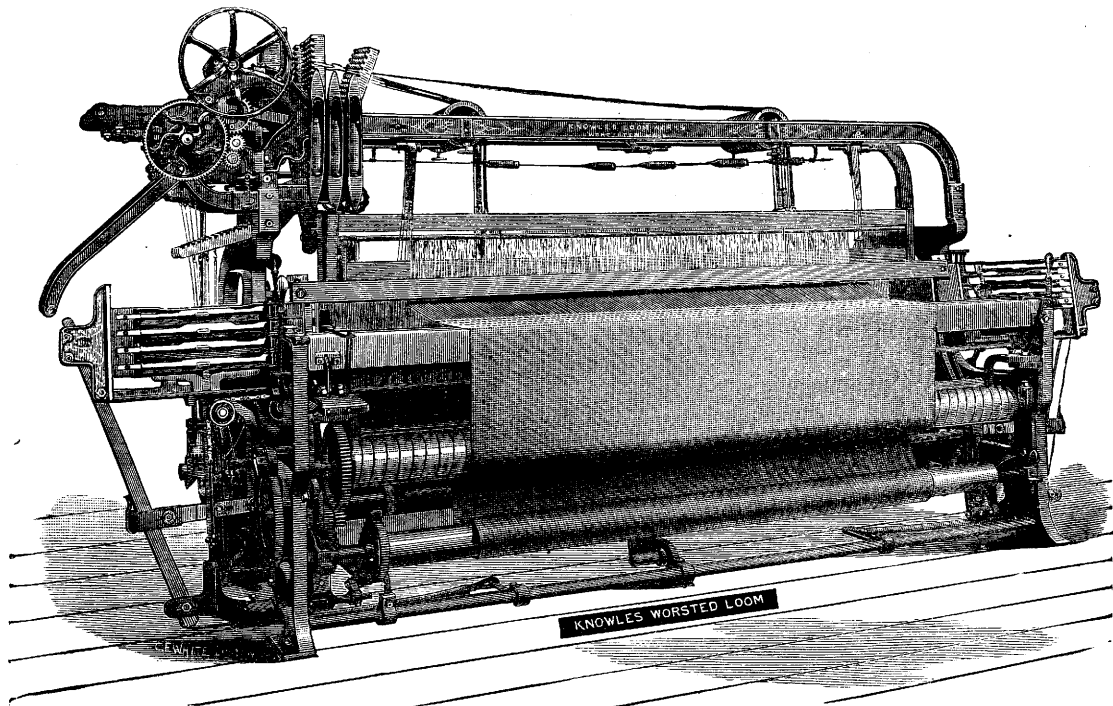
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THE ILLUSTRATION ON THIS PAGE REPRESENTS OUR

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The Loom is built with Entire New Driving Gears; Friction pulley if desired, Positive Box Motion, Heavier Upright Shaft and Gears, complete system of Positive and Conditional Take-up Motions, Filling Stop Motion, Equal Driving Gears for crank and bottom shafts, and other new devices which combine to make this the very best loom in the market, and one upon which we *guarantee to weave every variety of fabrics from the simplest to the most intricate that can be woven on any loom in the world.*

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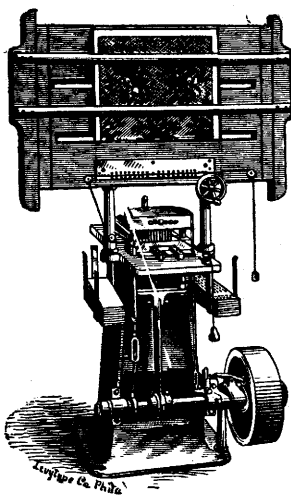
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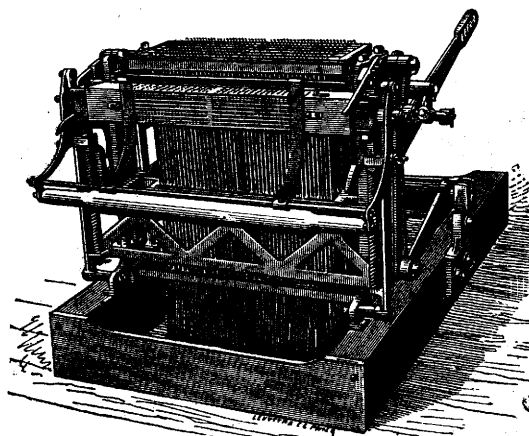
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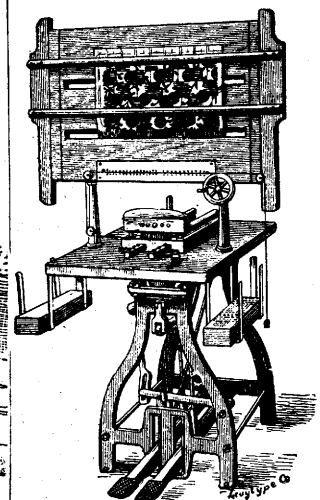
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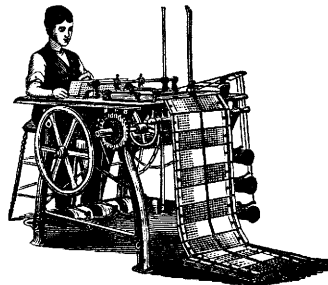
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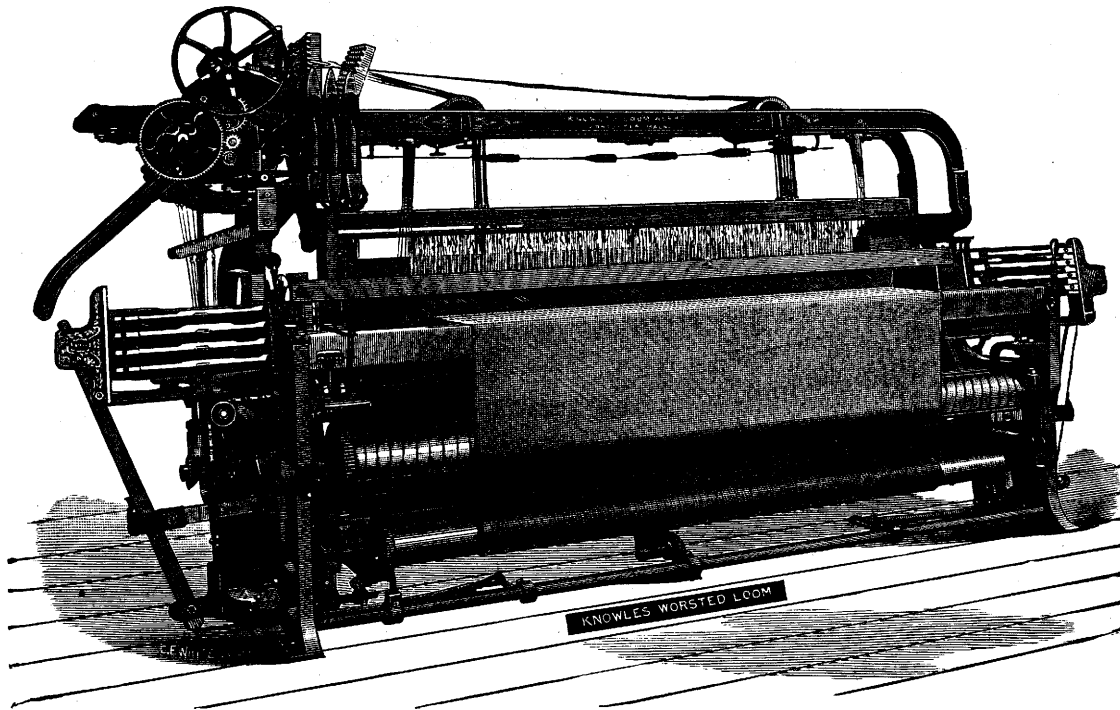
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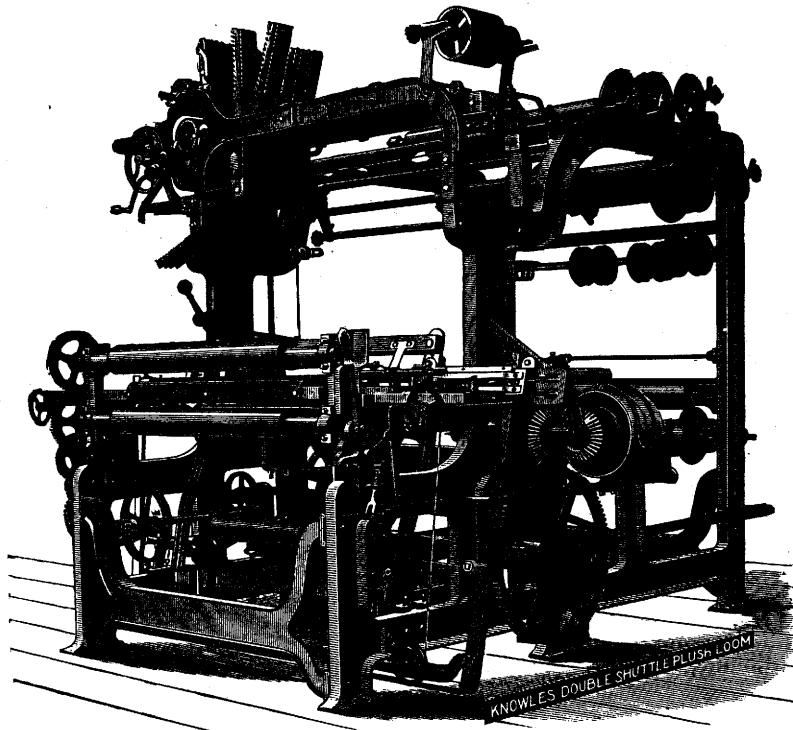
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# Technology of Textile Design.

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—

E. A. POSSELT,

CONSULTING EXPERT ON TEXTILE DESIGNING AND MANUFACTURING,  
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Professor of the Advanced Study in Textile Designing and Lecturer on the Structure of Fibres and the Manufacture of  
Yarns and Fabrics at the ~~Textile Department of the Pennsylvania Museum and School of Industrial Art, Phila-~~  
*2152 North 21st Street, Philada.*  
delphia; Author and Publisher of "THE STRUCTURE OF FIBRES, YARNS AND FABRICS;" "THE  
JACQUARD MACHINE ANALYZED AND EXPLAINED; THE PREPARATION OF JACQUARD  
CARDS, AND PRACTICAL HINTS TO LEARNERS OF JACQUARD DESIGNING," Etc.

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PHILADELPHIA:

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LONDON:

SAMPSON LOW, MARSTON, SEARLE & RIVINGTON, Limited,  
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BY

E. A. POSSELT.

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## PREFACE TO THE FIRST EDITION.

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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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## PREFACE TO THE FOURTH EDITION.

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The quick sale of the first three editions of this work, in the short time of only three years, clearly demonstrates the favor which "Technology of Textile Design" has found amongst all interested in Textile industries.

Philadelphia, December, 1891.

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## 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.)

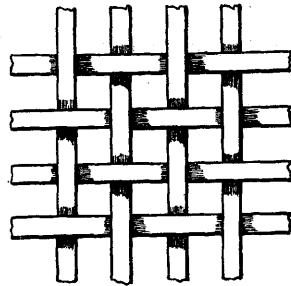


FIG. I.

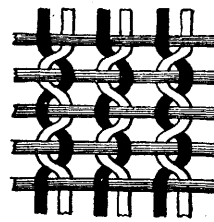


FIG. II.

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.

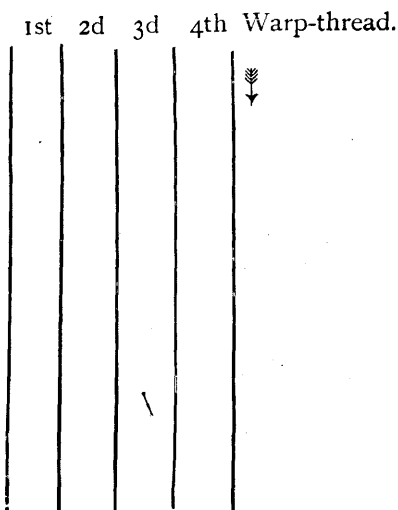


FIG. 3.

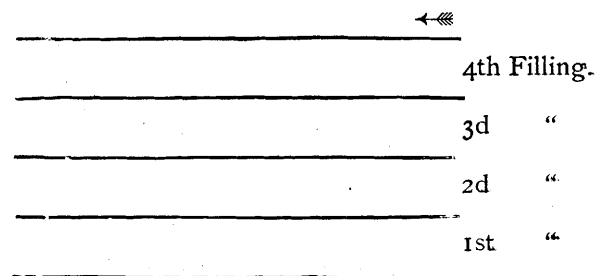


FIG. 4.



1st	2d	3d	4th	Warp-thread.
				↓
<i>n</i>	<i>o</i>	<i>p</i>	<i>r</i>	←
<i>i</i>	<i>k</i>	<i>l</i>	<i>m</i>	4th Filling.
<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	3d "
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	2d "
				1st "

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.

"	"	<i>f</i>	"	"	"	"	"	2	"	"	2.
"	"	<i>g</i>	"	"	"	"	"	3	"	"	2.
"	"	<i>h</i>	"	"	"	"	"	4	"	"	2.
"	"	<i>i</i>	"	"	"	"	"	1	"	"	3.
"	"	<i>k</i>	"	"	"	"	"	2	"	"	3.
"	"	<i>l</i>	"	"	"	"	"	3	"	"	3.
"	"	<i>m</i>	"	"	"	"	"	4	"	"	3.
"	"	<i>n</i>	"	"	"	"	"	1	"	"	4.
"	"	<i>o</i>	"	"	"	"	"	2	"	"	4.
"	"	<i>p</i>	"	"	"	"	"	3	"	"	4.
"	"	<i>r</i>	"	"	"	"	"	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  $1/2$  inch heavy squares and one forming  $3/4$  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:

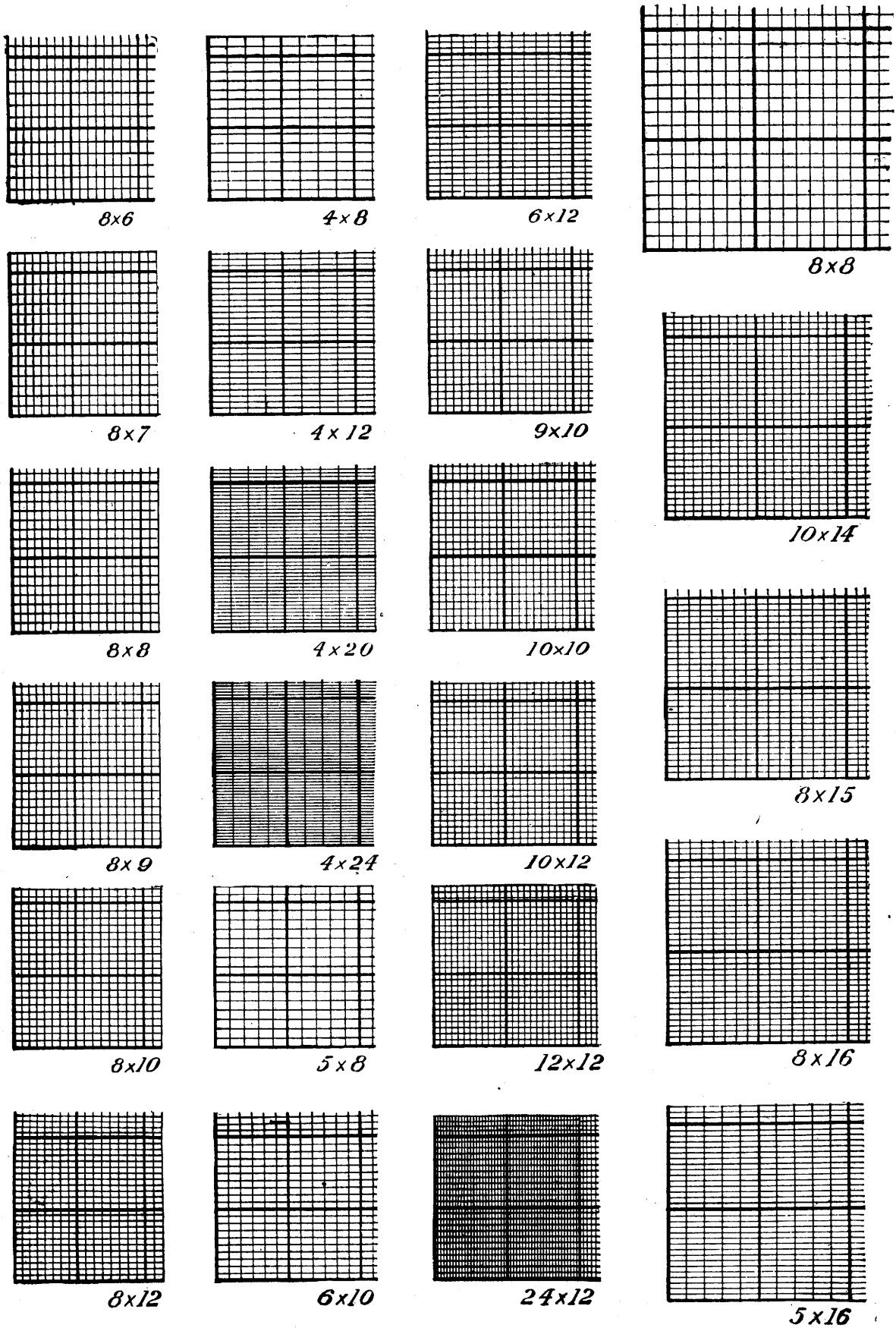


FIG. 6.

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 a 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 of 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  $\frac{80}{120}$  (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.

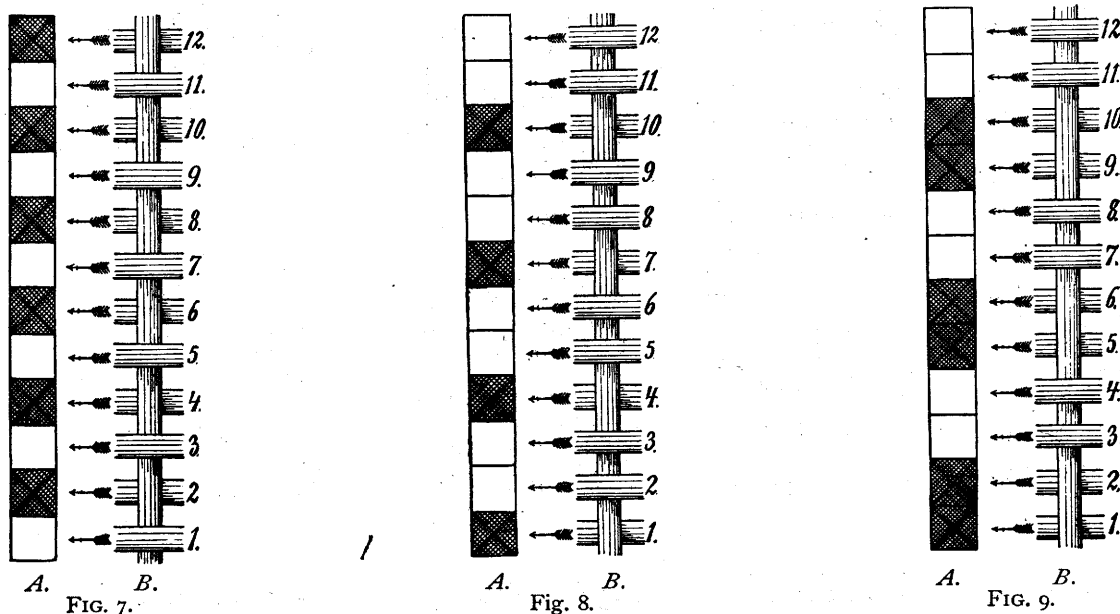


Fig. 7 shows under *A* the enlargement of a warp-thread taken from a regular designing paper, and containing in its repeat 12 picks in rotation. A careful examination of the diagram, and commencing to read from the bottom, illustrates the warp-thread alternately down and up; also at *B* the reproduction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

W.

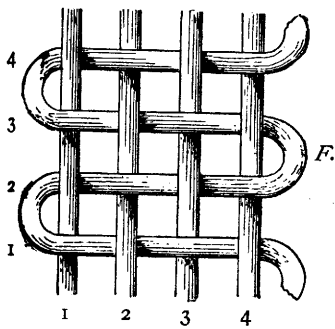


FIG. 10.

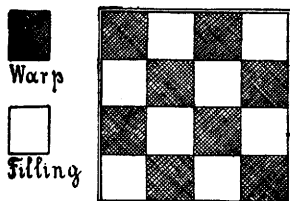


FIG. 11.

## 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 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).



FIG. 12.

The filling is represented in full black.

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.

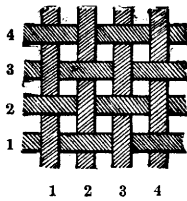


FIG. 15.

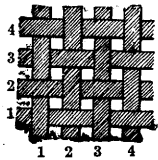


FIG. 16.

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.

*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.

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.

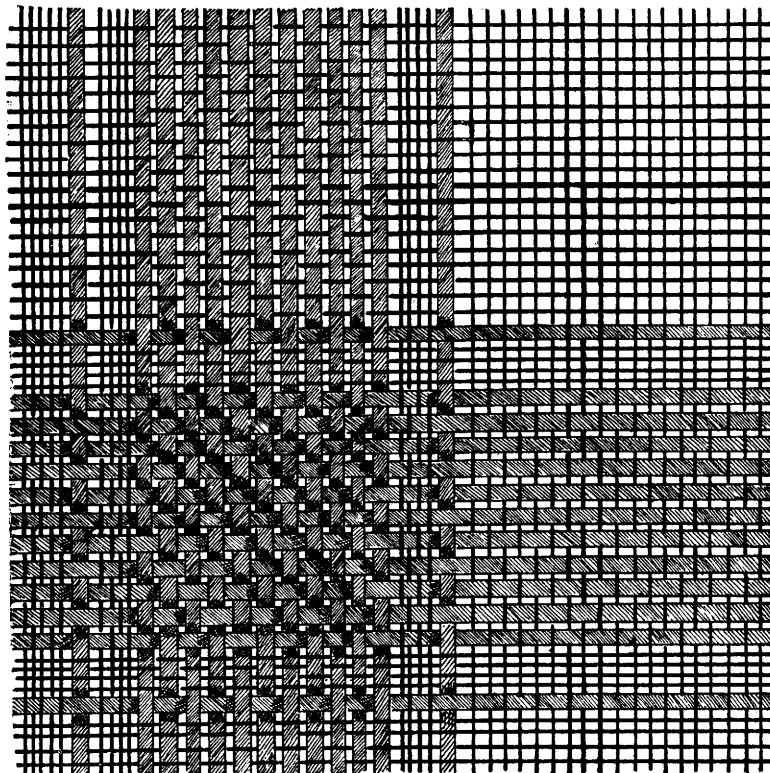


FIG. 17.

These effects are used to a large extent in the manufacture of gingham, 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.

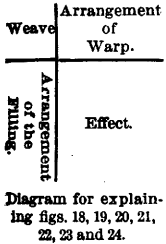


Fig. 18 illustrates the effect as produced by this arrangement. If the interweaving of the filling, as explained in fig. 18, is changed to the other pick, we get the stripe effect across the fabric or in the direction of the filling. This effect, known as "imitation tricot," is illustrated in Fig. 19. 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,

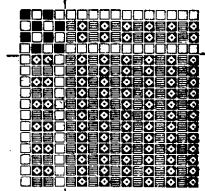


FIG. 18.

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.

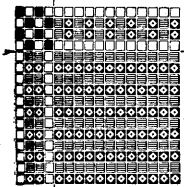


FIG. 19.

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.

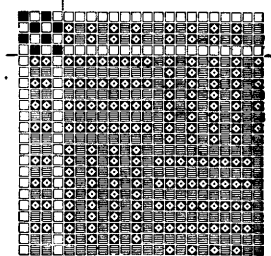


FIG. 20.

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.

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.

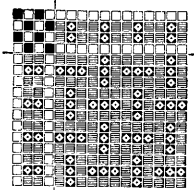


FIG. 21.

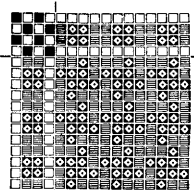


FIG. 22.

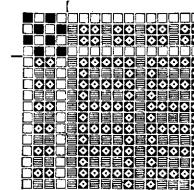


FIG. 23.

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.

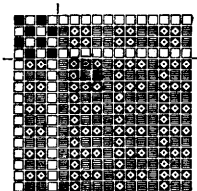


FIG. 24.

Fig. 24 is constructed as follows:

Arrangement of the warp,  $\begin{matrix} 2 \text{ ends light,} \\ 2 \text{ ends dark,} \\ \hline 4 \text{ ends in the repeat.} \end{matrix}$

Arrangement of the filling:  $\begin{matrix} 1 \text{ pick light,} \\ \text{to alternate with } 1 \text{ pick dark,} \\ \hline 2 \text{ picks in the repeat.} \end{matrix}$

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.)

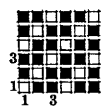


FIG. 25.

3-harness twill.  
 $\frac{2}{1} u. /$   
Warp for face.

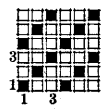


FIG. 26.

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  $\frac{2}{1}$ , filling face  $\frac{1}{2}$ , 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.

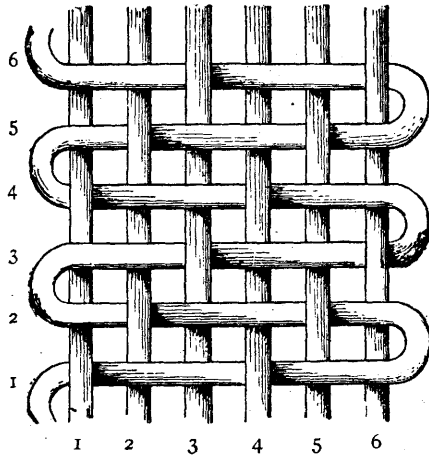


FIG. 27.



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.

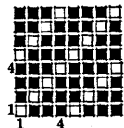


FIG. 29.

4-harness twill.

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

Warp for face.

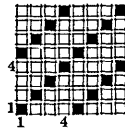


FIG. 29a.

4-harness twill.

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

Filling for face.

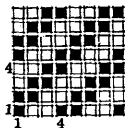


FIG. 30.

4-harness twill.

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

Warp and filling equal.

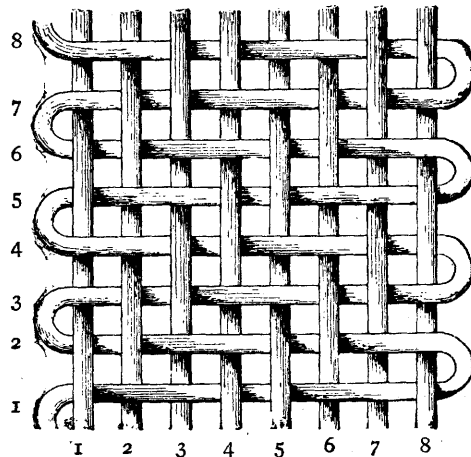


FIG. 31.



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.*

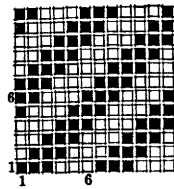
- 1 down 4 up (*u*), or
- 3 up 2 down (*u*), “
- 1 down 1 up, 1 down 2 up (*u*), “

*Filling Face.*

- 1 up 4 down (*u*).
- 3 down 2 up (*u*).
- 1 up 1 down, 1 up 2 down (*u*).



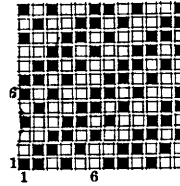




6-harness twill.

$$\frac{3}{3} e.$$

FIG. 45.



6-harness twill.

$$\frac{2 \text{ I}}{1 \text{ 2}} e.$$

FIG. 46.

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

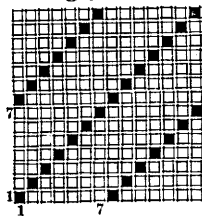
*Filling Face.*

- 1 up 6 down
- 2 up 5 down
- 3 up 4 down
- 1 up 1 down 1 up 4 down
- 2 up 1 down 1 up 3 down
- 2 up 2 down 1 up 2 down
- 1 up 3 down 1 up 2 down
- 1 up 1 down 1 up 1 down 1 up 2 down

*Warp Face.*

- or 1 down 6 up,
- " 2 down 5 up,
- " 3 down 4 up,
- " 1 down 1 up 1 down 4 up,
- " 2 down 1 up 1 down 3 up,
- " 2 down 2 up 1 down 2 up,
- " 1 down 3 up 1 down 2 up,
- " 1 down 1 up 1 down 1 up 1 down 2 up.

*Filling for Face.*

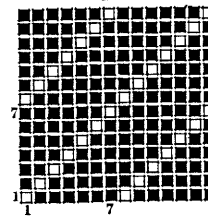


7-harness twill.

$$\frac{1}{6}$$

FIG. 47.

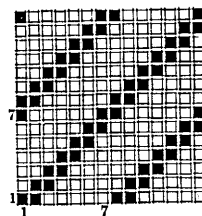
*Warp Face.*



7-harness twill.

$$\frac{6}{1}$$

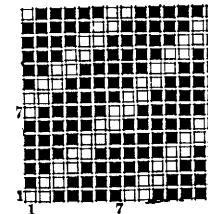
FIG. 48.



7-harness twill.

$$\frac{2}{5}$$

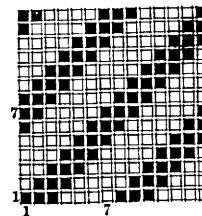
FIG. 49.



7-harness twill.

$$\frac{5}{2}$$

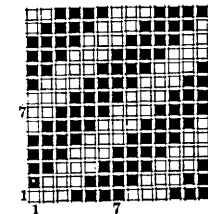
FIG. 50.



7-harness twill.

$$\frac{3}{4}$$

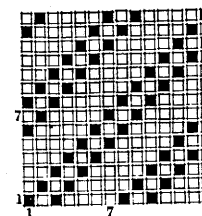
FIG. 51.



7-harness twill.

$$\frac{4}{3}$$

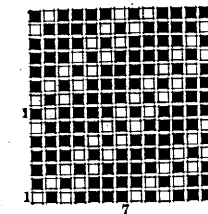
FIG. 52.



7-harness twill.

$$\frac{1 \text{ I}}{1 \text{ 4}}$$

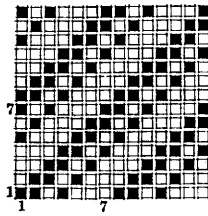
FIG. 53.



7-harness twill.

$$\frac{1 \text{ 4}}{1 \text{ 1}}$$

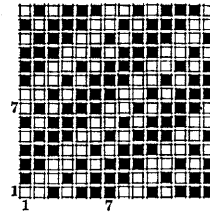
FIG. 54.



7-harness twill.

$$\begin{array}{r} 2 \quad 1 \\ \hline 1 \quad 3 \end{array}$$

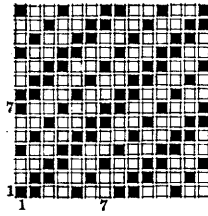
FIG. 55.



7-harness twill.

$$\begin{array}{r} 1 \quad 3 \\ \hline 2 \quad 1 \end{array}$$

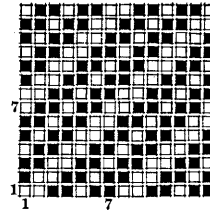
FIG. 56.



7-harness twill.

$$\begin{array}{r} 2 \quad 1 \\ \hline 2 \quad 2 \end{array}$$

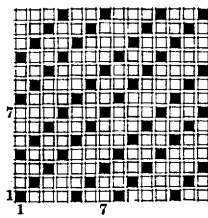
FIG. 57.



7-harness twill.

$$\begin{array}{r} 2 \quad 2 \\ \hline 2 \quad 1 \end{array}$$

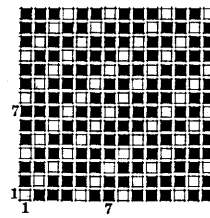
FIG. 58.



7-harness twill.

$$\begin{array}{r} 1 \quad 1 \\ \hline 3 \quad 2 \end{array}$$

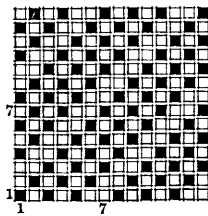
FIG. 59.



7-harness twill.

$$\begin{array}{r} 3 \quad 2 \\ \hline 1 \quad 1 \end{array}$$

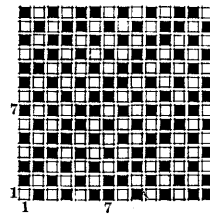
FIG. 60.



7-harness twill.

$$\begin{array}{r} 1 \quad 1 \quad 1 \\ \hline 1 \quad 1 \quad 2 \end{array}$$

FIG. 61.



7-harness twill.

$$\begin{array}{r} 1 \quad 1 \quad 2 \\ \hline 1 \quad 1 \quad 1 \end{array}$$

FIG. 62.

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

*Filling Face.*

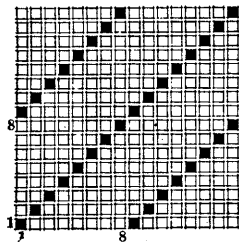


FIG. 63.

$$\begin{array}{r} 1 \\ \hline 7 \quad u. \end{array}$$

*Warp Face.*

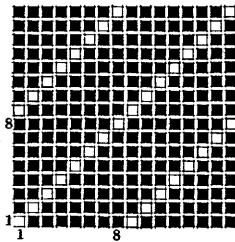


FIG. 64.

$$\begin{array}{r} 7 \quad u. \\ \hline 1 \end{array}$$

*Filling Face.*

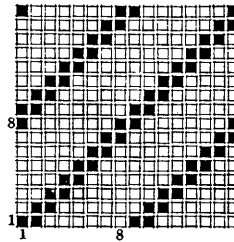


FIG. 65.

$$\begin{array}{r} 2 \\ \hline 6 \quad u. \end{array}$$

*Warp Face.*

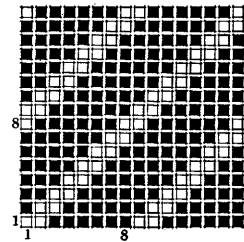


FIG. 66.

$$\begin{array}{r} 6 \quad u. \\ \hline 2 \end{array}$$

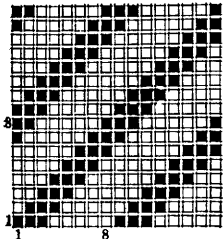


FIG. 67.

$$\frac{3}{5} u.$$

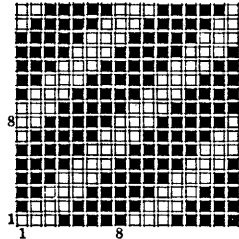


FIG. 68.

$$\frac{5}{3} u.$$

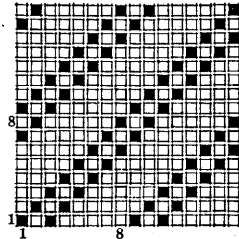


FIG. 69.

$$\frac{I \quad I}{I \quad 5} u.$$

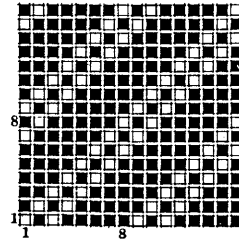


FIG. 70.

$$\frac{I \quad 5}{I \quad I} u.$$

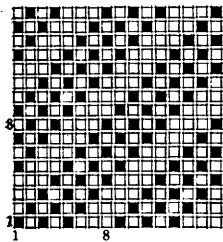


FIG. 71.

$$\frac{I \quad I \quad I}{I \quad I \quad 3} u.$$

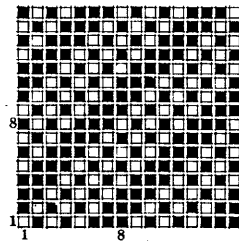


FIG. 72.

$$\frac{I \quad I \quad 3}{I \quad I \quad I} u.$$

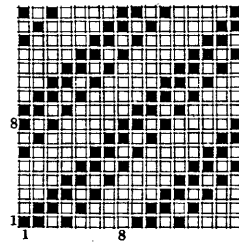


FIG. 73.

$$\frac{2 \quad I}{I \quad 4} u.$$

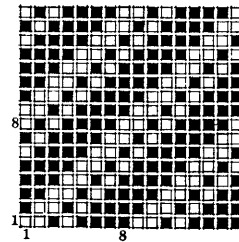


FIG. 74.

$$\frac{I \quad 4}{2 \quad I} u.$$

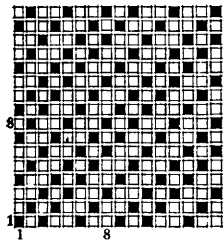


FIG. 75.

$$\frac{I \quad I \quad I}{I \quad 2 \quad 2} u.$$

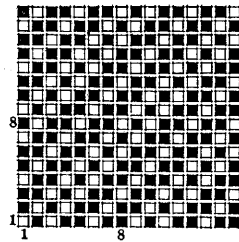


FIG. 76.

$$\frac{I \quad 2 \quad 2}{I \quad I \quad I} u.$$

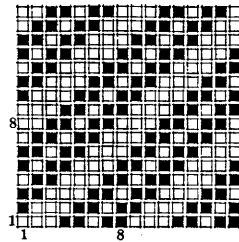


FIG. 77.

$$\frac{2 \quad 2}{3 \quad I} u.$$

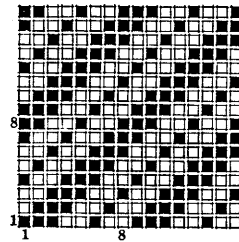


FIG. 78.

$$\frac{3 \quad I}{2 \quad 2} u.$$

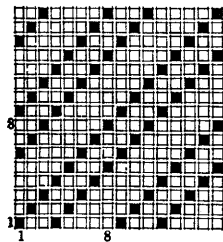


FIG. 79.

$$\frac{I \quad I}{2 \quad 4} u.$$

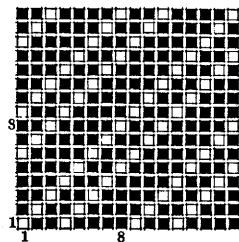


FIG. 80.

$$\frac{2 \quad 4}{I \quad I} u.$$

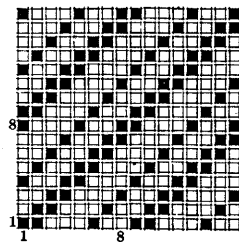


FIG. 81.

$$\frac{2 \quad I}{3 \quad 2} u.$$

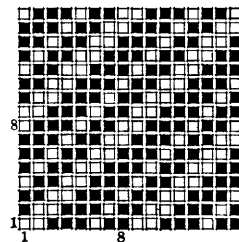


FIG. 82.

$$\frac{3 \quad 2}{2 \quad I} u.$$

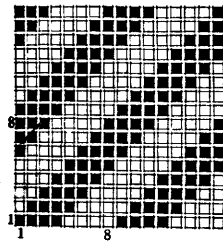


FIG. 83.

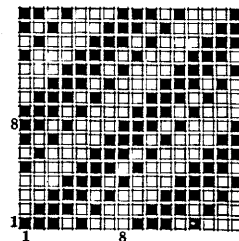


FIG. 84.

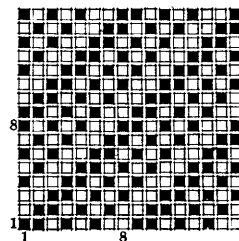


FIG. 85.

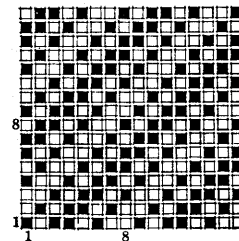


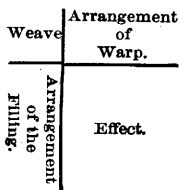
FIG. 86.

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  $\frac{3}{1}$  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.

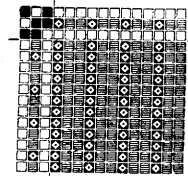


FIG. 87.

The effect represents what is technically known as "hair line."

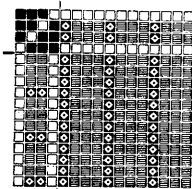


FIG. 88.

Weave Fig. 88, illustrating the 4-leaf twill  $\frac{3}{1}$ , 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.

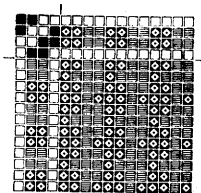


FIG. 89.

The dark filling has again to cover its own color in the warp to produce the required effect. This weave, ( $\frac{3}{1}$ ), can also be used in an arrangement of 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.

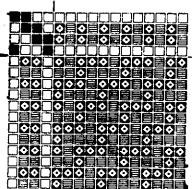


FIG. 90.

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

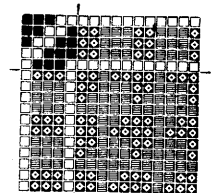


FIG. 91.

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. 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.

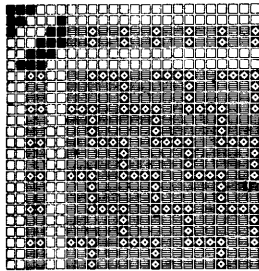


FIG. 92.

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.

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.

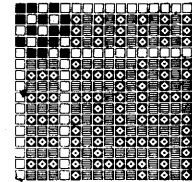


FIG. 93.

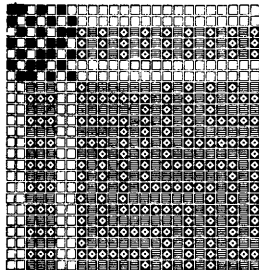


FIG. 94.

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

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

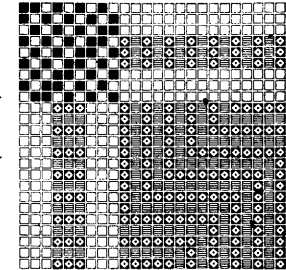


FIG. 95.

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.

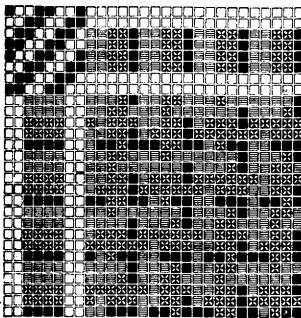


FIG. 96.

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

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

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

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, } color No. 1.  
4 ends medium, } or, " 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.

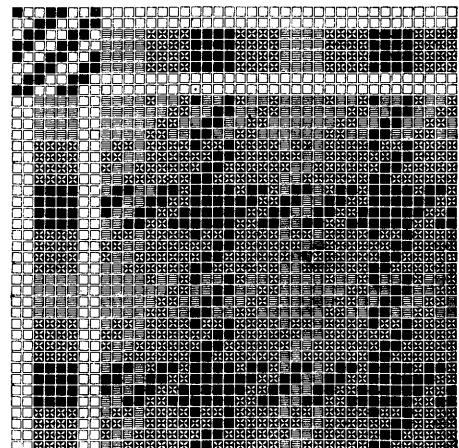


FIG. 97.

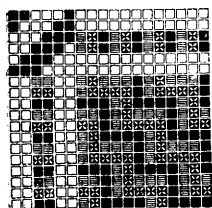


FIG. 98

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 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.

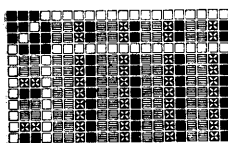


FIG. 100.

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.

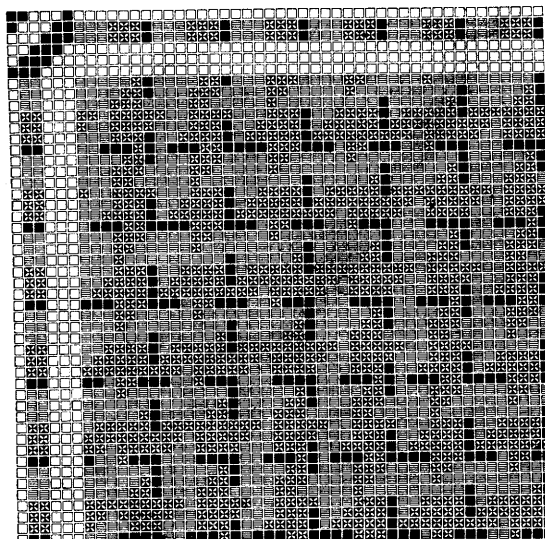


FIG. 99.

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.

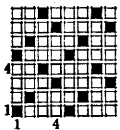
It will be seen by the student that these effects, until now produced with two or three colors in each example, can readily be extended to effects with four or more colors in warp, or in filling, or in both systems combined at the same time.

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:

$1 + 2 = 3 + 2 = 5 + 2 = 7$  or  $2 + 2 = 4 + 2 = 6$  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.

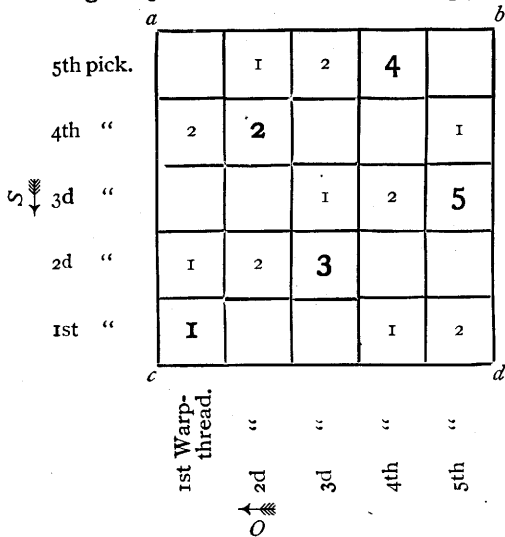


FIG. 102.

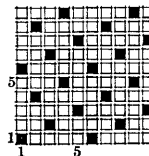


FIG. 103.

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

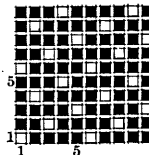


FIG. 104.



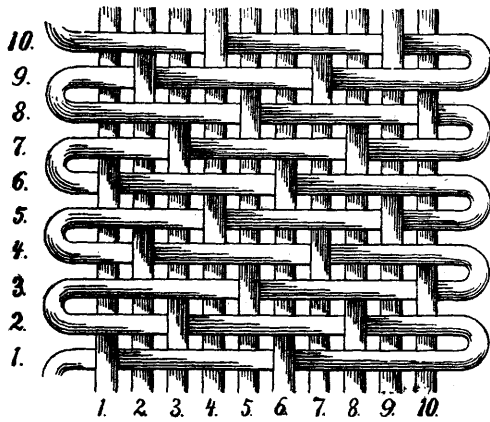


FIG. 105.

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.

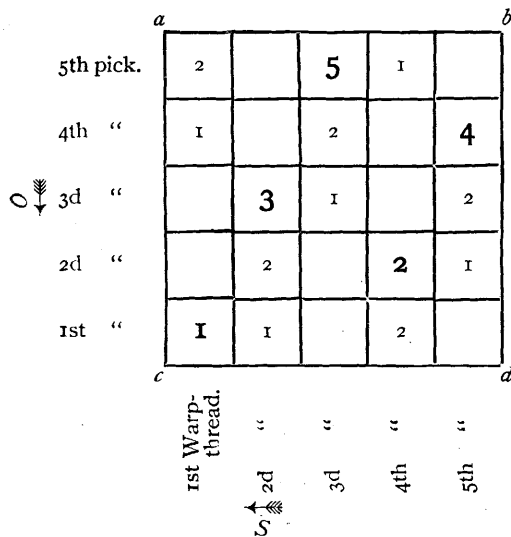


FIG. 106.

Filling for face.

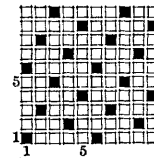


FIG. 107.

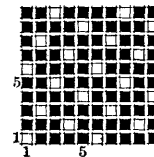


FIG. 108.

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

$$1 + 3 = 4 + 3 = 7 = 2 + 3 = 5 + 3 = 8 = 3 + 3 = 6 = 1,$$

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.

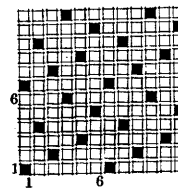


FIG. 109.

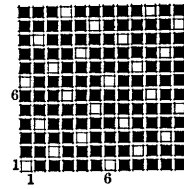


FIG. 110.

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.

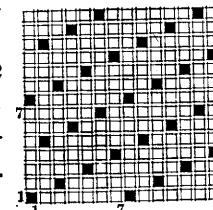


FIG. 111.

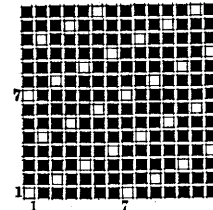


FIG. 112.

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.

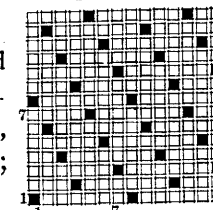


FIG. 113.

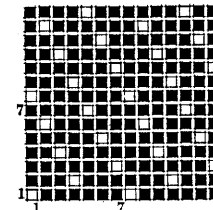


FIG. 114.

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.

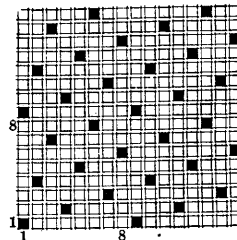


FIG. 115.

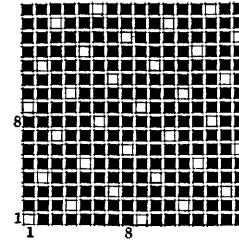


FIG. 116.

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).

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.

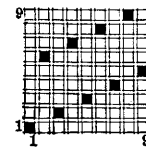


FIG. 117.

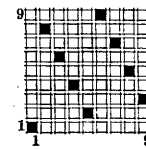


FIG. 118.

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.

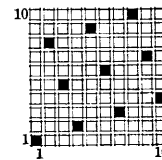


FIG. 119.

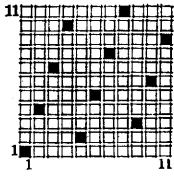


FIG. 120.

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.

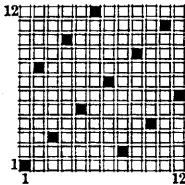


FIG. 121.

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.

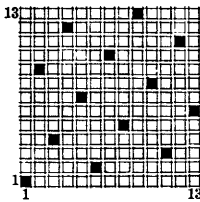


FIG. 122.

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.

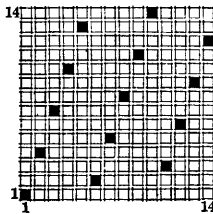


FIG. 123.

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.

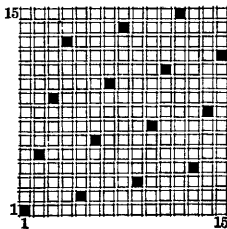


FIG. 124.

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.

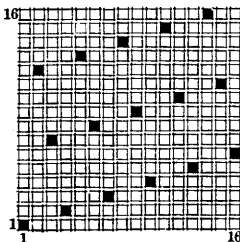


FIG. 125.

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...	I.	3.	5.	2.	4.												2.
6 " ...	I.	3.	5.	2.	6.	4.											0.
7 " ...	I.	3.	5.	7.	2.	4.	6.										2.
8 " ...	I.	4.	7.	2.	5.	8.	3.	6.									3.
9 " ...	I.	3.	5.	7.	9.	2.	4.	6.	8.								2.
10 " ...	I.	4.	7.	10.	3.	6.	9.	2.	5.	8.							3.
11 " ...	I.	5.	9.	2.	6.	10.	3.	7.	11.	4.	8.						4.
12 " ...	I.	8.	3.	10.	5.	12.	7.	2.	9.	4.	11.	6.					7.
13 " ...	I.	6.	11.	3.	8.	13.	5.	10.	2.	7.	12.	4.	9.				5.
14 " ...	I.	6.	11.	2.	7.	12.	3.	8.	13.	4.	9.	14.	5.	10.			5.
15 " ...	I.	5.	9.	13.	2.	6.	10.	14.	3.	7.	11.	15.	4.	8.	12.		4.
16 " ...	I.	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.

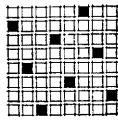


FIG. 128.

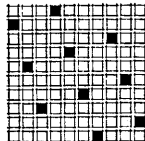


FIG. 129.

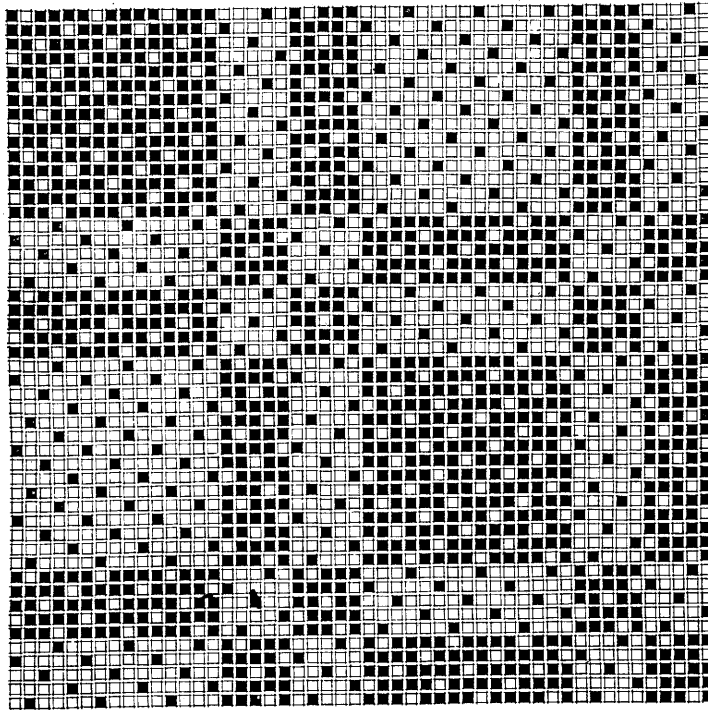


FIG. 130.

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.

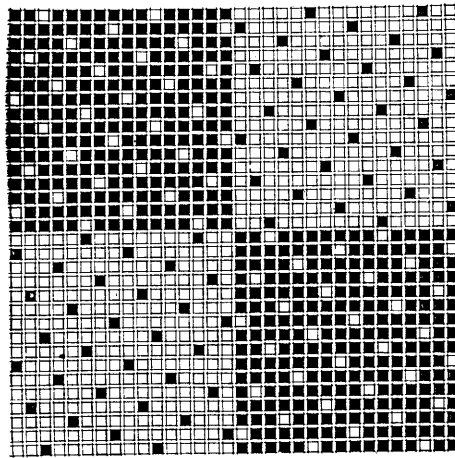


FIG. 131.

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*.

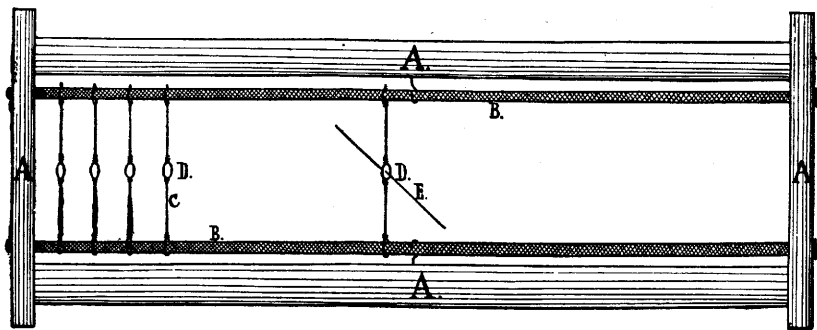


FIG. 132.

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).

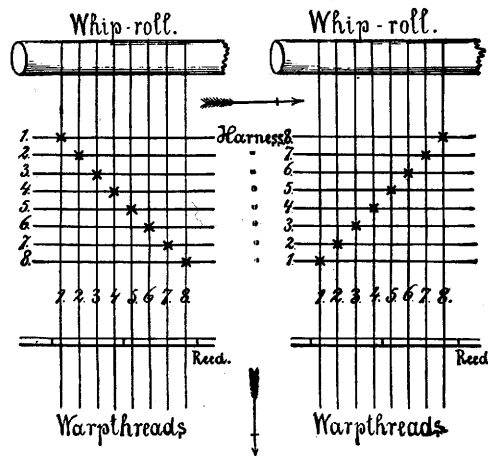


FIG. 133.

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 or the other of the following methods:

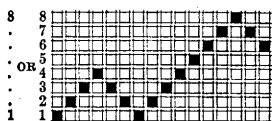


FIG. 135.

*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

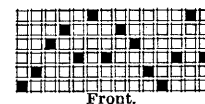


FIG. 136.

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).

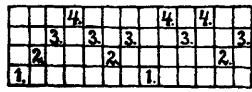


FIG. 137.

*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.



FIG. 139.

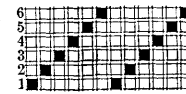


FIG. 140.

*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. Forexample: 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).

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.

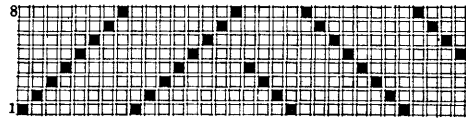


FIG. 141.

Fig. 142 illustrates a broken draw for 4-harness.

" 143 " " " " 5 "  
 " 144 " " " " 8 "

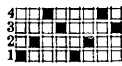


FIG. 142.

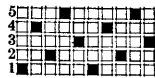


FIG. 143.

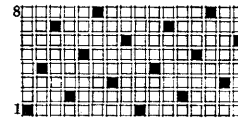


FIG. 144.

**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.

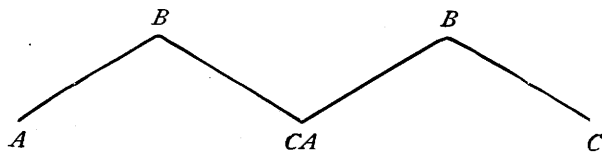
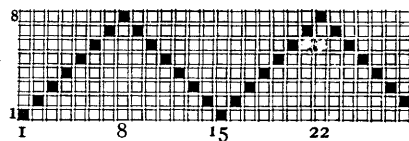


FIG. 145.

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.



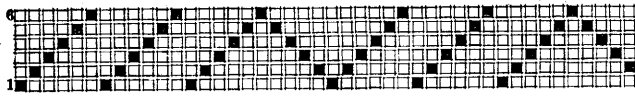


FIG. 147.

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.

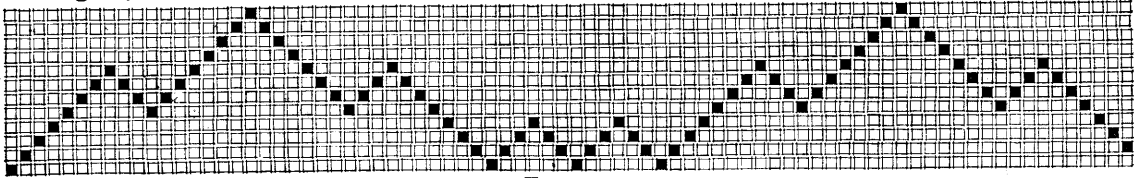


FIG. 148.

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

**1ST.—PLAIN DRAW.**

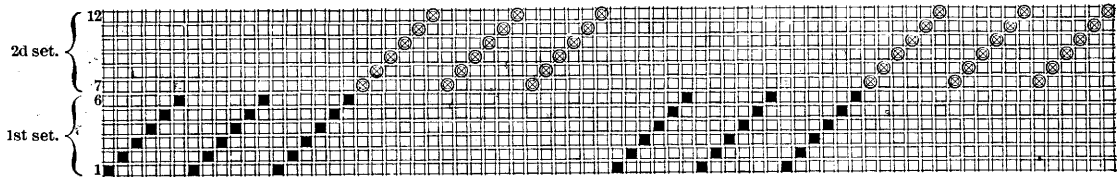


FIG. 149.

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.

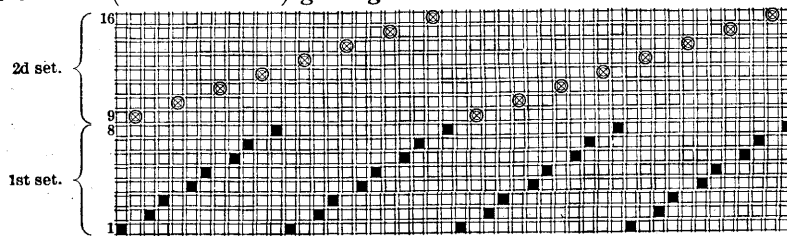


FIG. 150.

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.

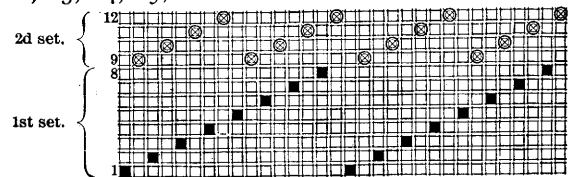


FIG. 151.

**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.

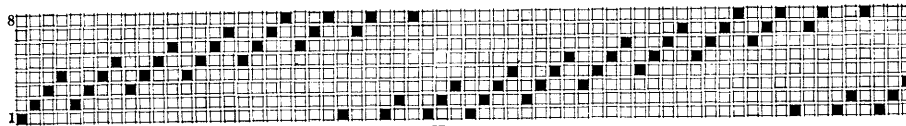


FIG. 152.

**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.)

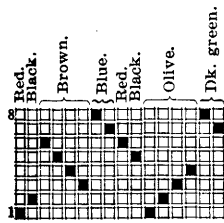


FIG. 153.

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  $13 \times 4 = 69\frac{1}{4}$  inches width of warp, in reed.

Dressing: 6 threads black 4 run.  
 D. N. 4. 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.

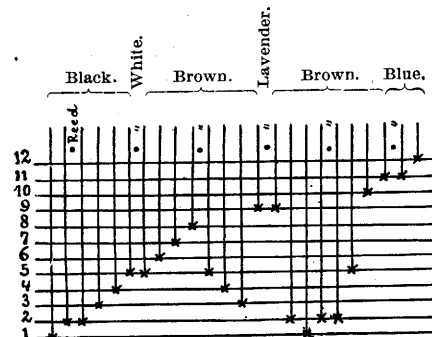


FIG. 154.

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
	<hr style="width: 50px; margin-left: auto; margin-right: 0;"/>	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.

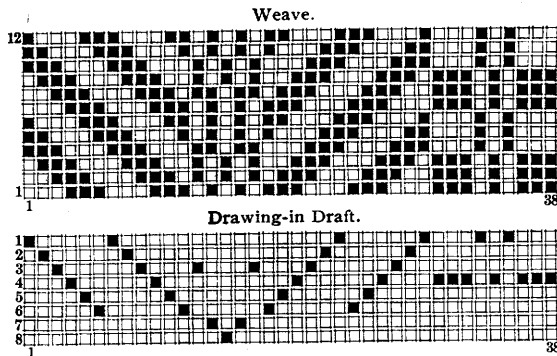


FIG. 157.

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):								$\frac{3}{3} \frac{3}{3}$
The 2d	"	"	"	"	"	"	"	$\frac{1}{3} \frac{3}{3} \frac{2}{3}$
The 3d	"	"	"	"	"	"	"	$\frac{2}{3} \frac{3}{3} \frac{1}{3}$
The 4th	"	"	"	"	"	"	"	$\frac{3}{3} \frac{3}{3}$
The 5th	"	"	"	"	"	"	"	$\frac{1}{3} \frac{3}{3} \frac{2}{3}$
The 6th	"	"	"	"	"	"	"	$\frac{2}{3} \frac{3}{3} \frac{1}{3}$
The 7th	"	"	"	"	"	"	"	$\frac{2}{2} \frac{5}{5} \frac{1}{1}$
The 8th	"	"	"	"	"	"	"	$\frac{2}{2} \frac{2}{2}$

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

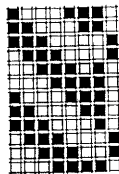


FIG. 158.

**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:*  $4800 \div 8 = 600$ ; 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:*  $4800 \div 9 = 533$  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.

$3200 \div 32 = 100$  repeats of pattern in warp.

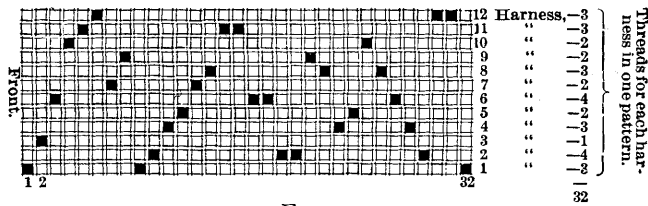


FIG. 159.

No. of Harness.	Threads per Pattern.	X 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
	<u>32</u>		<u>3200</u>

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  $2\frac{1}{2}$  to 3 inches height.

Cotton fabrics "  $2\frac{1}{2}$  to  $3\frac{1}{4}$  " "

Woolen fabrics " 4 to  $4\frac{1}{2}$  " "

Carpets "  $4\frac{1}{2}$  to 5 " "

It is advisable to have the height of a reed  $\frac{1}{4}$  to  $\frac{3}{8}$  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  $16\frac{1}{2}$  reed, we want a reed having  $16\frac{1}{2}$  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.

$$\begin{array}{r} \times 70 \text{ width of warp in reed} \\ \hline 2520 \text{ ends in warp.} \end{array}$$

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  $13\frac{1}{2}$  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  $12 \times 3 = 3600$  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.

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.

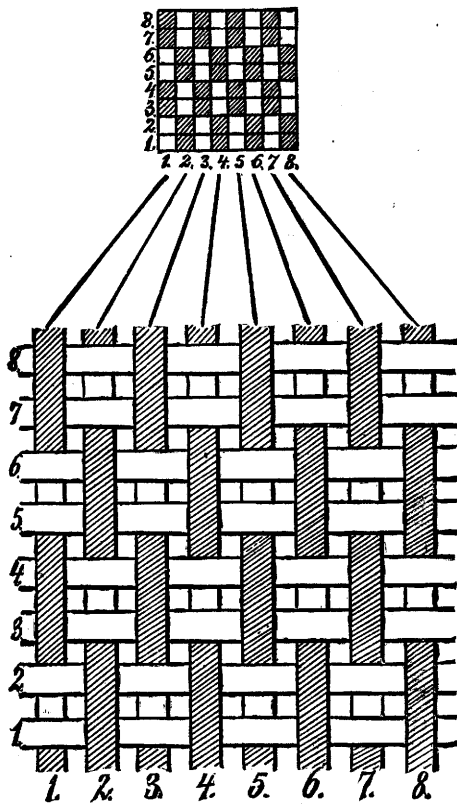


FIG. 161.

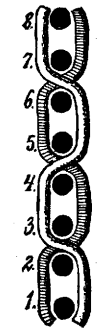


FIG. 162.

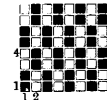


FIG. 160.

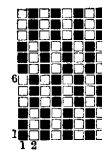


FIG. 163.

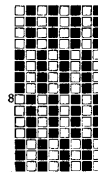


FIG. 164.

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.



*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.

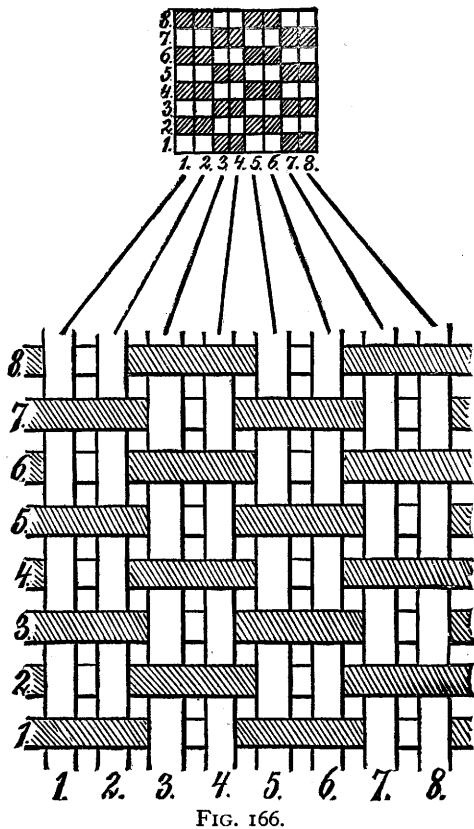


FIG. 166.

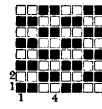


FIG. 165.

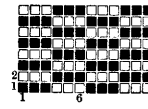


FIG. 167.

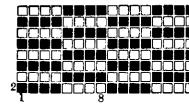


FIG. 168.

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

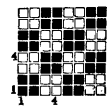


FIG. 169.

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.

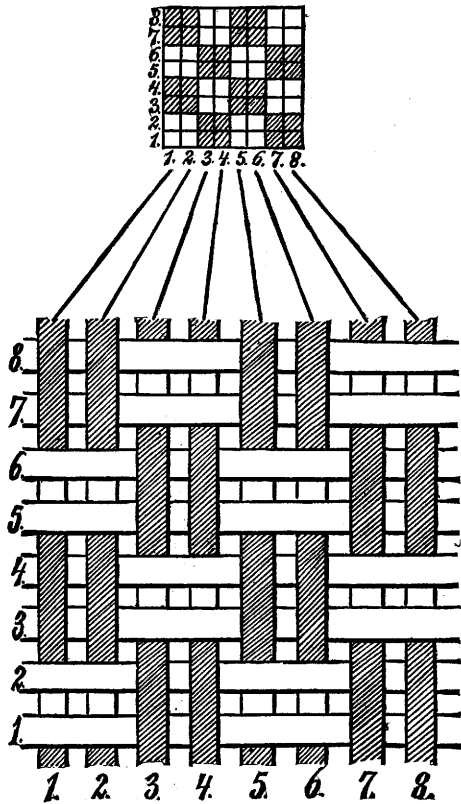


FIG. 170.

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.

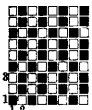


FIG. 174.

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

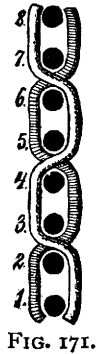


FIG. 171.

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-har-

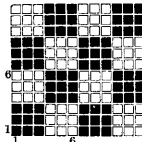


FIG. 172.

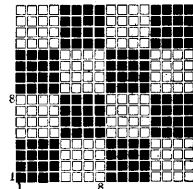


FIG. 173.

ness basket-weave, having three successive warp and filling-threads working the same, and forming also a combination of weaves, Figs. 163 and 167.

Fig 173 represents the common 8-harness basket-weave, with four successive warp-

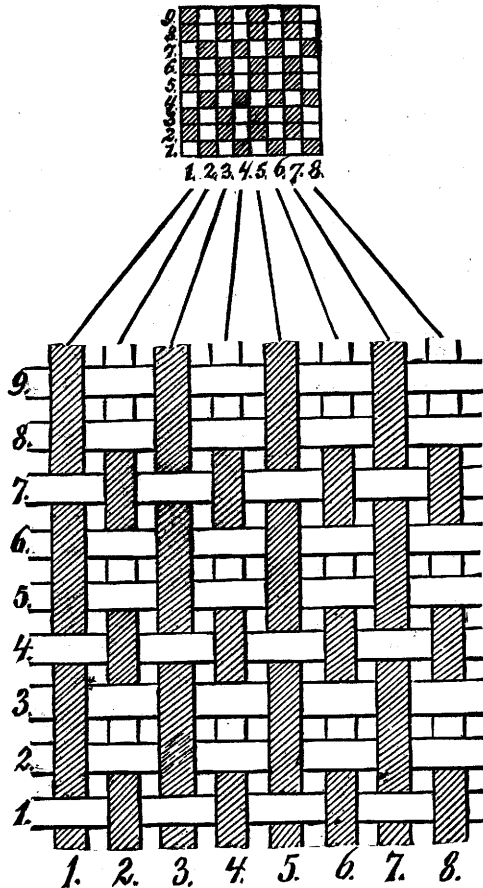


FIG. 175.

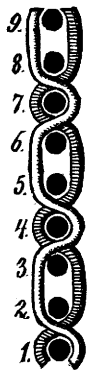


FIG. 176.

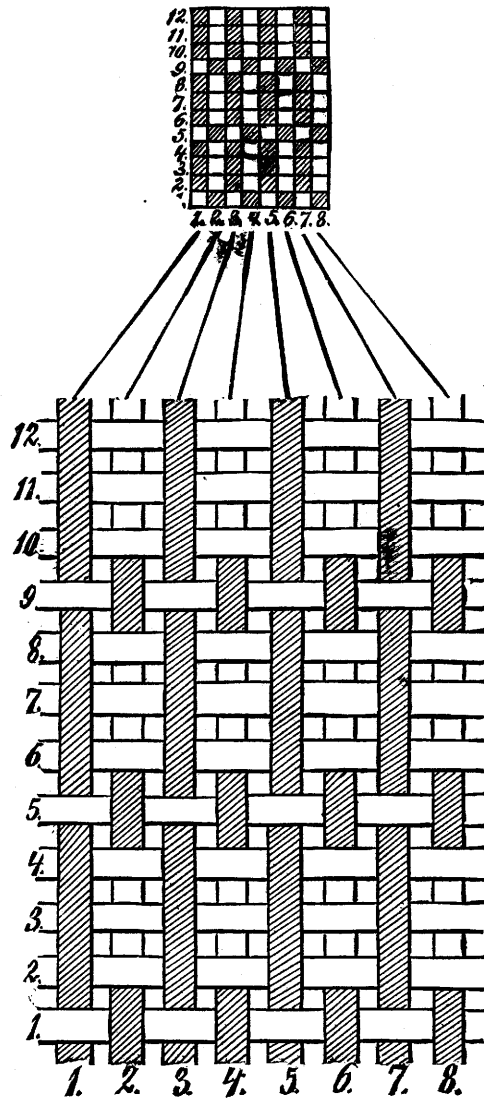


FIG. 178.

or two changes of the plain weave and

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.

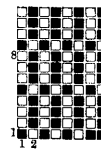


FIG. 177.



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 one change of three picks in the same shed.

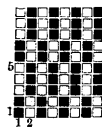


FIG. 180.

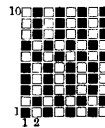


FIG. 181.

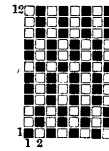


FIG. 182.

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.

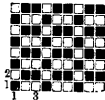


FIG. 183.

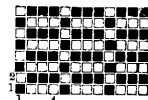


FIG. 184.

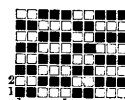


FIG. 185.

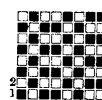


FIG. 186.

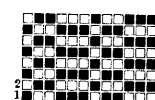


FIG. 187.

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.

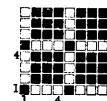


FIG. 189.

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

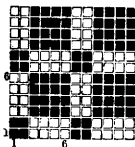


FIG. 190.

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

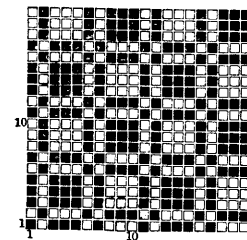


FIG. 191.

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 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.

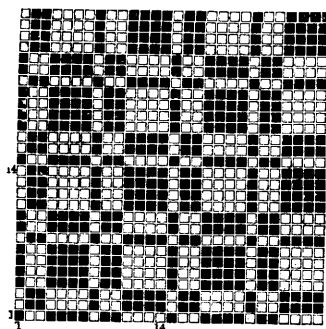


FIG. 192.

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.

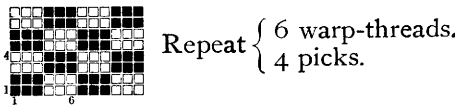


FIG. 193.

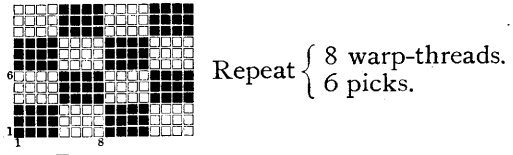


FIG. 194.

### 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,  $2 \text{---} 2$ . 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,  $\times$  number of changes, = warp-threads required for full design.  $6 \times 4 = 24$ .

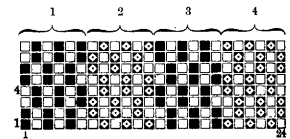


FIG. 195.

Fig. 196 contains for its principle of construction the common rib-weave, Fig. 163,  $3 \text{---} 3$ . 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,  $4 \text{---} 4$ . 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.

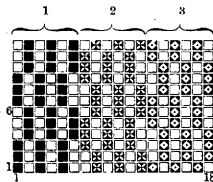


FIG. 196.

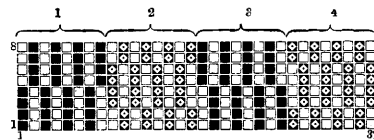


FIG. 197.

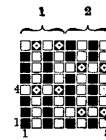


FIG. 198.

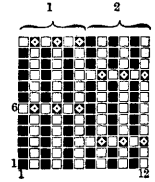


FIG. 199.

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

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

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

Fig. 201 is constructed out of the regular fancy rib-weave,  $6 \text{---} 2$ , 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,  $\frac{3}{3}-1$ . Repeat: 4 warp-threads and 8 picks.

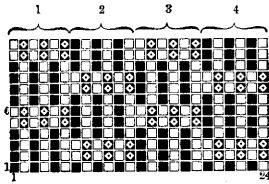


FIG. 200.

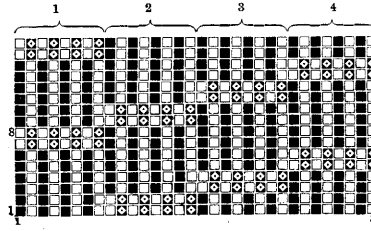


FIG. 201.

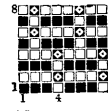


FIG. 202.

Fig. 203 is constructed out of the regular fancy rib-weave,  $\frac{4}{4}-2$ . 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,  $\frac{4}{4}-4$ , warp effect, with the common rib-weave,  $\frac{4}{4}-4$ , 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.

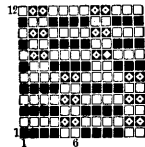


FIG. 203.

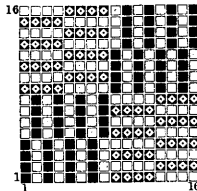


FIG. 204.

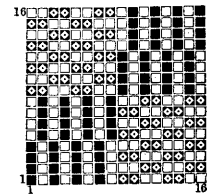


FIG. 205.

Fig. 205 illustrates the combination of the common rib-weave  $\frac{4}{4}-4$ , warp effect with the common rib-weave  $\frac{2}{2}-2$ , 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  $\begin{pmatrix} \blacksquare & \blacksquare \\ \blacksquare & \blacksquare \end{pmatrix}$ .

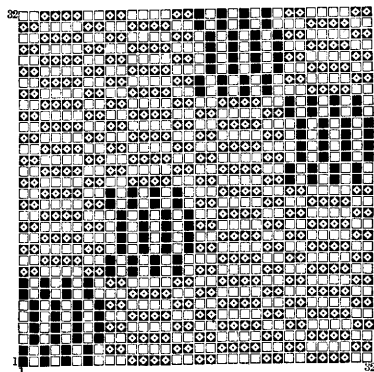


FIG. 206.

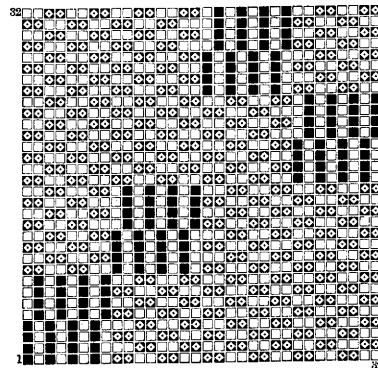


FIG. 207.

For warp and filling face the same fancy rib-weave ( $\frac{2}{4}-2$ ) 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.

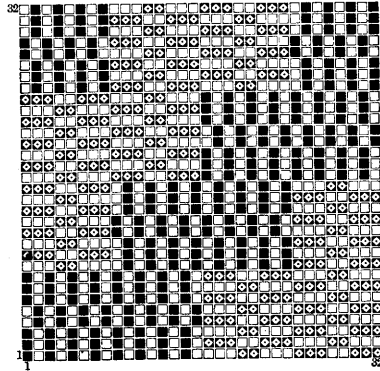


FIG. 208.

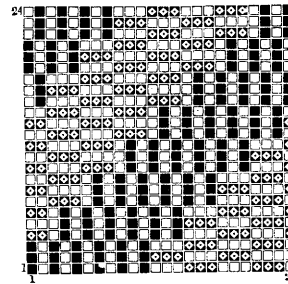


FIG. 209.


Fig. 208 illustrates a figured rib-weave having warp and filling changes equal ( $\frac{3}{2} \text{---} 3$ ), 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 ( $\frac{3}{3} \text{---} 3$ ), 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.

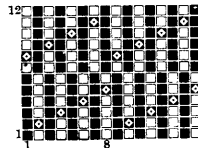


FIG. 210.

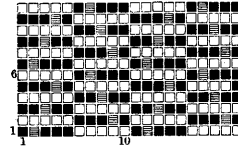


FIG. 211.

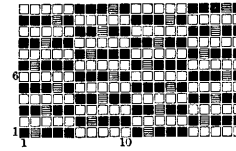


FIG. 212.

Fig. 210 illustrates the common  $\frac{6}{6} \text{---} 6$  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  $\frac{5}{5} \text{---} 5$  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)  $\frac{2}{2}$ .

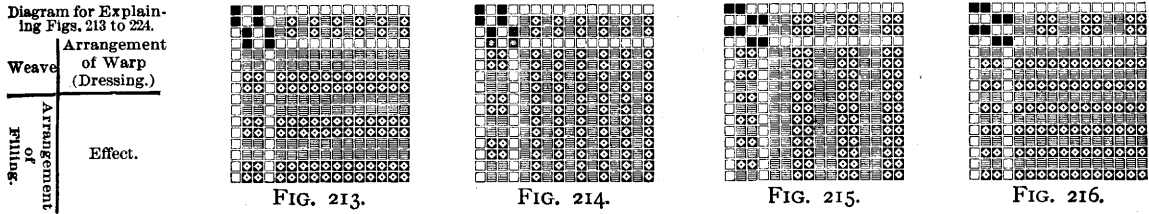


Fig. 214 illustrates the same weave and the same arrangement of the warp as Fig. 213. The arrangement of the filling is also, 2 picks dark, 2 picks light, as used in Fig. 213, but is started on the opposite shed. In Fig. 213 the light filling covers the dark warp and the dark filling covers the light 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  $\frac{2}{2}$ . 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.

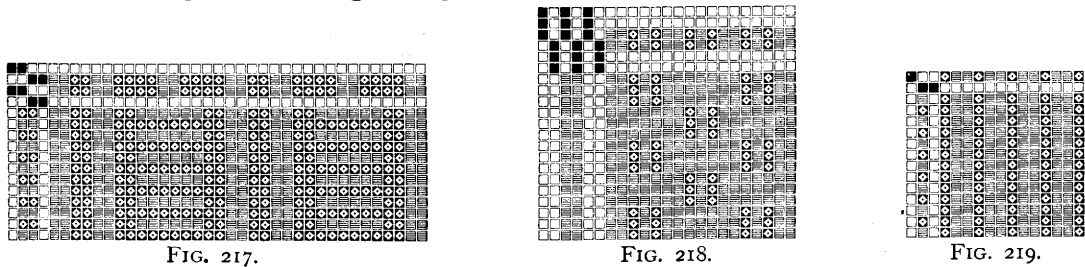


Fig. 217 illustrates an effect obtained by combining effects Figs. 215 and 216. Arrangement of the warp:

- 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)  $\frac{3}{3}$ , 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  $\frac{1}{1}-2$  (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  $\frac{1}{1}-3$ . 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.

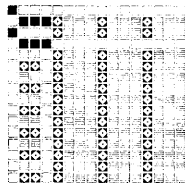


FIG. 220.

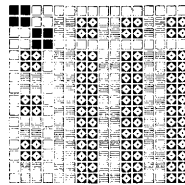


FIG. 221.

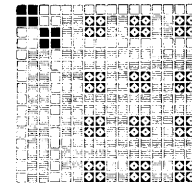


FIG. 222.

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.

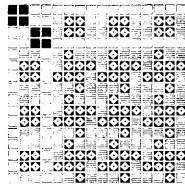


FIG. 223.

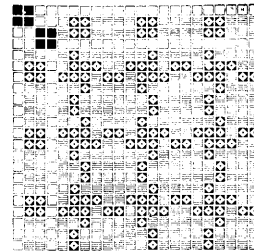


FIG. 224.

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

- 2 ends dark, } 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  $\square a, b, c, d$  to form the repeat for the weave, warp

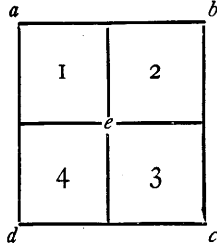


FIG. 225.

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

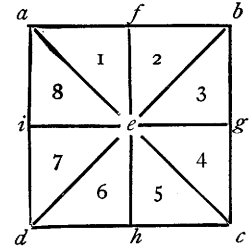


FIG. 226.

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. 227.

Repeat { 6 warp-threads.  
6 picks.

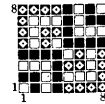


FIG. 228.

Repeat { 8 warp-threads.  
8 picks.

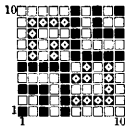


FIG. 229.

Repeat { 10 warp-threads.  
10 picks.

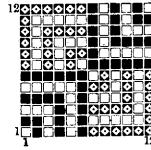


FIG. 230.

Repeat { 12 warp-threads.  
12 picks.



FIG. 231.

Repeat { 6 warp-threads.  
6 picks.

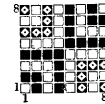


FIG. 232.

Repeat { 8 warp-threads.  
8 picks.

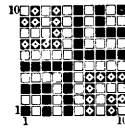


FIG. 233.

Repeat { 10 warp-threads.  
10 picks.

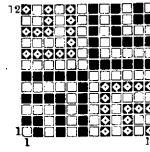


FIG. 234.

Repeat { 12 warp-threads.  
12 picks.

### Combining Common Rib and Oblique Rib-Weaves.

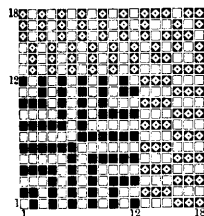


FIG. 235.

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  $1\text{---}3$  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.

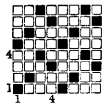


FIG. 236.

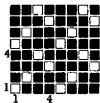


FIG. 237.



FIG. 238.

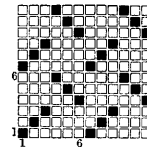


FIG. 239.

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

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

Fig. 238 illustrates the 4-harness  $1\text{---}3$  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  $1\text{---}5$  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.

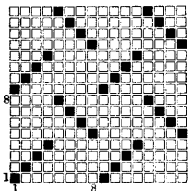


FIG. 240.

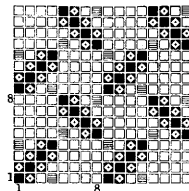


FIG. 241.

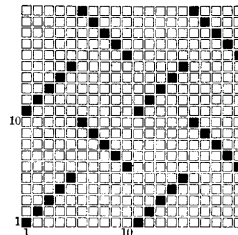


FIG. 242.

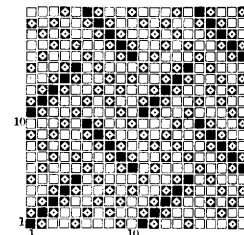


FIG. 243.

Fig. 240 illustrates the  $1\text{---}7$  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  $1\text{---}9$  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  $\frac{2}{2}$  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.

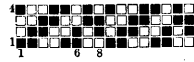


FIG. 244.

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 ( $\frac{2}{2}$  regular twill) for the harness-chain.

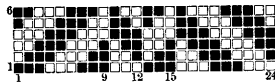


FIG. 245.

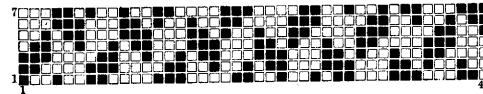


FIG. 246.

Fig. 245 shows the 6-harness  $\frac{3}{3}$  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.	
<hr/>					
24	"		in full repeat.		

Drawing-in draft will call for 6-harness ; and for harness-chain the foundation twill  $\frac{3}{3}$  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  $\frac{3}{4}$  twill.

Fig. 247 represents 5 warp-threads of the  $\frac{3}{1} \frac{3}{3} \frac{1}{3}$  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  $27^\circ$ — $63^\circ$ — $70^\circ$ , 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  $63^\circ$  steep-twill  $\frac{5}{2} \frac{1}{2}$  in a direction from left to right, and 12 additional threads of the same weave having its direction of twill from right to left.

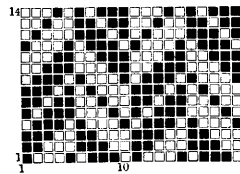


FIG. 247.

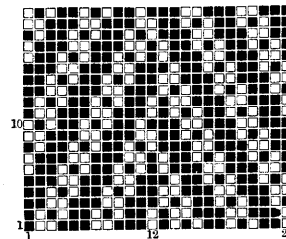


FIG. 248.

The arrangement of a steep-twill containing  $70^\circ$ ,  $63^\circ$ ,  $45^\circ$ ,  $36^\circ$  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  $\frac{4}{1} \frac{1}{4} \frac{1}{1}$  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  $\frac{4}{4}$  twill broken filling ways after every four successive picks. Repeat: 8 warp-threads and 8 picks.

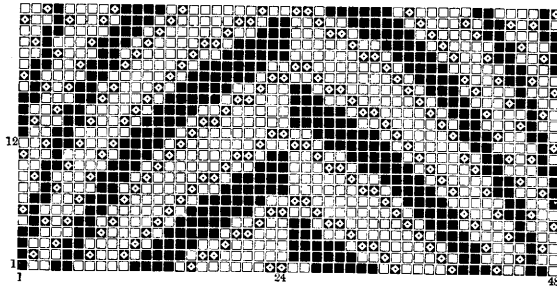


FIG. 249.

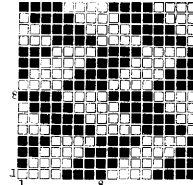


FIG. 250.

Fig. 251 shows the  $\frac{2}{1}$  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.

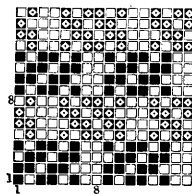


FIG. 251.

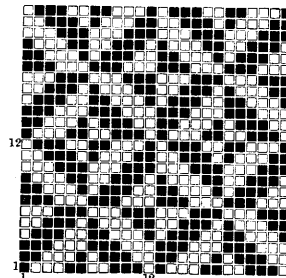


FIG. 252.

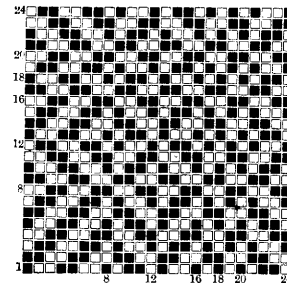


FIG. 253.

Fig. 252 is obtained from the  $\frac{3}{3}$  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  $\frac{2}{2}$  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.

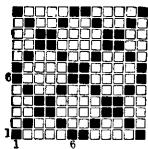


FIG. 254.

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  $\frac{3}{3}$  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.

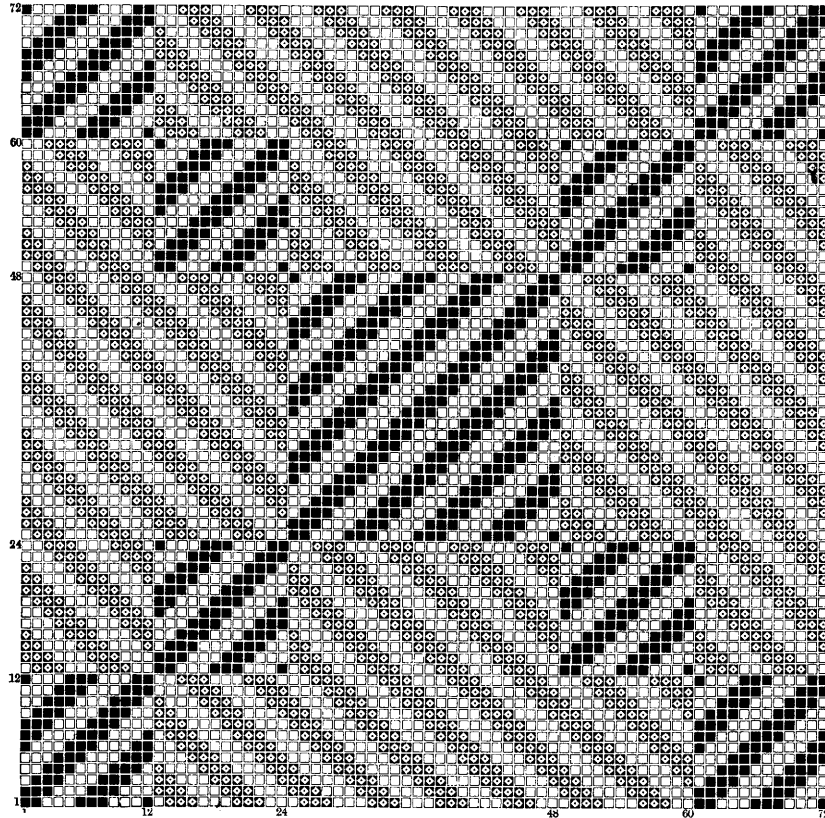


FIG. 255.

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-

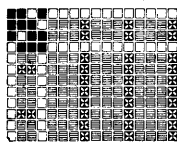


FIG. 256.

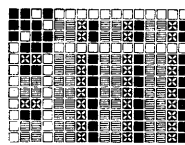


FIG. 257.

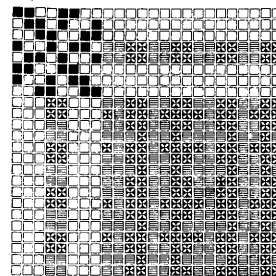


FIG. 258.

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.

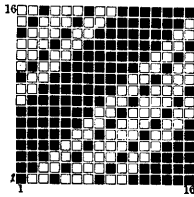


FIG. 259.

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.

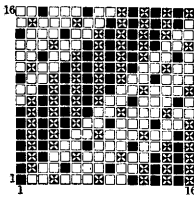


FIG. 260.

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

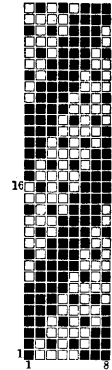


FIG. 261.

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.

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

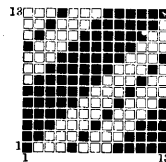


FIG. 262.

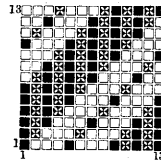


FIG. 263.

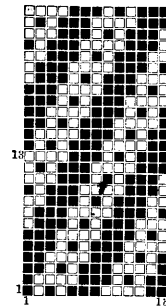
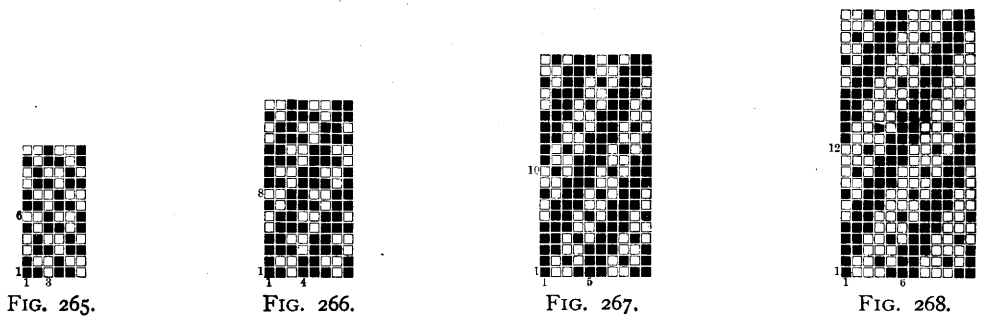


FIG. 264.

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.



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

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

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

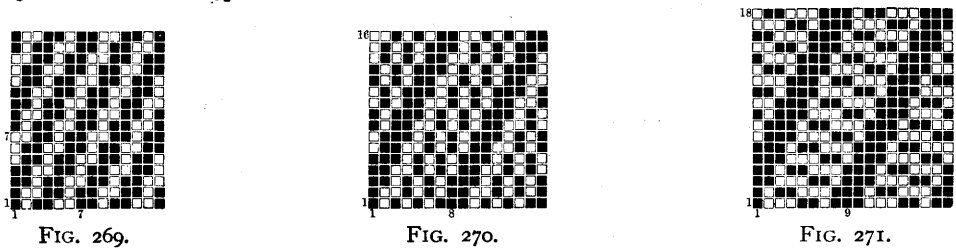


Fig. 266 represents the 4-harness steep-twill ( $63^\circ$ ) derived from the regular 8-harness twill  $\frac{4}{2} \frac{1}{1}$ . Repeat: 4 harness and 8 picks.

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

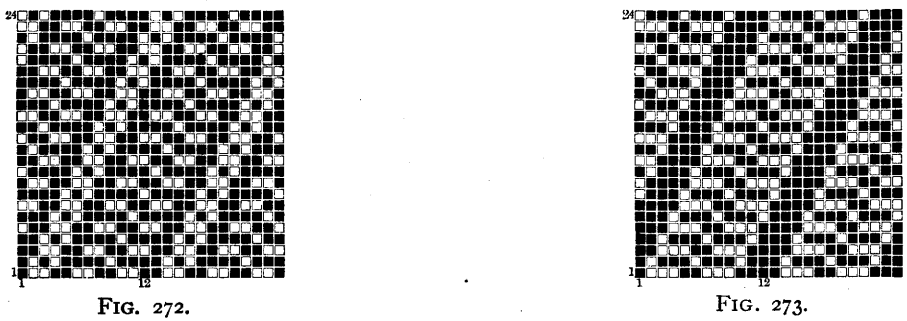


Fig. 268 represents the 6-harness steep-twill ( $63^\circ$ ) derived from the regular 12-harness twill,  $\frac{5}{2} \frac{1}{4}$ . Repeat: 6 harness and 12 picks.

Fig. 269 illustrates the 7-harness steep-twill ( $63^\circ$ ) derived from the regular 7-harness twill,  $\frac{4}{1} \frac{1}{3}$ . Repeat: 7 harness and 7 picks.



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

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

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

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

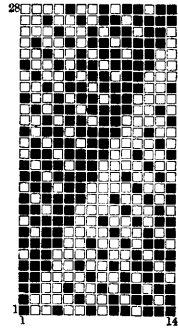


FIG. 274.

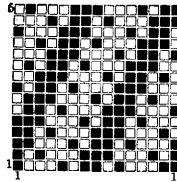


FIG. 275.

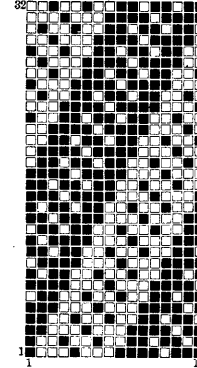


FIG. 276.

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

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

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

*2d. Steep-Twills having a grading of  $70^\circ$ .*

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  $\frac{4}{1} \frac{1}{2}$  8-harness twill; *B* illustrates the drafting of the different warp-threads according to previously given explanation for forming *C*, the new design.

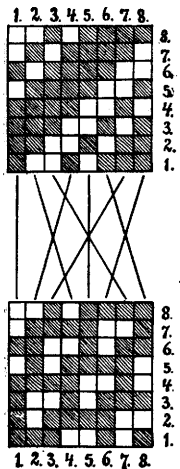


FIG. 277.

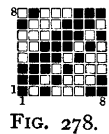


FIG. 278.

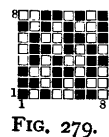


FIG. 279.

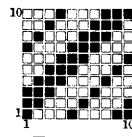


FIG. 280.

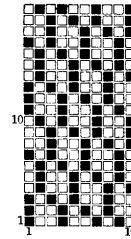


FIG. 281.

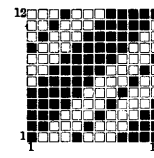


FIG. 282.

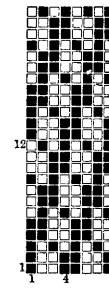


FIG. 283.

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

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

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

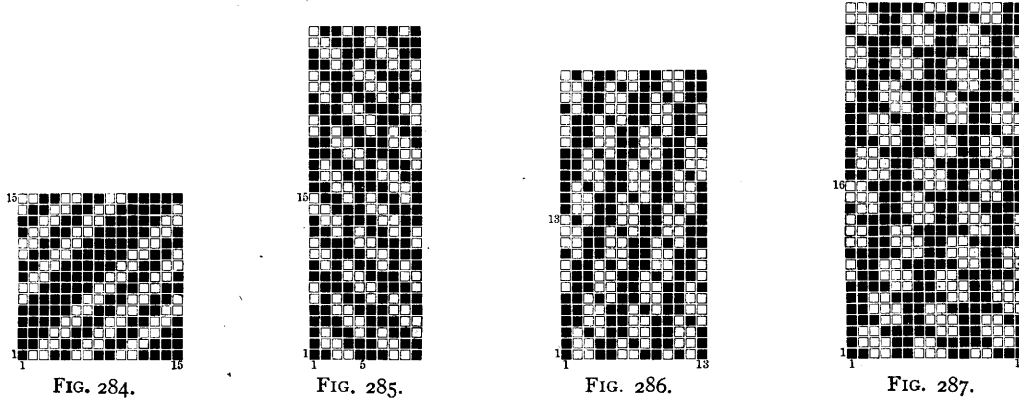
Fig. 280 the regular twill  $\frac{3}{3} \frac{1}{3}$  is shown, arranged for a  $70^\circ$  steep-twill in Fig. 281. Repeat: 10 harness, 10 picks.

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.



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.

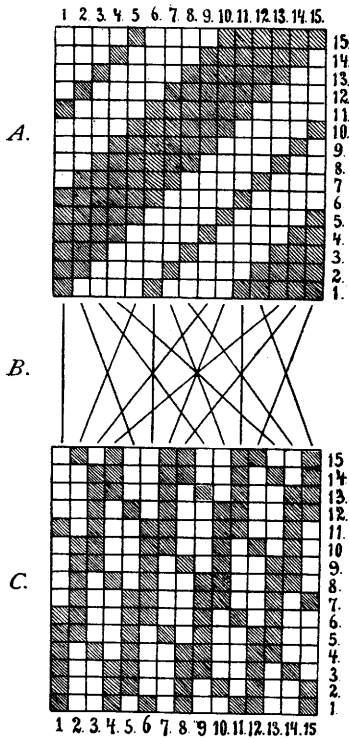


FIG. 288.

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.

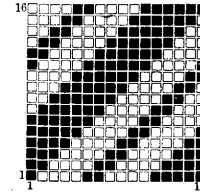


FIG. 289.

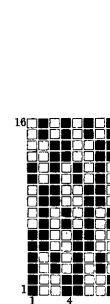


FIG. 290.

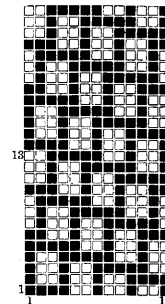


FIG. 291.

### 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.

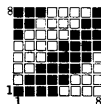


FIG. 292.

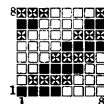


FIG. 293.

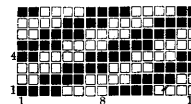


FIG. 294.

Fig. 292 represents the regular 8-harness twill  $\frac{4}{4}$ . 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  $\frac{4}{2} \frac{1}{2} = 9$ -harness. Fig. 296 is its analysis. Fig. 297 is the reclining twill derived from the latter. Repeat: 9-harness and 9 picks.

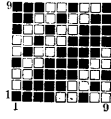


FIG. 295.

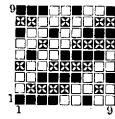


FIG. 296.

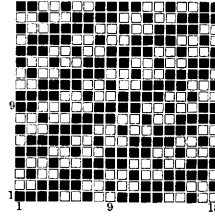


FIG. 297.

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.

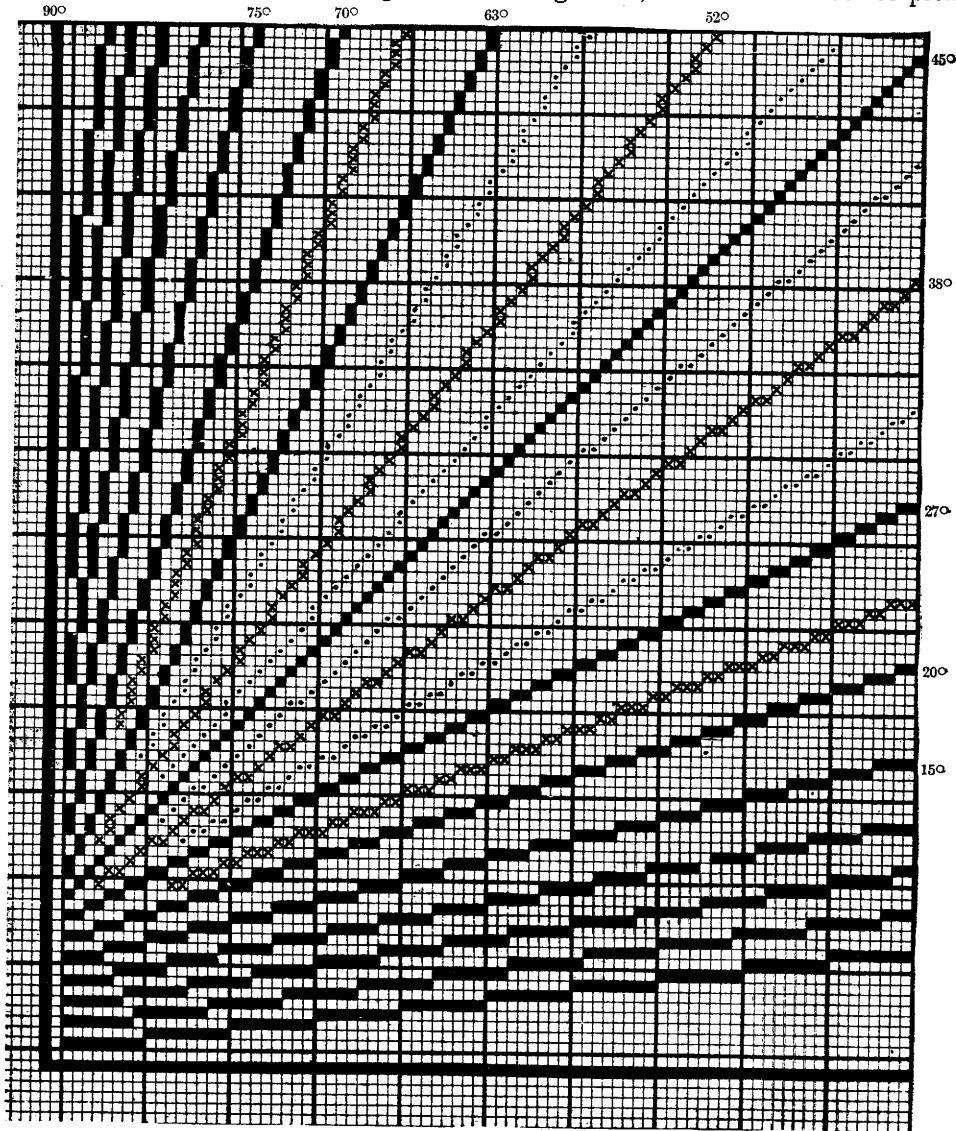


Diagram for illustrating the construction of steep twills of 52°, 63°, 70° and 75° grading, and reclining twills of 38°, 27°, 20°, and 15° grading.

IV. Curved Twills.

This sub-division of the "twills" is derived by a combination of "regular"  $45^\circ$  twills with  $63^\circ$ ,  $70^\circ$  or  $75^\circ$ , 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

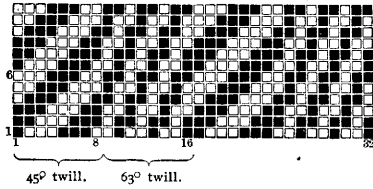


FIG. 298.

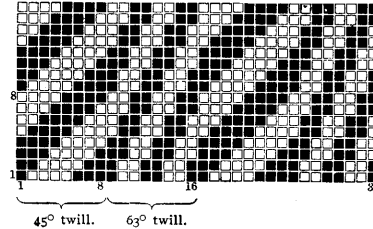


FIG. 299.

system. The same twill which is used in  $45^\circ$  must also be used in the construction of the steeper twills.

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

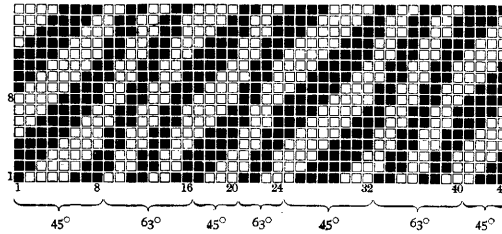


FIG. 300.

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

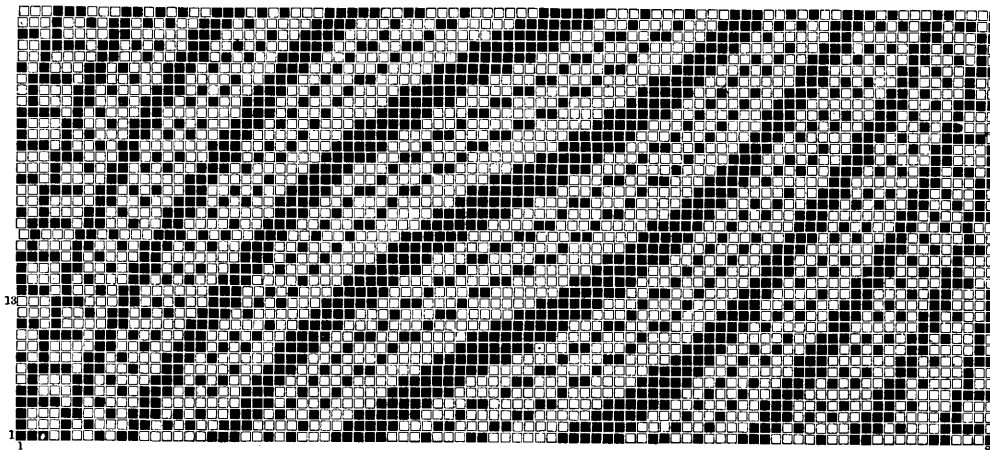


FIG. 301.

Fig. 299 illustrates the curved twill obtained from the  $\frac{4}{4}$  twill. 8 warp-threads are designed in the regular  $45^\circ$  twill and 8 warp-threads in its  $63^\circ$  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.

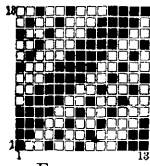


FIG. 302.

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.

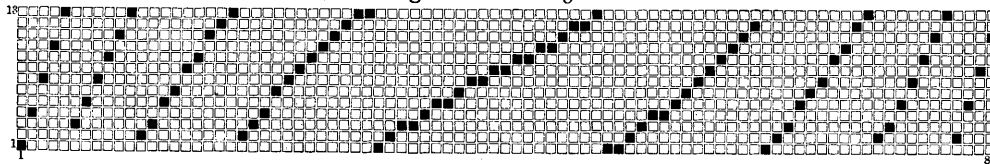


FIG. 303.

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.

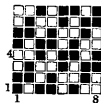


FIG. 306.



FIG. 307.

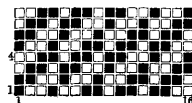


FIG. 308.



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  $\frac{3}{3}$  twill.

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

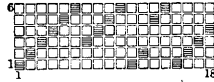


FIG. 310.

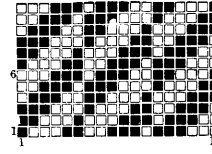


FIG. 311.

Fig. 313 shows another variation of the skip-twill, derived from the common twill  $\frac{3}{3}$  (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.

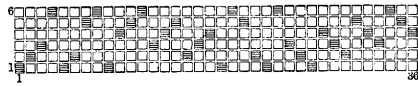


FIG. 312.

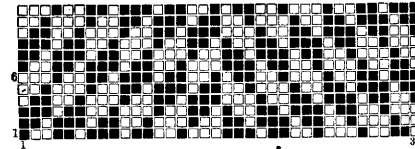


FIG. 313.

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  $\frac{3}{4}$  (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.

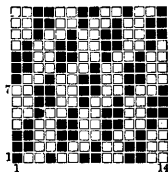


FIG. 314.

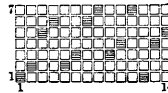


FIG. 315.

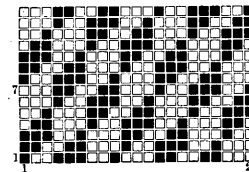


FIG. 316.

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.

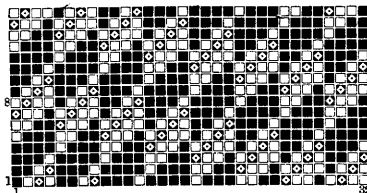


FIG. 317.

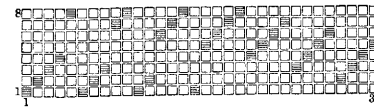


FIG. 318.

Fig. 317 represents a skip-twill derived from the 8-harness  $\frac{4}{2} \frac{1}{1}$  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.

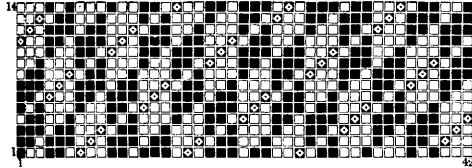


FIG. 319.

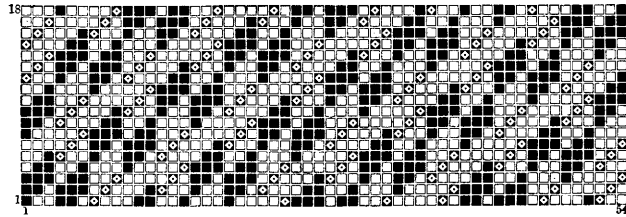


FIG. 320.

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.

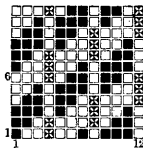


FIG. 321.

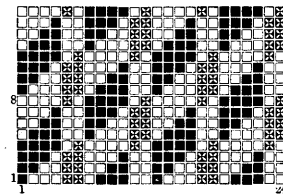


FIG. 322.

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  $2\text{---}2$  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  $3\text{---}2\text{---}1\text{---}2$ , as follows: Take three, miss four, eight times over.

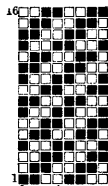


FIG. 323.

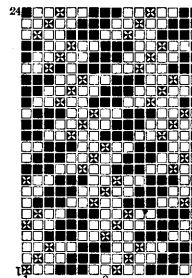


FIG. 324.

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)  $\times$  4 (picks in rotation) = 16 picks in one repeat.  
 “ 324—8 “ “  $\times$  3 “ “ = 24 “ “ “

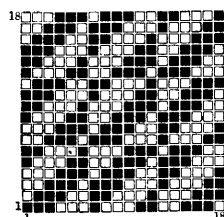


FIG. 325.

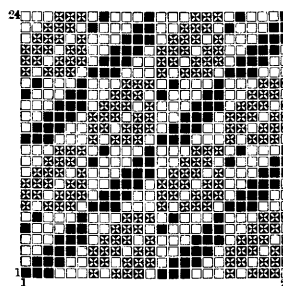


FIG. 326.

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  $3\text{---}3$  regular twill. Take six, miss two, three times over in one repeat for warp and filling directions.

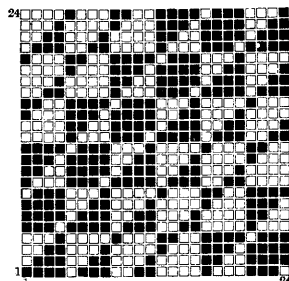


FIG. 327.

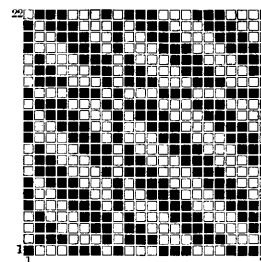


FIG. 328.

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.

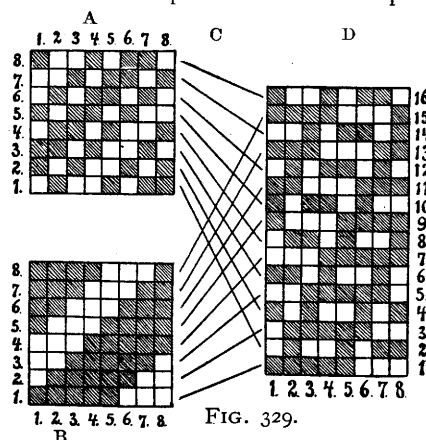
In Fig. 326 6 threads in rotation, warp and filling ways, are used before skipping. In Fig. 327 4 threads in rotation, warp and filling ways, are used before skipping 3 threads.

Fig. 328—repeat: 22 warp-threads, 22 picks—is designed to illustrate skip-effects irregularly arranged, and is derived from the common  $\frac{2}{3}$ — $\frac{1}{3}$  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

A represents the regular 8-harness twill  $\frac{1}{1} \frac{1}{2} \frac{1}{1} \frac{2}{3}$ .  
 B “ “ “ “  $\frac{1}{5} \frac{1}{3}$ .  
 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.

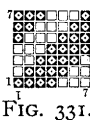


FIG. 331.

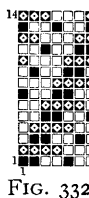


FIG. 332.



FIG. 333.

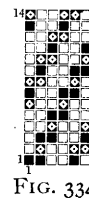


FIG. 334.

Fig. 330 illustrates the regular (45°) 7-harness twill  $\frac{2}{2} \frac{1}{2}$ .  
 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.

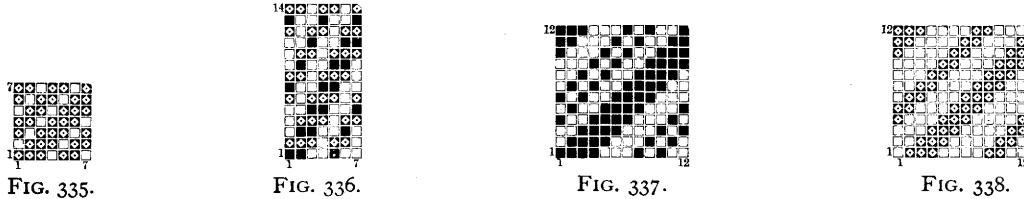


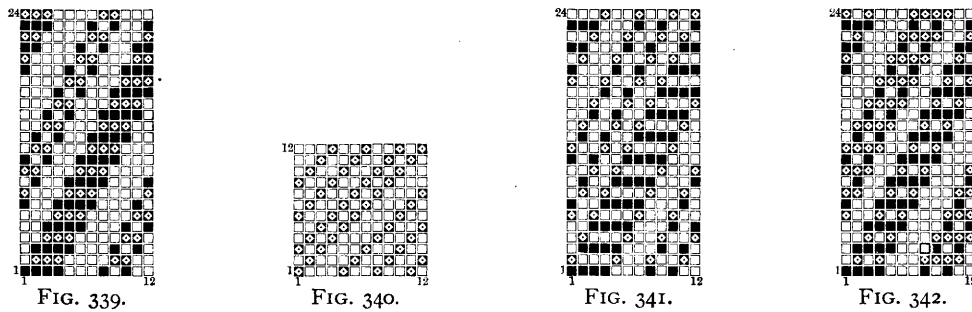
Fig. 330 is shown combined again with a different weave, Fig. 335, in the 7-harness and 14-picks combination twill-weave, Fig. 336.

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.



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

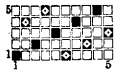


FIG. 344.

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

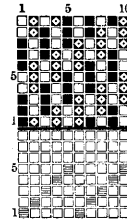


FIG. 345.

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

FIG. 346.

a number will allow an equal breaking off for the two twill-effects as visible on the face of the fabric.



FIG. 347.

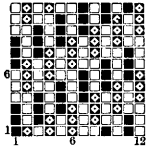


FIG. 348.



FIG. 349.

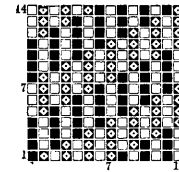


FIG. 350.

Fig. 347 shows the regular 6-harness  $\frac{3}{2}$  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.

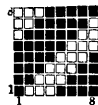


FIG. 351.

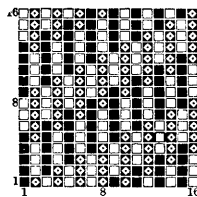


FIG. 352.

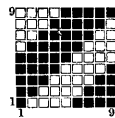


FIG. 353.

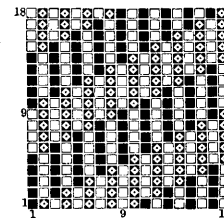


FIG. 354.

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

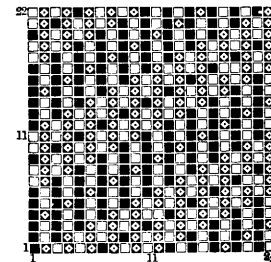


FIG. 355.

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

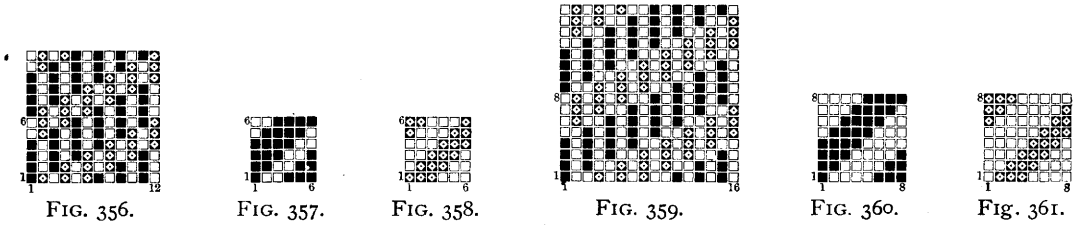
Thus the actual foundation for the present weave is the regular 11-harness  $\frac{6}{2} \frac{1}{2}$  twill.

*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  $\frac{4}{2}$  (see Fig. 357) and the 6-harness twill  $\frac{3}{3}$  (see Fig. 358).

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

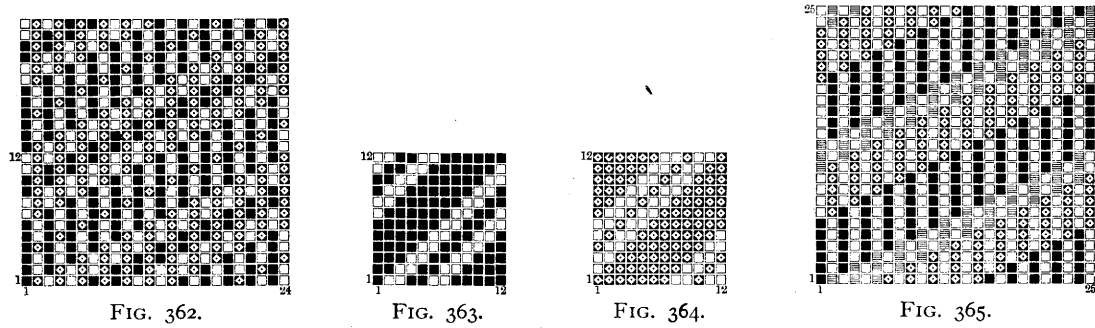
Repeat: 12 harness and 6 picks.



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.



In Fig. 359 we illustrate a 16-harness corkscrew, composed out of the regular twill  $\frac{4}{4}$  (Fig. 360) and  $\frac{3}{5}$  (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  $\frac{6}{2} \frac{2}{2}$ , shown in Fig. 363, and  $\frac{7}{2} \frac{1}{2}$ , 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  $\frac{6}{3}$  and  $\frac{7}{5}$ , 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.

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 } from common corkscrew.
- 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: ■■.

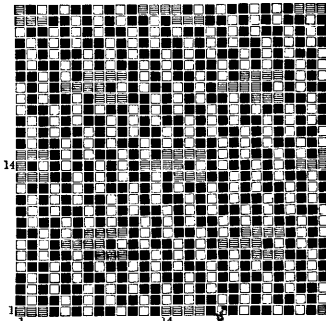


FIG. 366.

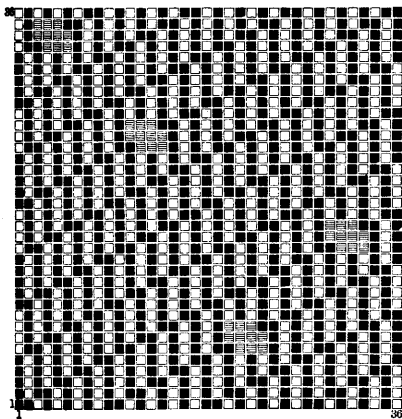


FIG. 367.

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  $\begin{matrix} \blacksquare & \square & \square \\ \square & \blacksquare & \square \\ \square & \square & \blacksquare \end{matrix}$

- for raisers } from common corkscrew.
- for sinkers } from common corkscrew.

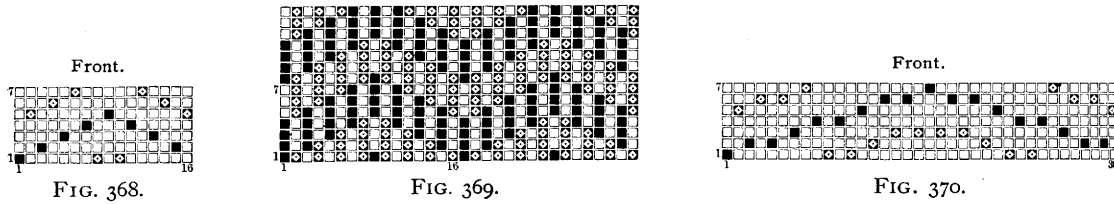
■ for sinkers for floating the filling upon the face of the fabric.

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.



For example: Take the 7-harness regular twill  $\frac{4}{3}$ , 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 ( $\frac{4}{3}$ ) 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  $\frac{4}{3}$  for harness chain.

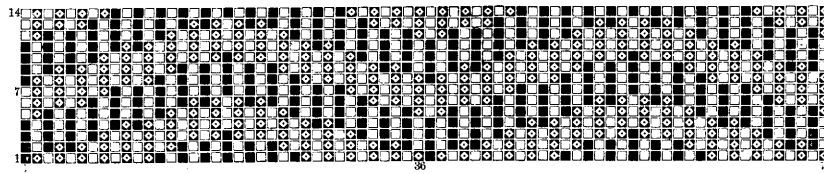


FIG. 371.

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

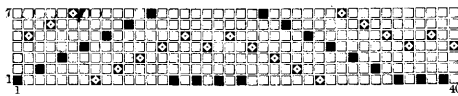


FIG. 372.

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. 371 illustrates the curved corkscrew as derived from the "regular"  $\frac{4}{3}$  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  $\frac{4}{3}$  twill.

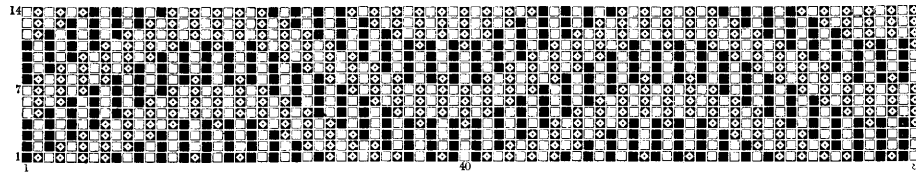


FIG. 373.

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.

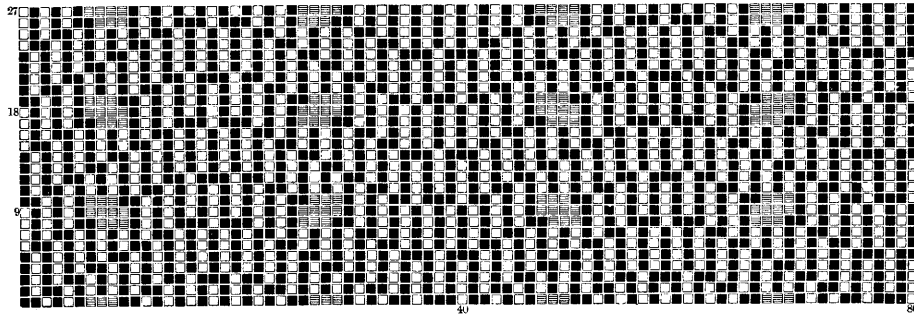


FIG. 374.

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

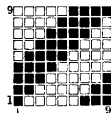


FIG. 375.

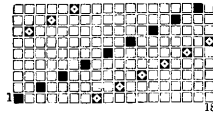


FIG. 376.

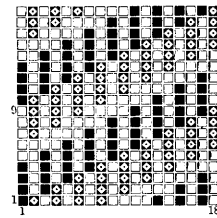


FIG. 377.

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.

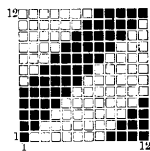


FIG. 378.

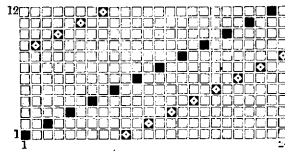


FIG. 379.

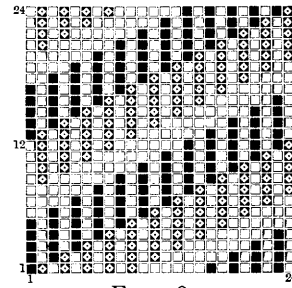


FIG. 380.

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  $\frac{4}{3}$  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,

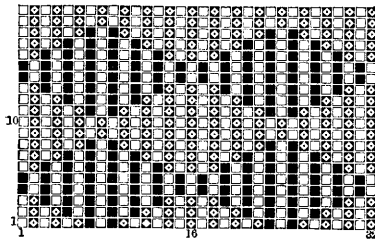


FIG. 381.

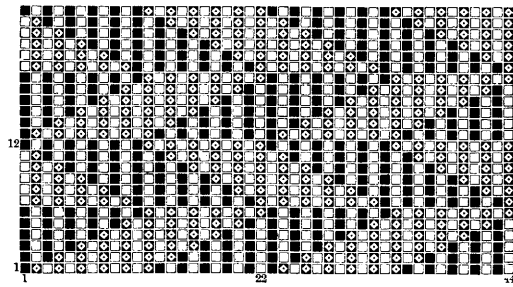


FIG. 382.

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.

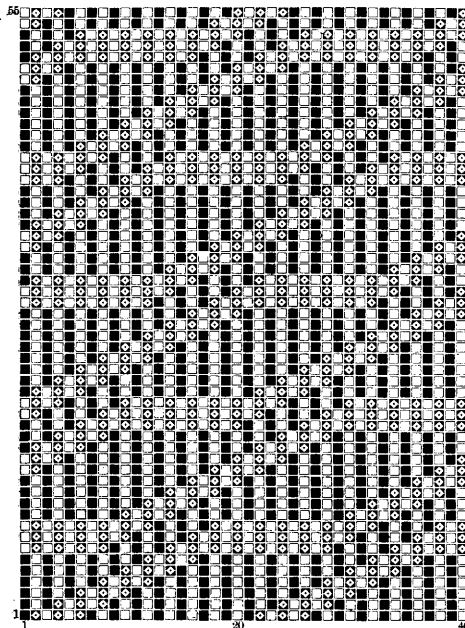


FIG. 383.

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 filling*; 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.

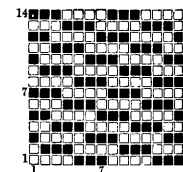


FIG. 384.

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  $\frac{2}{2}$  twill, and has two parallel lines of twills.

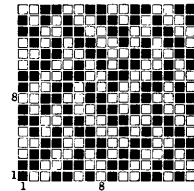


FIG. 385.

RULE FOR FINDING THE NUMBER OF HARNESS REQUIRED FOR ENTWING 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  $\times$  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  $\frac{2}{2}$  twill, using 3 pieces of twills = 12-harness;

$$4 \text{ " " } = 16\text{-harness;}$$

$$5 \text{ " " } = 20\text{-harness, etc., etc.}$$

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  $\frac{3}{3}$  twill and four pieces of twills. Thus  $6 \times 4 = 24$  warp-threads and picks for repeat.

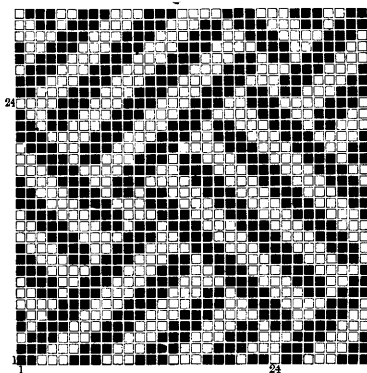


FIG. 386.

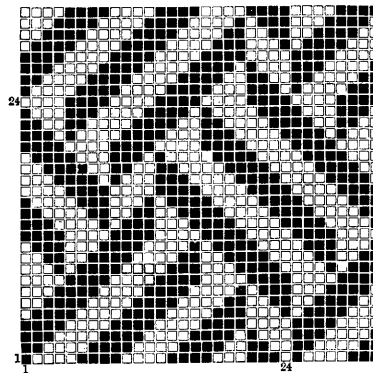


FIG. 387.

Fig. 387 illustrates the entwining twill produced with the 8-harness  $\frac{4}{4}$  twill, having three pieces of twills for the construction.  $8 \times 3 = 24$  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:

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

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.

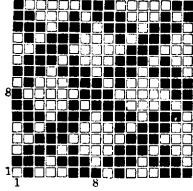


FIG. 388.

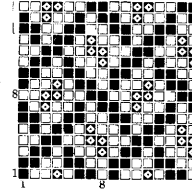


FIG. 389

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.

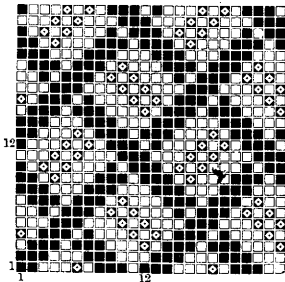


FIG. 390.

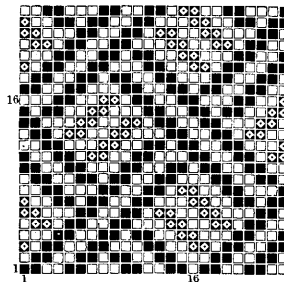


FIG. 391.

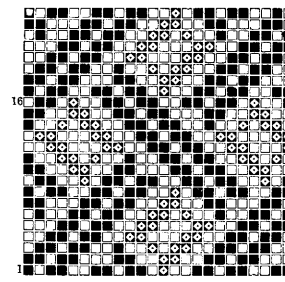


FIG. 392.

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

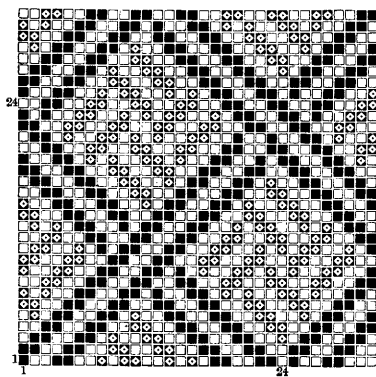


FIG. 393.

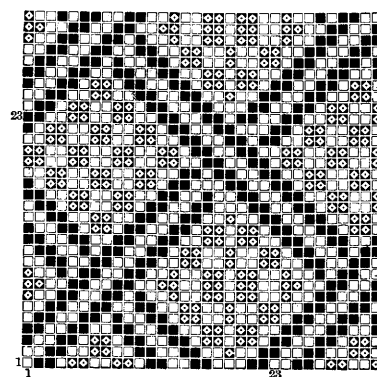


FIG. 394.

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.

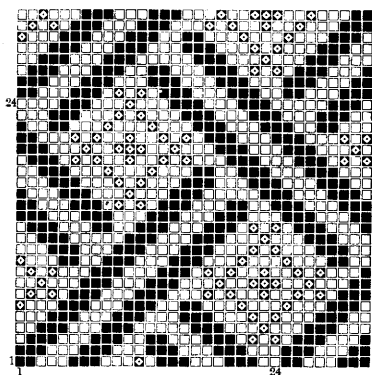


FIG. 395.

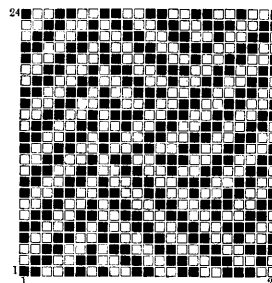


FIG. 396.

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  $45^\circ$  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).

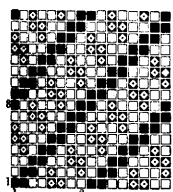


FIG. 397.

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 twill effect"  $\frac{2}{2}$  for 2 warp-threads.

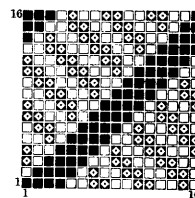


FIG. 398.

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.

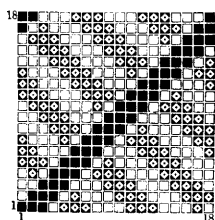


FIG. 399.

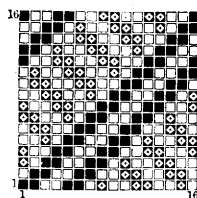


FIG. 400.

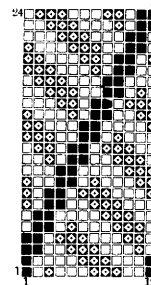


FIG. 401.

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

Twills of a different grading than  $45^\circ$  for the main twill line can also be used. For example, steep-twills of  $63^\circ$ ,  $70^\circ$  or  $75^\circ$  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  $63^\circ$  steep-twill derived from the  $\frac{4-20}{20} = 24$ -harness foundation-twill for the main twill, and the  $\frac{3-3}{3} = 6$  harness  $45^\circ$  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.

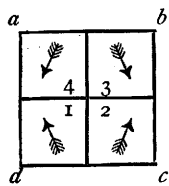


FIG. 402.  
a, b, c, d, repeat of weave.

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  $\frac{2-1}{1} = 3$  with a double repeat of its corresponding filling effect  $\frac{1-2}{2} = 3$ . Repeat: 12 warp-threads, 12 picks.

Design Fig. 404 is constructed from the 4-harness  $\frac{3-1}{1} = 4$  and  $\frac{1-3}{3} = 4$  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.

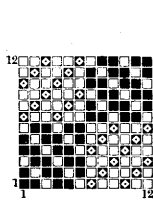


FIG. 403.

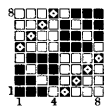


FIG. 404.

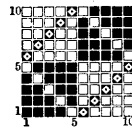


FIG. 405.

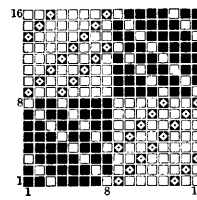


FIG. 406.

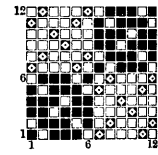


FIG. 407.

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

Design Fig. 406 illustrates the checkerboard effect derived from combining the 8-harness twill  $\frac{2-4}{1-4} = 8$  or warp face, with  $\frac{1-1}{4-2} = 8$ , 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  $1\frac{1}{2}$  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. 408a and 410 illustrate two examples, which readily explain their construction after the motives given in Figs. 408 and 409.

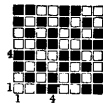


FIG. 408.

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

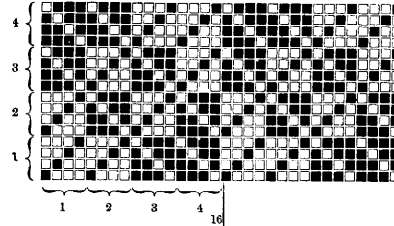


FIG. 408a.

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

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

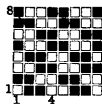


FIG. 409.

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

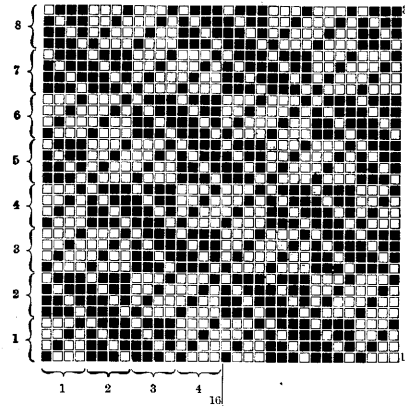


FIG. 410.

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  $(4 \times 8 =) 32$  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  $\begin{smallmatrix} 3 \\ \text{---} \\ 1 \end{smallmatrix}$  and  $\begin{smallmatrix} 1 \\ \text{---} \\ 3 \end{smallmatrix}$  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:

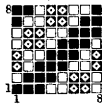


FIG. 411.

Repeat: { 8 warp-threads,  
8 picks.

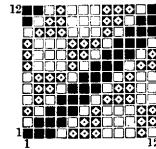


FIG. 412.

Repeat: { 12 warp-threads,  
12 picks.

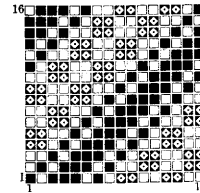


FIG. 413.

Repeat: { 16 warp-threads,  
16 picks.

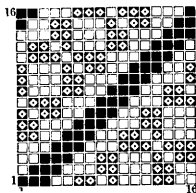


FIG. 414.

Repeat: { 16 warp-threads,  
16 picks.

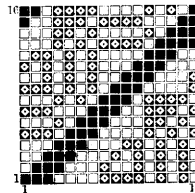


FIG. 415.

Repeat: { 16 warp-threads,  
16 picks.

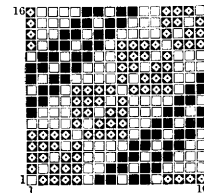


FIG. 416.

Repeat: { 16 warp-threads,  
16 picks.

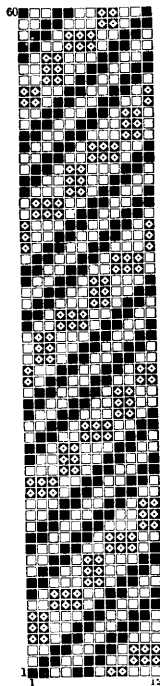


FIG. 417.

Repeat: { 12 warp-threads,  
60 picks.

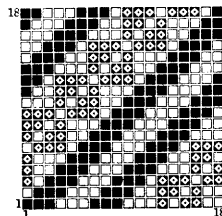


FIG. 418.

Repeat: { 18 warp-threads,  
18 picks.

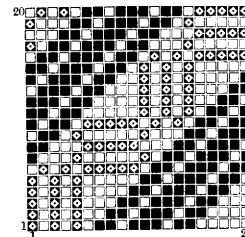


FIG. 419.

Repeat: { 20 warp-threads,  
20 picks.

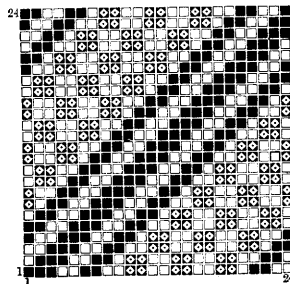


FIG. 420.

Repeat: { 24 warp-threads,  
24 picks.

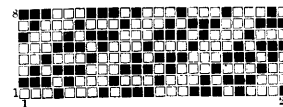


FIG. 421.

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*.

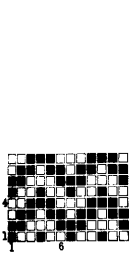


FIG. 422.

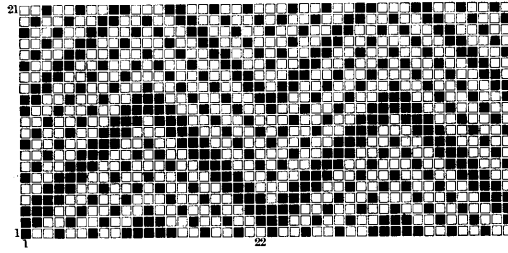


FIG. 423.

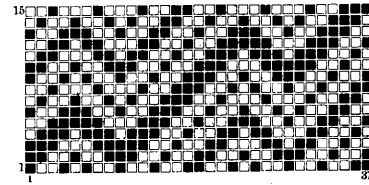


FIG. 424.

Fig. 422 illustrates a "point twill" composed of the  $\frac{2}{2}$  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  $\frac{3}{2} \frac{1}{2} \frac{1}{2} \frac{2}{2} \frac{1}{2} \frac{1}{2}$  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  $\frac{3}{2} \frac{1}{2} \frac{2}{2} \frac{1}{2}$  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.

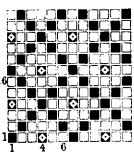


FIG. 425.

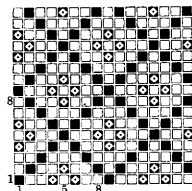


FIG. 426.

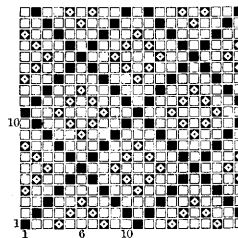


FIG. 427.

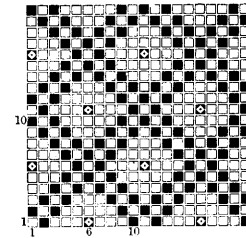


FIG. 428.

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  $\frac{1}{2}$  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.

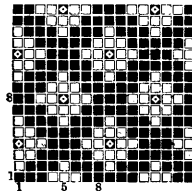


FIG. 429.

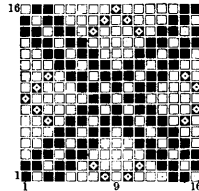


FIG. 430

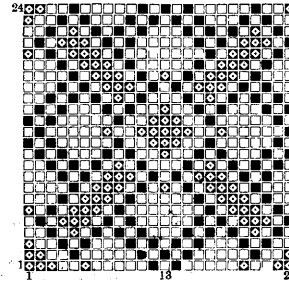


FIG. 431.

Fig. 428 illustrates a pointed twill derived from the  $\frac{1}{3}$  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.

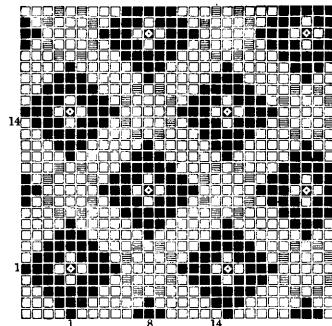


FIG. 432.

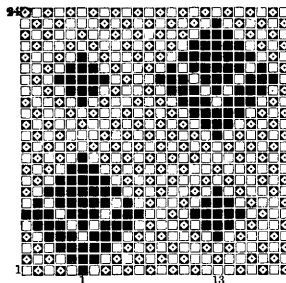


FIG. 433.

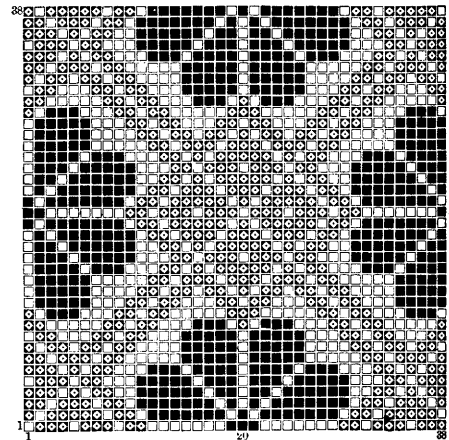


FIG. 434.

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.

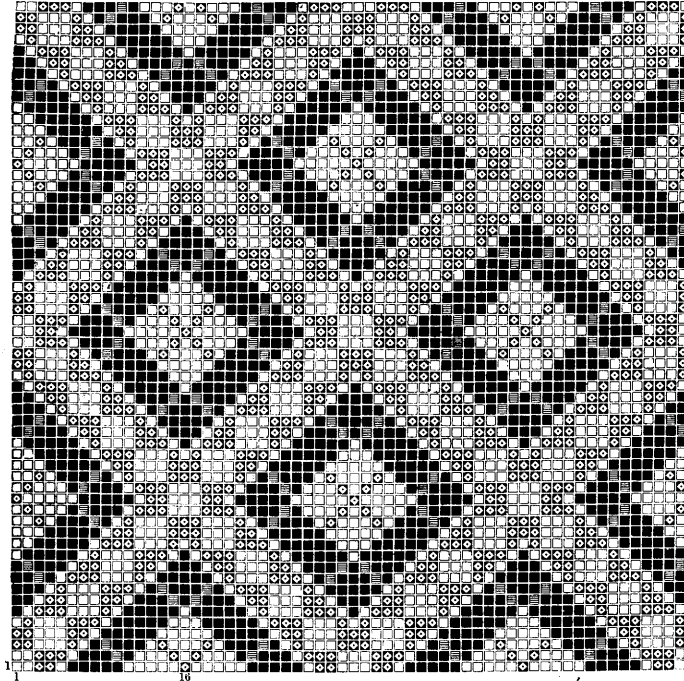


FIG. 435.

□, ■, 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.

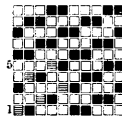


FIG. 436.

■ and ■ for Raisers.

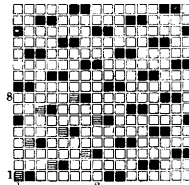


FIG. 437.

■ and ■ for Raisers.

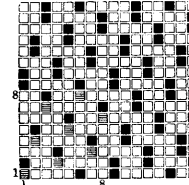


FIG. 438.

■ 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  $1\text{---}4$  to  $1\text{---}1\text{---}2$ , 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.

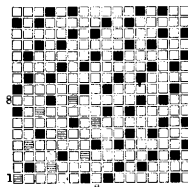


FIG. 439.

■ and ■ for Raisers.

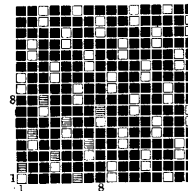


FIG. 440.

□ 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.

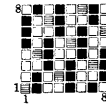


FIG. 444.

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 (■).

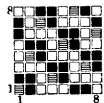


FIG. 445.

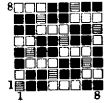


FIG. 446.

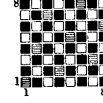


FIG. 447.

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.

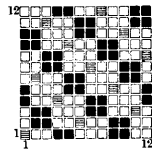


FIG. 448.

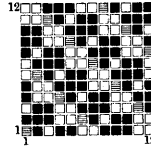


FIG. 449.

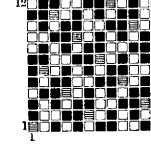


FIG. 450.

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.

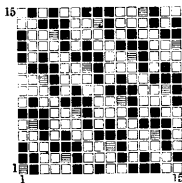


FIG. 451.

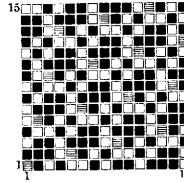


FIG. 452.

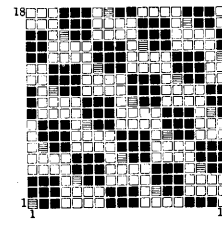


FIG. 453.

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

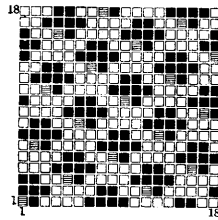


FIG. 454.

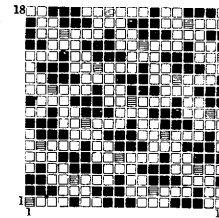


FIG. 455.

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.

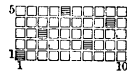


FIG. 456.

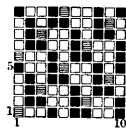


FIG. 457.

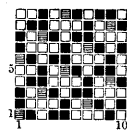


FIG. 458.

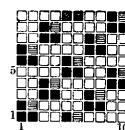


FIG. 459.

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.

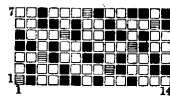


FIG. 460.

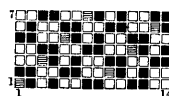


FIG. 461.

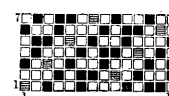


FIG. 462.

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.

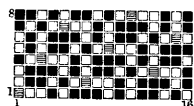


FIG. 463.

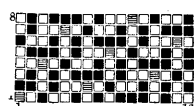


FIG. 464.

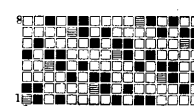


FIG. 465.

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.

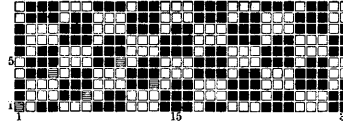


FIG. 467.

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."

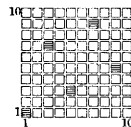


FIG. 468.

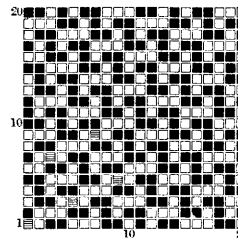


FIG. 469.

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.

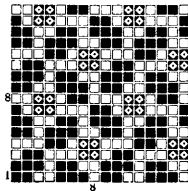


FIG. 470.

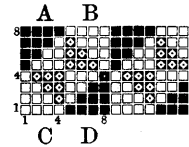


FIG. 471.

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.

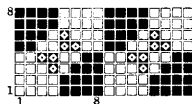


FIG. 472.

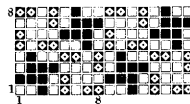


FIG. 473.

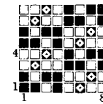


FIG. 474.

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  $4 \times 4 = 16$  squares (each separated by a break) in complete weave.

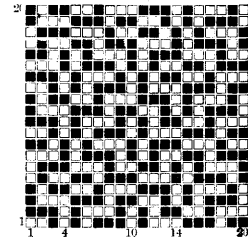


FIG. 475.

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.

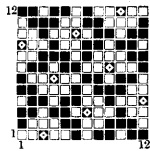


FIG. 476.

Repeat:  $\left\{ \begin{array}{l} 12 \text{ warp-threads,} \\ 12 \text{ picks.} \end{array} \right.$

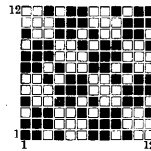


FIG. 477.

Repeat:  $\left\{ \begin{array}{l} 12 \text{ warp-threads,} \\ 12 \text{ picks.} \end{array} \right.$

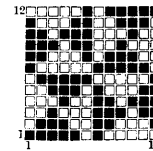


FIG. 478.

Repeat:  $\left\{ \begin{array}{l} 12 \text{ warp-threads,} \\ 12 \text{ picks.} \end{array} \right.$

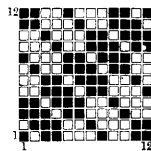


FIG. 479.

Repeat:  $\left\{ \begin{array}{l} 12 \text{ warp-threads,} \\ 12 \text{ picks.} \end{array} \right.$

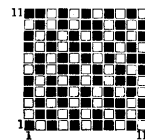


FIG. 480.

Repeat:  $\left\{ \begin{array}{l} 11 \text{ warp-threads,} \\ 11 \text{ picks.} \end{array} \right.$

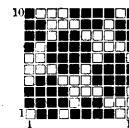


FIG. 481.

Repeat:  $\left\{ \begin{array}{l} 10 \text{ warp-threads,} \\ 10 \text{ picks.} \end{array} \right.$

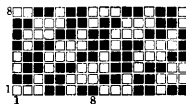


FIG. 482.

Repeat:  $\left\{ \begin{array}{l} 8 \text{ warp-threads,} \\ 8 \text{ picks.} \end{array} \right.$

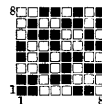


FIG. 483.

Repeat:  $\left\{ \begin{array}{l} 8 \text{ warp threads,} \\ 8 \text{ picks.} \end{array} \right.$

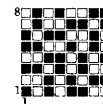


FIG. 484.

Repeat:  $\left\{ \begin{array}{l} 8 \text{ warp-threads,} \\ 8 \text{ picks.} \end{array} \right.$

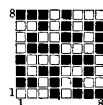


FIG. 485.

Repeat:  $\left\{ \begin{array}{l} 8 \text{ warp-threads,} \\ 8 \text{ picks.} \end{array} \right.$

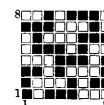


FIG. 486.

Repeat:  $\left\{ \begin{array}{l} 8 \text{ warp-threads,} \\ 8 \text{ picks.} \end{array} \right.$



## 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 desired 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.

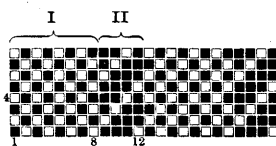


FIG. 487.

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.

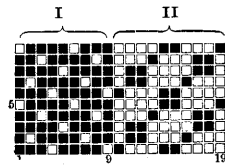


FIG. 488.

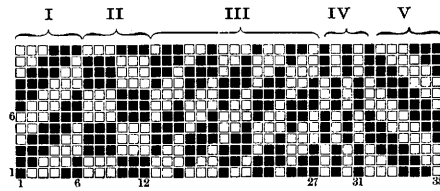


FIG. 489.

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  $\frac{3}{3}$  twill. Direction of twill from the left to the right. Warp-threads 7 to 12 are interlaced with the common 6-harness  $\frac{3}{3}$  basket-weave. Warp-threads 13 to 27 have for their weave the skip twill derived from the regular 6-harness  $\frac{3}{3}$  twill by means of "take three threads successively and skip two." Warp-threads 28 to 31 are interlaced with the common rib-weave  $\frac{3}{3}$  warp for face. Warp-threads 32 to 38 are interlaced with the filling by means of the  $\frac{3}{3}$  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  $\frac{4}{4}$ , used for six successive warp-threads, and the 16 harness corkscrew, used for 18 successive warp-threads, is shown.

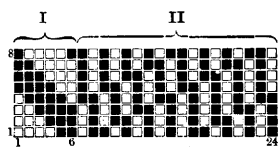


FIG. 490.

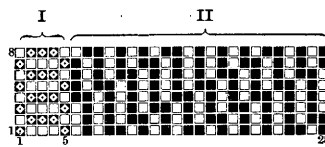


FIG. 491.

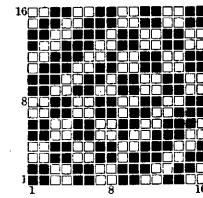


FIG. 492.

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  $\frac{2}{2} \frac{2}{2} \frac{3}{3}$  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.

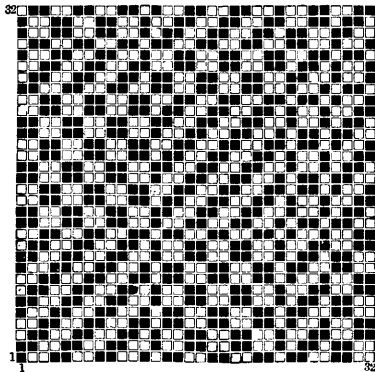


FIG. 493.

$4 \times 12$ . Basket.	$4 \times 12$ . Twill.	$4 \times 4$ . Basket.	$4 \times 4$ . Twill.
$4 \times 12$ . Twill.	$4 \times 12$ . Basket.	$4 \times 4$ . Twill.	$4 \times 4$ . Basket.
$12 \times 12$ . 4-harness Basket.	$12 \times 12$ . 4-harness Twill.	$12 \times 4$ . Basket.	$12 \times 4$ . Twill.
$12 \times 12$ . 4-harness Twill.	$12 \times 12$ . 4-harness Basket.	$12 \times 4$ . Twill.	$12 \times 4$ . 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.

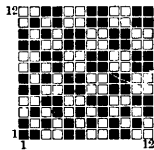


FIG. 495.

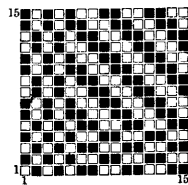


FIG. 496.

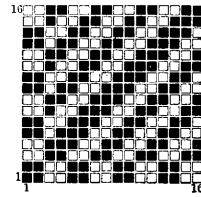


FIG. 497.

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.

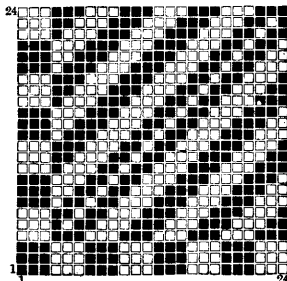


FIG. 498.

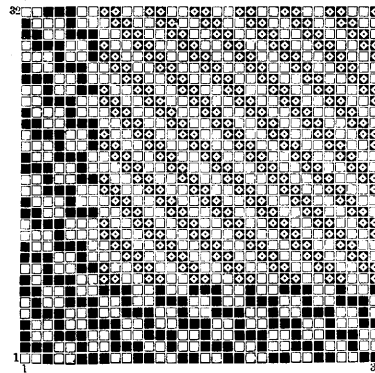


FIG. 499.

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  $\frac{2}{2}$  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  $\frac{2}{2}$  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.

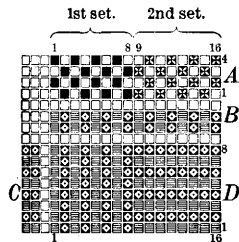


FIG. 500.

(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.

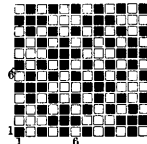


FIG. 501.  
Motive.

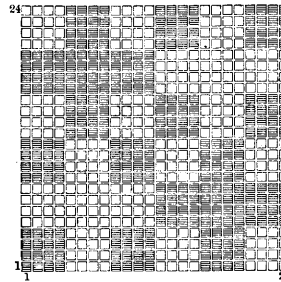


FIG. 502.  
Ground-plan.

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.

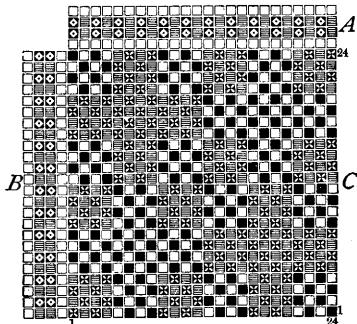


FIG. 503.  
Weave.

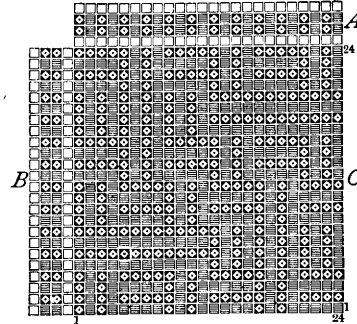


FIG. 504.  
Effect in Fabric.

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 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.

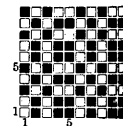


FIG. 505.

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.

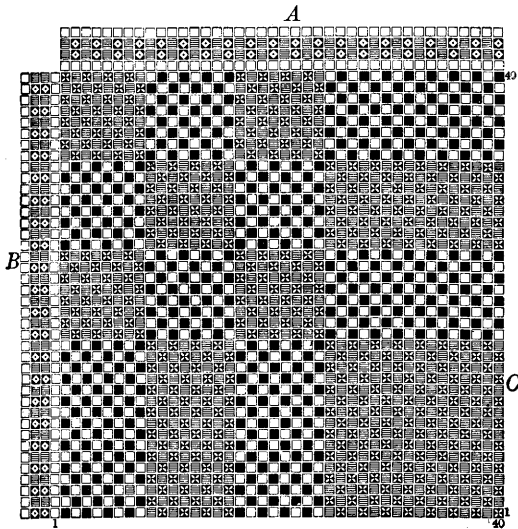


FIG. 506.

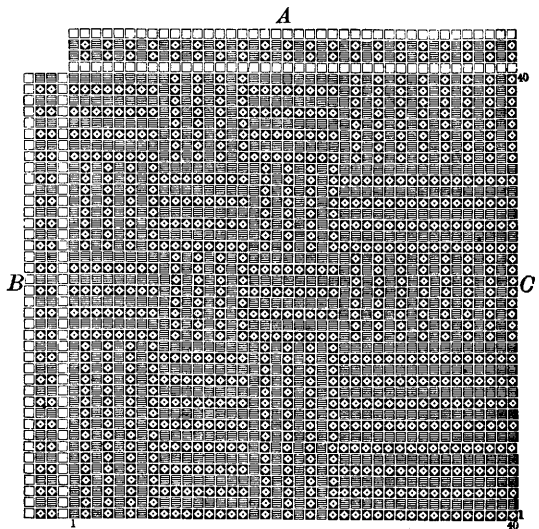


FIG. 507.

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.

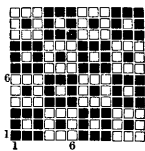


FIG. 508.

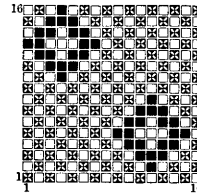


FIG. 510.

16 harness and 16 picks for repeat.

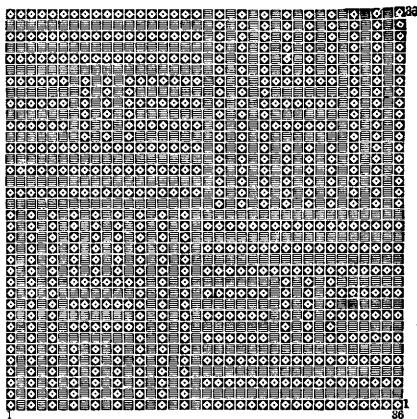


FIG. 509.

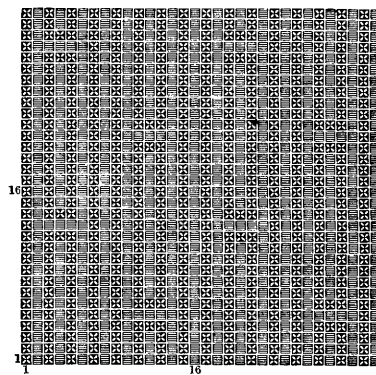


FIG. 511.

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.

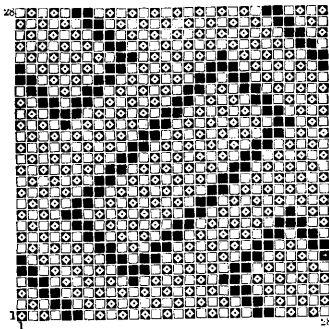


FIG. 512.  
28 harness and 28 picks for repeat.

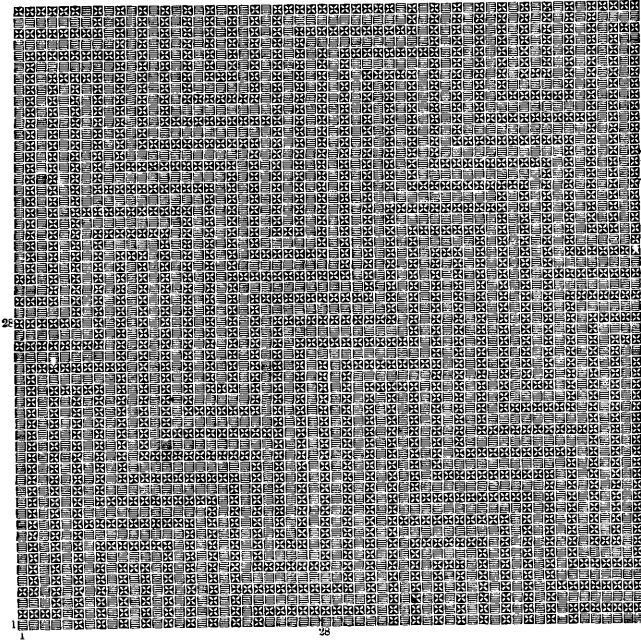


FIG. 513.

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.

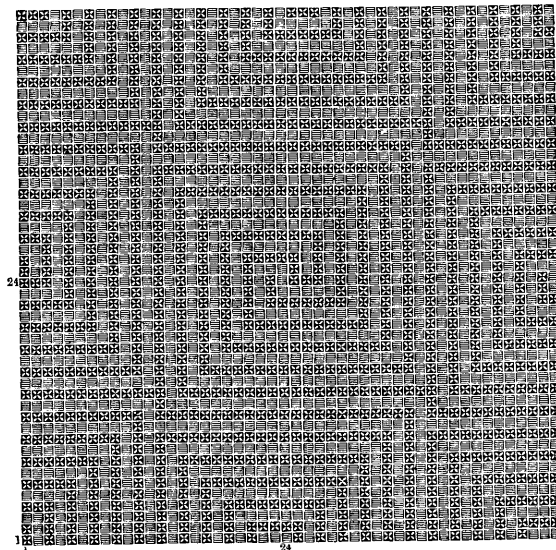


FIG. 515.

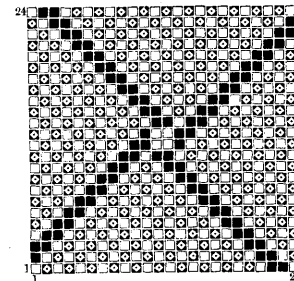


FIG. 514.

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.

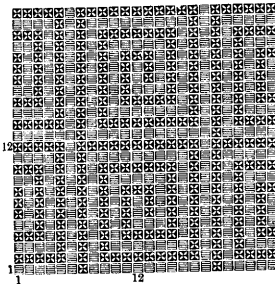


FIG. 516.

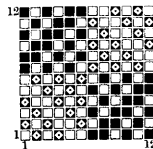


FIG. 517.

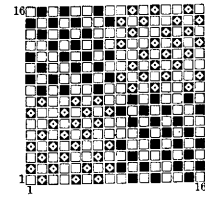


FIG. 518.

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.

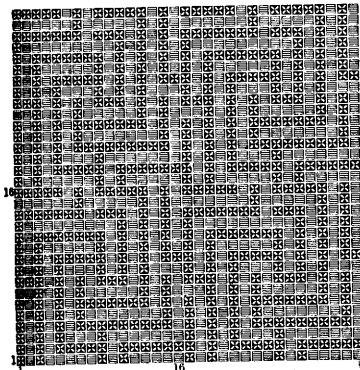


FIG. 519.

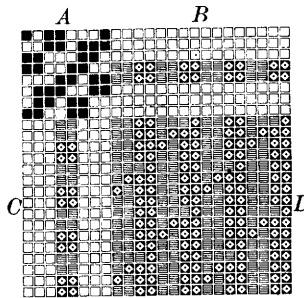


FIG. 520.

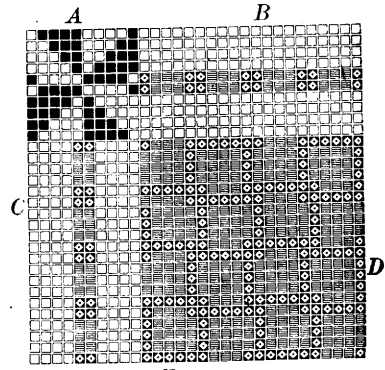


FIG. 521.

*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.

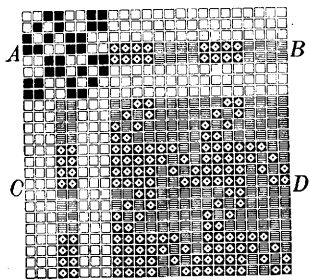


FIG. 522.

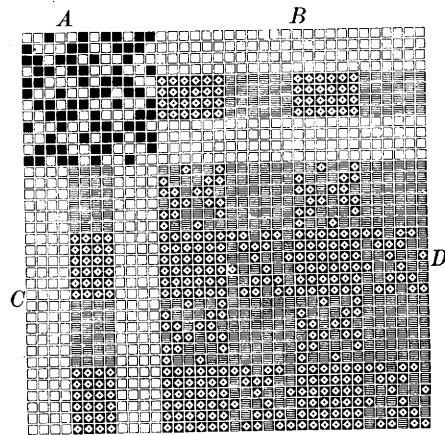


FIG. 523.

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.

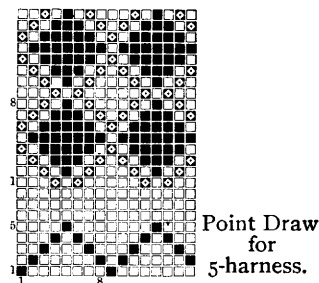


FIG. 524.



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.

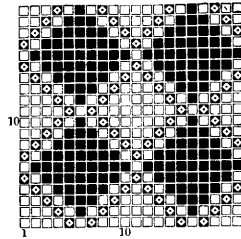


FIG. 527.

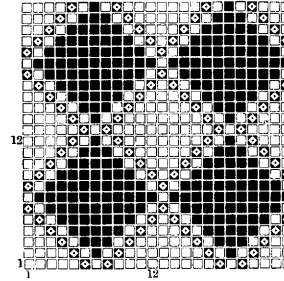


FIG. 528.

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.

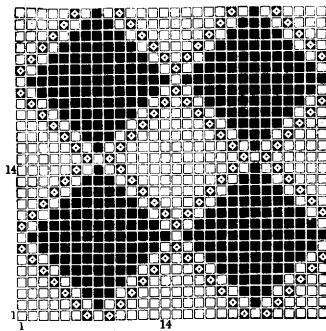


FIG. 529.

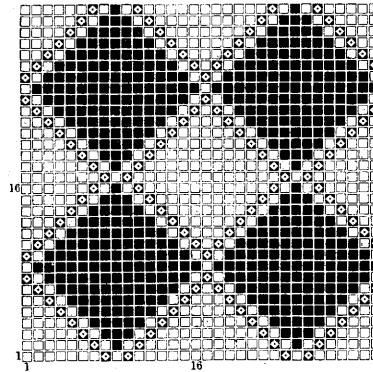


FIG. 530.

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.

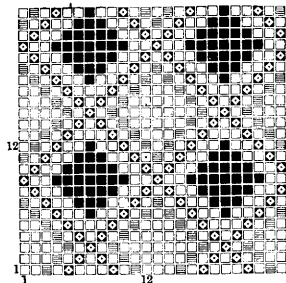


FIG. 531.

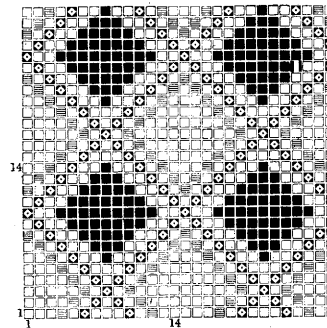


FIG. 532.

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).

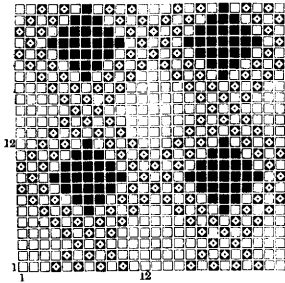


FIG. 533.

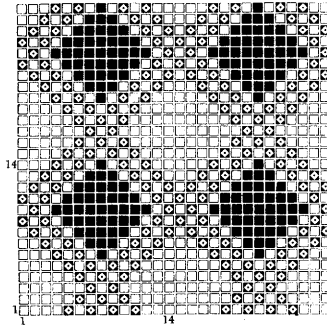


FIG. 534.

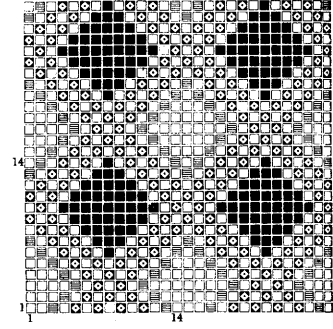


FIG. 535

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.

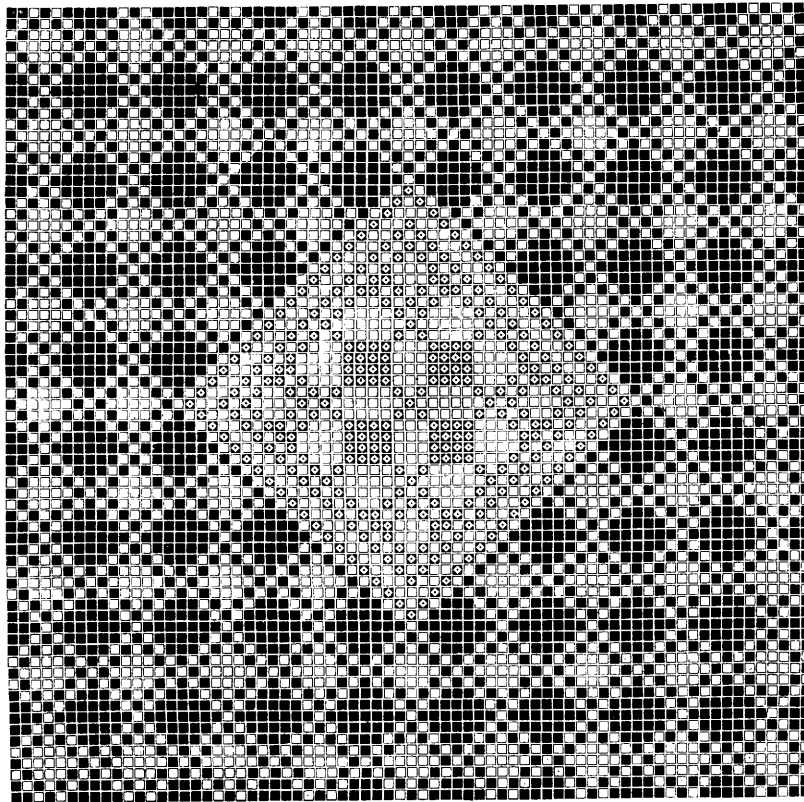


FIG. 536.

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.

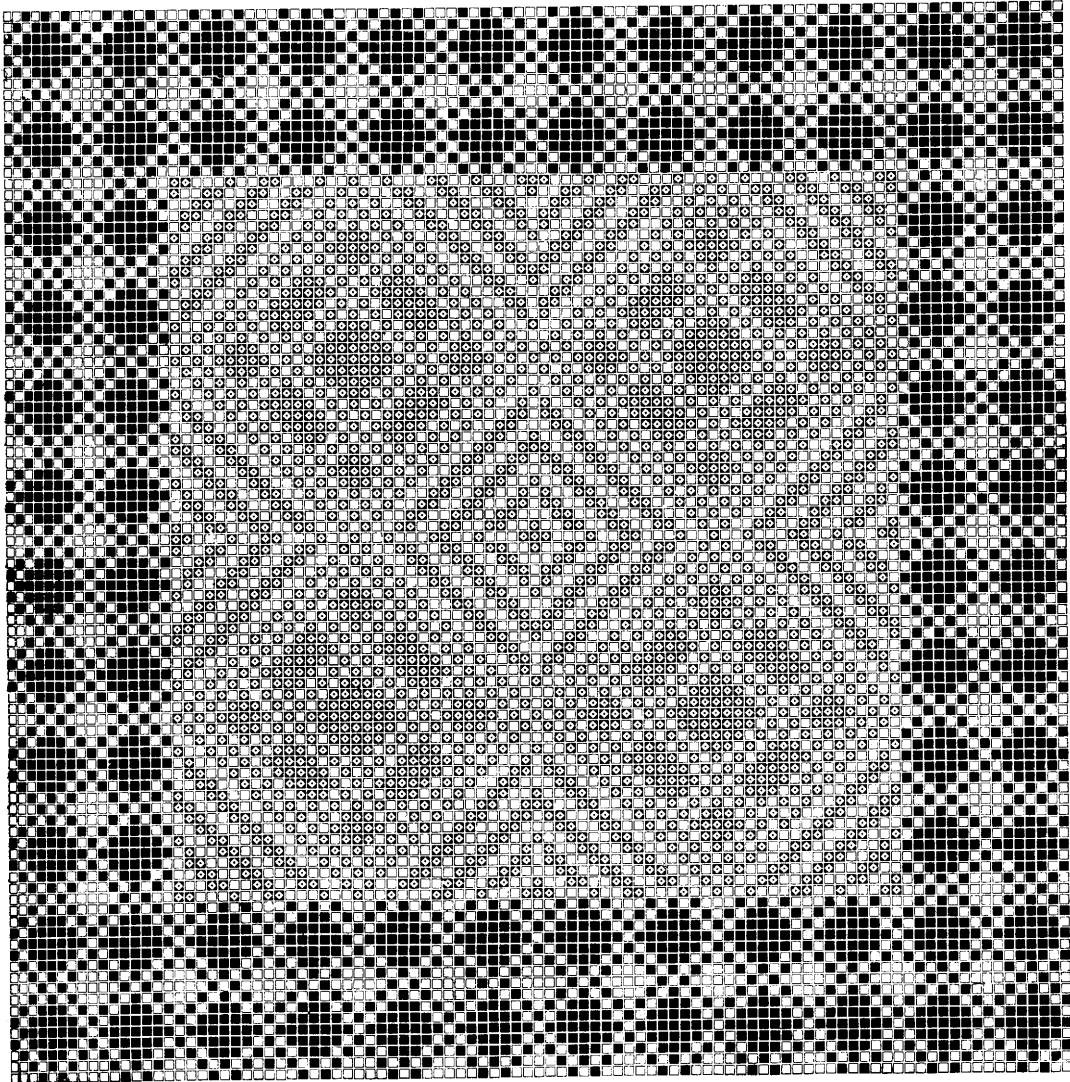


FIG. 537.

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.

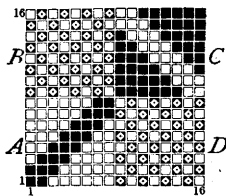


FIG. 538.

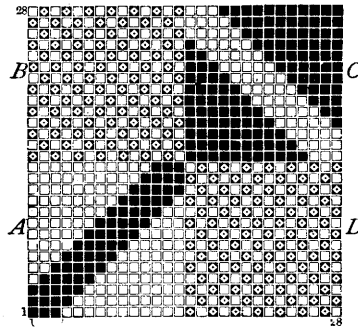


FIG. 539.

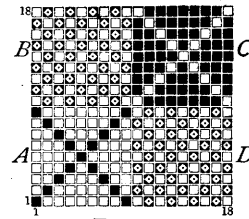


FIG. 540.

Fig. 540. Repeat: 18 warp-threads and 18 picks. This weave contains in its principle, in check indicated by *A*, the  $\times$  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."

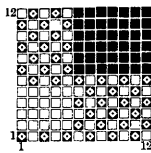


FIG. 541.

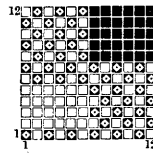


FIG. 542.

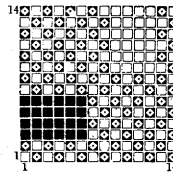


FIG. 543.

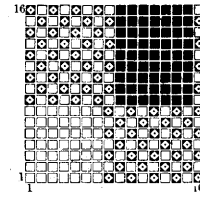


FIG. 544.

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.

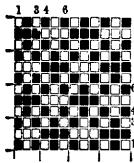


FIG. 545.

Fig. 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.

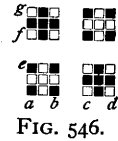


FIG. 546.

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.

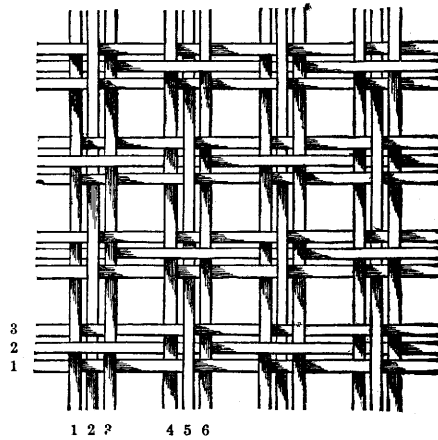


FIG. 547.

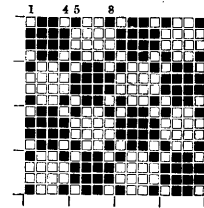


FIG. 548.

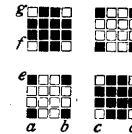


FIG. 549.

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.

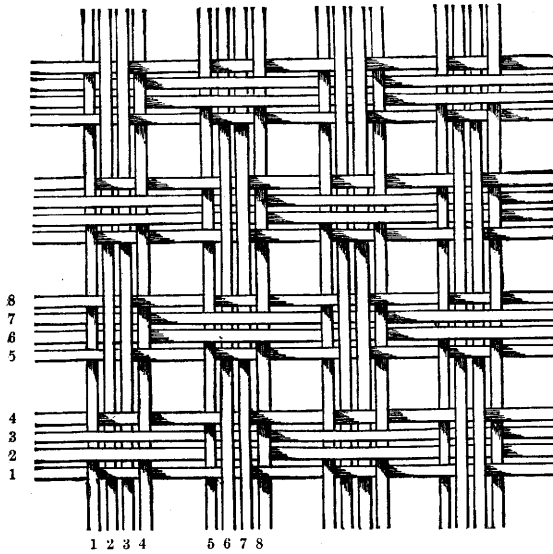


FIG. 550.

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

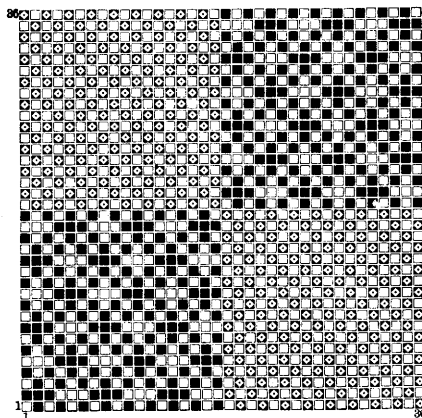


FIG. 552.

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.

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.

### 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

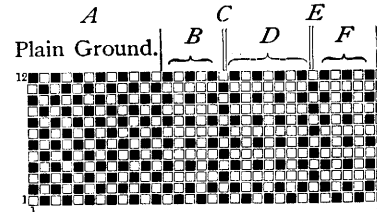


FIG. 551.

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, *C* and *D* forming open work (separated by thread *C*). *D* is the close-reeded part, *E* and *F* forming open work (separated by thread *E*). *F* close-reeded part. Repeat

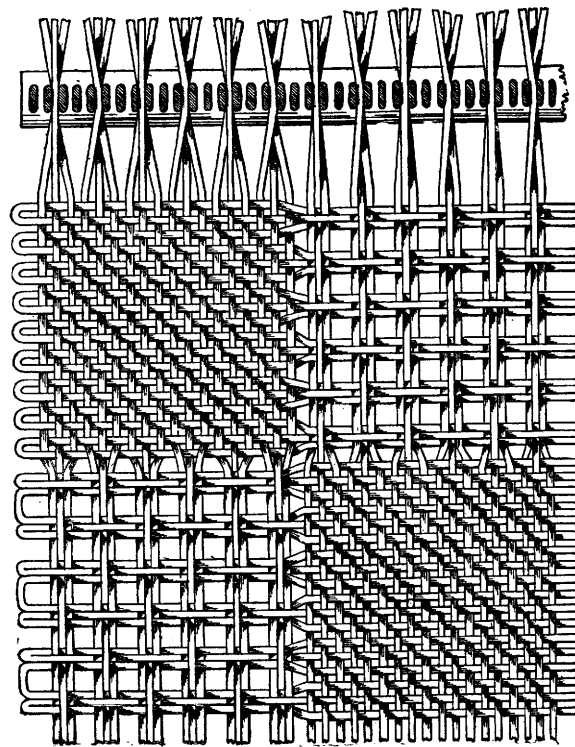


FIG. 553.

## 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" wools, 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.

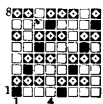


FIG. 554.



FIG. 555.

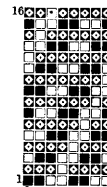


FIG. 556.

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  $\frac{1}{2}$ - $\frac{1}{3}$  twill (see ■ type). The interlacing of the back filling arrange with the  $\frac{2}{2}$ - $\frac{1}{4}$  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  $\frac{7}{1}$ - $\frac{1}{1}$  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.

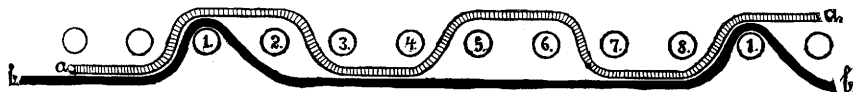


FIG. 557.

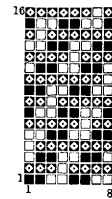


FIG. 558.

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  $\frac{4}{1} \frac{10}{2}$  16-harness twill.

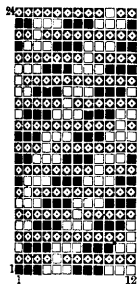


FIG. 559.

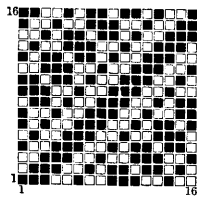


FIG. 560.

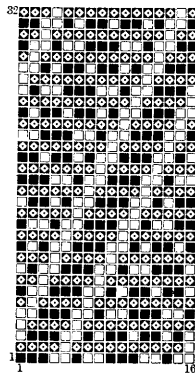


FIG. 561.

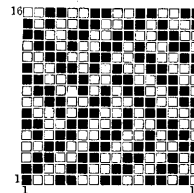


FIG. 562.

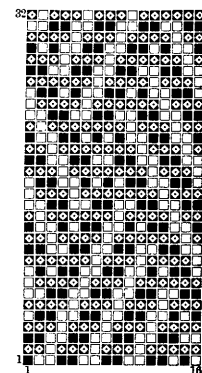


FIG. 563.

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.

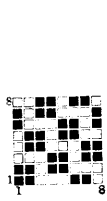


FIG. 564.

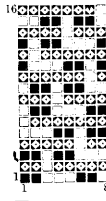


FIG. 565.

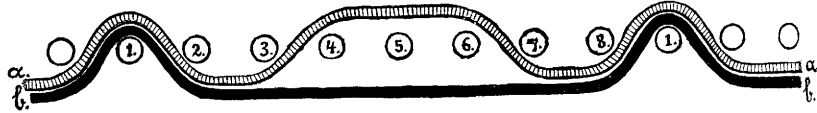


FIG. 566.

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  $\frac{3}{3}$  6-harness twill with the  $\frac{11}{1}$  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

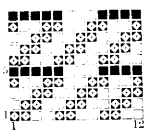


FIG. 568.

generally limited to stripes and checks, whereas if used for dress goods they are often of a very elaborate design.

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  $\frac{2}{2}$ . 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.

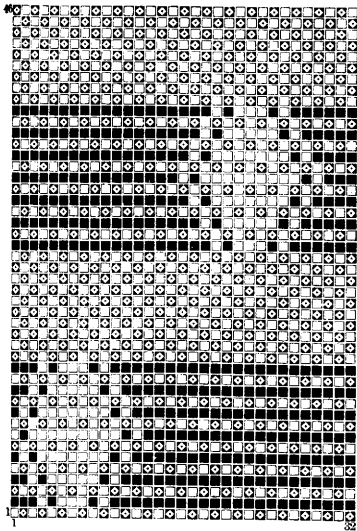


FIG. 569.

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 Ratine 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.

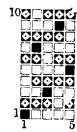


FIG. 570.

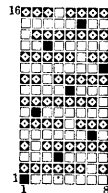


FIG. 571.

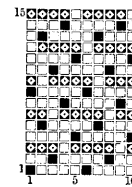


FIG. 572.

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.

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.

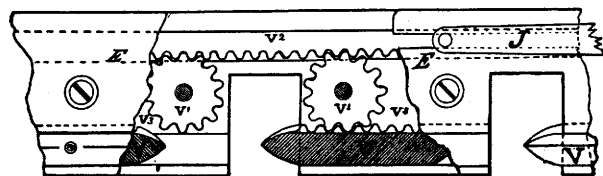


FIG. 573.

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.

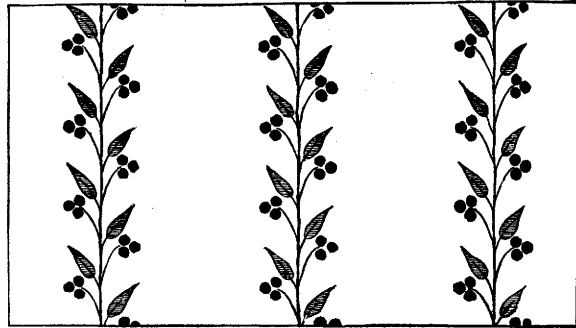


FIG. 574.

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

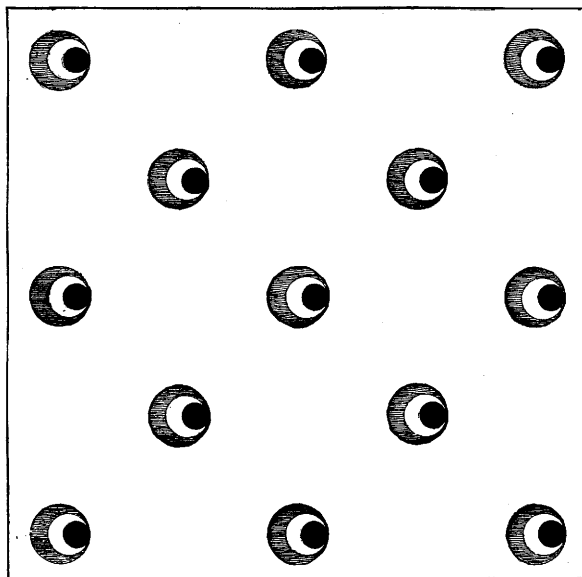


FIG. 575.



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, illustrat-

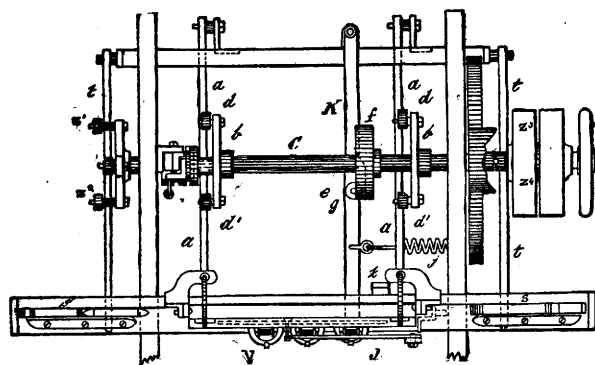


FIG. 577.

ing only one effect, has to be arranged for practical use according to the fabric for which it is required.

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,  $z^1 z^2$ , 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  $z^1, z^2, z^3$  and  $z^4$  must be so placed in relation to

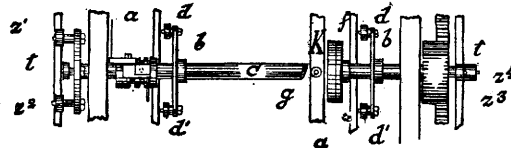


FIG. 578.

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.

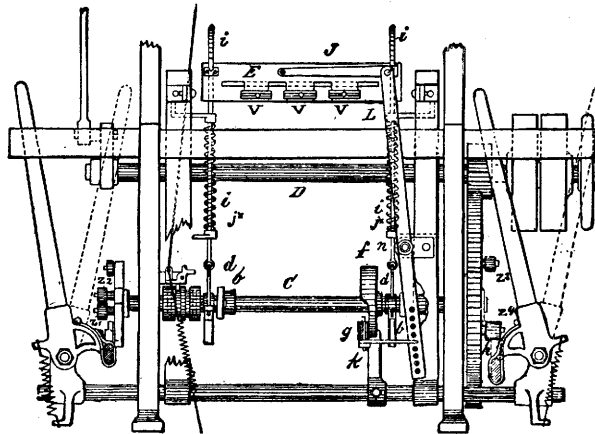


FIG. 579.

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  $z^1 z^2$  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  $j^x j^x$ , 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-

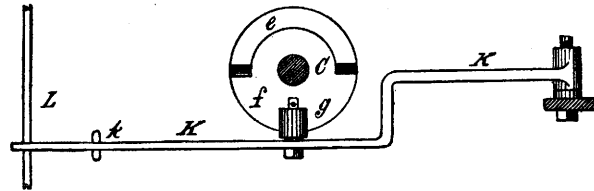


FIG. 580.

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.