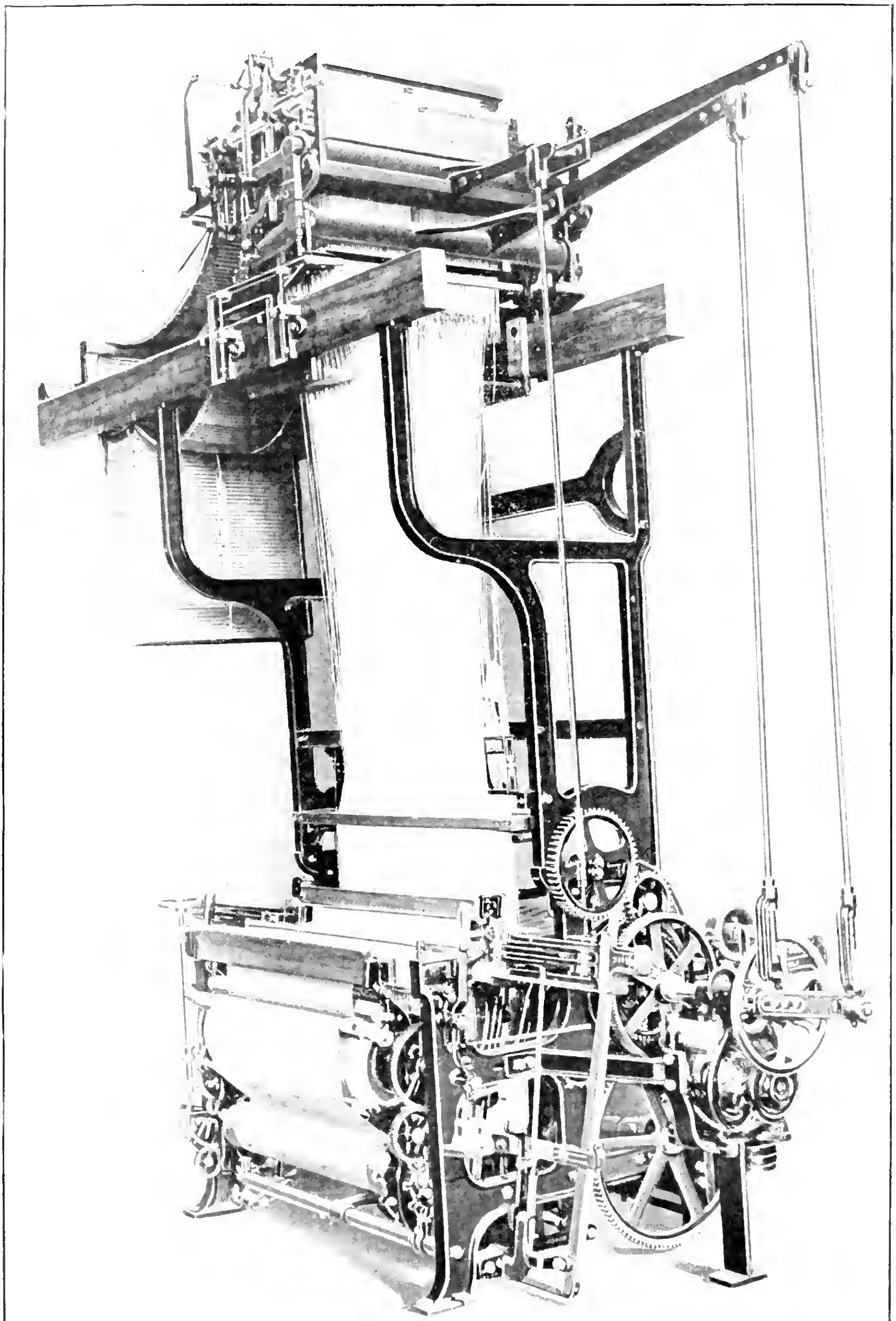

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ON COTTON, WOOLEN AND WORSTED YARN MANUFACTURE, WEAVING, DESIGNING, CHEMISTRY AND DYEING, FINISHING, KNITTING, AND ALLIED SUBJECTS.

TEXTILE EXPERTS AND LEADING MANUFACTURERS

SEVEN VOLUMES

CHICAGO
AMERICAN SCHOOL OF CORRESPONDENCE
1907

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HE editors have freely consulted the standard technical literature of Europe and America in the preparation of these volumes and desire to express their indebtedness, particularly to the following eminent authorities, whose well known treatises should be in the library of every one connected with textile manufacturing.

Grateful acknowledgment is here made also for the invaluable co-operation of the foremost manufacturers of textile machinery, in making these volumes thoroughly representative of the best and latest practice in the design and construction of textile appliances; also for the valuable drawings and data, suggestions, criticisms, and other courtesies.

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THE Cyclopedia of Textile Work is compiled from the most practical and comprehensive instruction papers of the American School of Correspondence. It is intended to furnish instruction to those who cannot take a correspondence course, in the same manner as the American School of Correspondence affords instruction to those who cannot attend a resident textile school.

The instruction papers forming the Cyclopedia have been prepared especially for home study by acknowledged authorities, and represent the most careful study of practical needs and conditions. Although primarily intended for correspondence study they are used as text-books by the Lowell Textile School, the Textile Department of the Clemson Agricultural College, the Textile Department of the North Carolina College of Agriculture and Mechanic Arts, the Mississippi Textile School, and for reference in the leading libraries and mills.

Years of experience in the mill, laboratory and class room have been required in the preparation of the various sections of the Cyclopedia. Each section has been tested by actual use for its practical value to the man who desires to know the latest and best practice from the card room to the finishing department.

Numerous examples for practice are inserted at intervals. These, with the test questions, help the reader to fix in mind the essential points, thus combining the advantages of a textbook with a reference work.

Grateful acknowledgment is due to the corps of authors and collaborators, who have prepared the many sections of this work. The hearty co-operation of these men — manufacturers and educators of wide practical experience and acknowledged ability — has alone made these volumes possible.

The Cyclopedia has been compiled with the idea of making it a work thoroughly technical, yet easily comprehended by the man who has but little time in which to acquaint himself with the fundamental branches of textile manufacturing. If, therefore, it should benefit any of the large number of workers who need, yet lack, technical training, the editors will feel that its mission has been accomplished.

VOLUME III.

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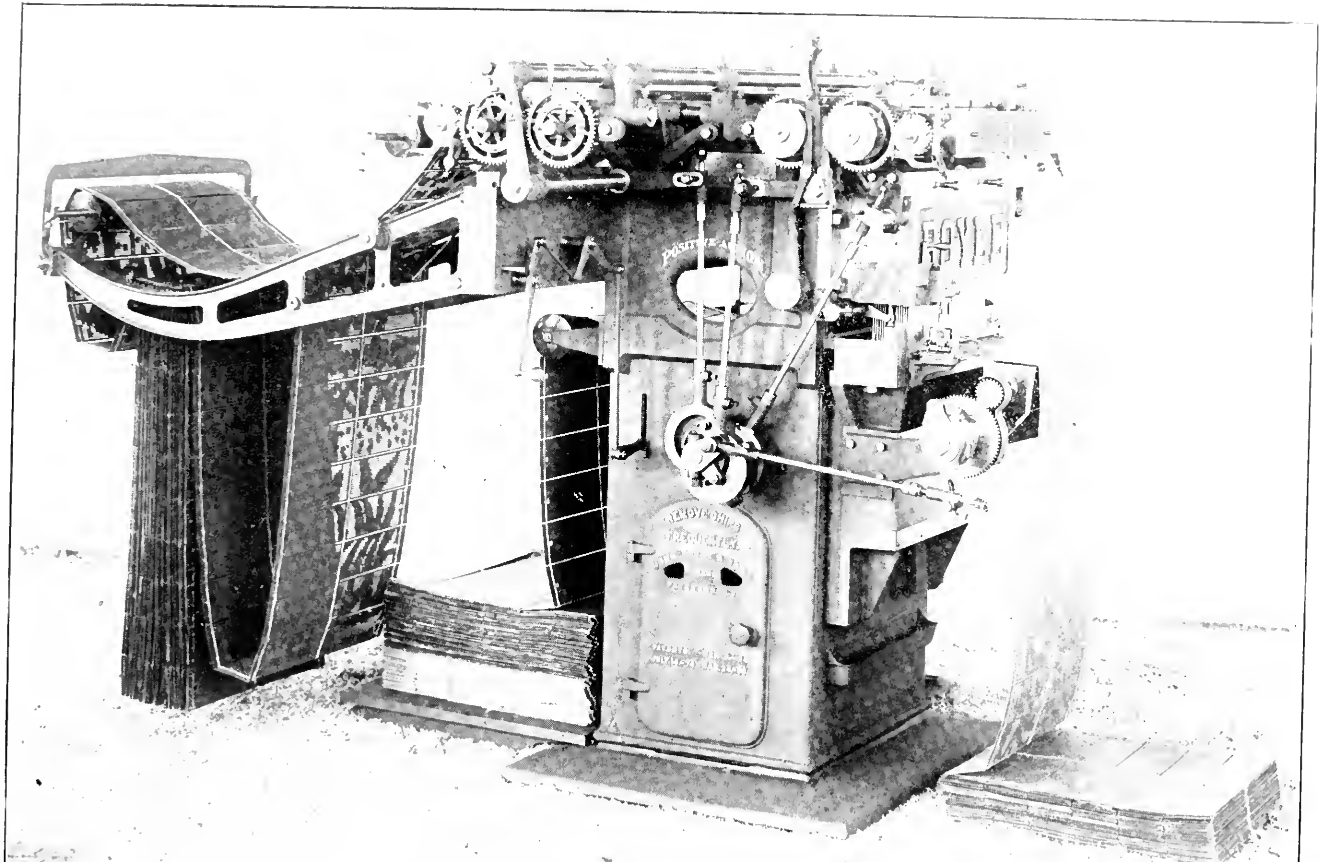


ROYLE'S AUTOMATIC POSITIVE ACTION REPEATER WITH DOUBLE EXTENDED AND REVERSE CYLINDERS

TEXTILE DESIGN.

PART I.

There are three primary elements in textile design.

First, the weave.

Second, amalgamation and combination of weaves.

Third, the mixing and blending of colors as applied to textile fabrics.

The object to which a design is to be applied is of the utmost importance; the designer must first know the intended uses of the fabric. When a draftsman makes the drawings of a machine, or an engineer of a bridge, he first studies the convenience of arrangement, the conditions as to strength, durability and utility. It is necessary to consider all these particulars in the construction of a piece of cloth. Therefore a textile design, or the design of a woven fabric and its specifications, is, when complete, a perfect working plan, — descriptive and illustrative of the arrangement and character of all the component parts and processes. It describes the different materials, as to quality, kind, character, size, or counts and color of the yarn; it gives the arrangement of the threads, also quantities and proportions. The design illustrates the construction of the fabric, and the lay-out describes special processes and operations. To be complete and perfect, it should be so comprehensive that any qualified manager could produce the desired fabric without further instructions.

USE OF DESIGN PAPER.

These papers are ruled with a heavy line to represent squares, and the sides are again divided by fainter lines into eight, ten, twelve or more divisions as required.

Fig. 1 represents a portion of design paper ruled 12×12. The use of ruled paper is exceedingly simple if the first principles and rudiments are comprehended. To have a clear and proper conception of the use of design paper, it will be necessary for the student to divide the squares into two distinct systems. *First*, suppose that there is a series of vertical lines and no horizontal lines (see Fig. 2.) *Second*, that there is a series of horizontal lines and no vertical lines (see Fig. 3.)

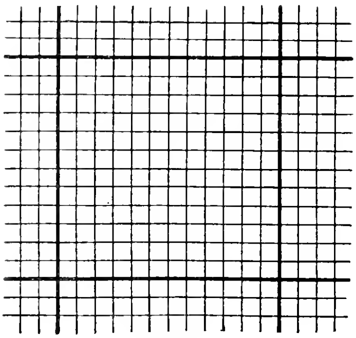


Fig. 1.

It is universally understood that woven fabrics in general have two systems of threads: *first*, the warp threads; *second*, the weft or woof. The weft is commonly called the filling threads. These are the two most important things to form the plainest of woven cloth.

Warp is the set of threads that run *lengthwise* in woven goods, that is, if you had a piece of cloth four yards long there would be four yards of warp. Warp is represented on the design paper by the *vertical* or perpendicular series of small squares. The weft or filling is the set of threads that interlace the warp at right angles, and is represented on the design paper by the transverse or *horizontal* series of small squares. The weft runs across the width of the cloth. It should be clearly understood that these two systems, warp or vertical squares, and filling or transverse squares, form the fabric or design.

Fig. 2.

One object of point paper designing is to reproduce an imitation of the cloth and show the method of interlacing in the fabric, another object of the ruled paper is to show a plan of the fabric exactly as it would appear if looking down upon it.

The error that is usually made by beginners is that each small square is considered by itself, without taking into consideration that each *line* of squares, either vertical or horizontal, forms the design. This will be more readily understood by an examination of Fig. 4. Marks of any description—crosses, dots or circles—represent the raised warp threads, unless otherwise specified.

In the plain or cotton weave, there are only two movements, one thread up and one thread down: this operation is repeated until the warp is woven out. Fig. 5 is a sketch or diagram of an enlarged section of a fabric woven on this principle: it is a simple

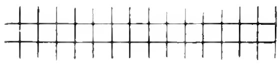


Fig. 3.

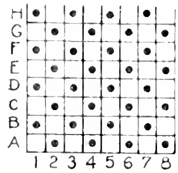


Fig. 4.

interweaving of one thread of filling over and under the warp threads alternately, first thread down and second thread up, etc. The 1st, 3rd, 5th and 7th threads are down, the 2nd, 4th, 6th and 8th threads are up, a thread or pick of filling A, is now lying between 1 and 2 warp threads: the next movement is to lift 1, 3, 5, 7, and sink 2, 4, 6, 8 and put in another thread or pick of filling B; the third pick is like the first and the fourth pick is like the second. These two movements are repeated over and over again until the web or warp is woven out. This constitutes a plain or cotton weave, and the appearance of the enlarged diagram (Fig. 5) is somewhat like the interlacing of the strips of willow in the making of baskets and mats.

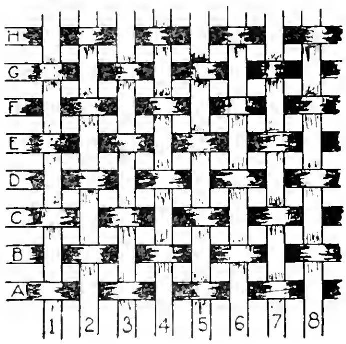


Fig. 5.

To thoroughly comprehend the use of design paper, the main fact to be borne in mind is the continuity of every individual thread, either in the warp or filling. In making a twill design, the leading consideration is that it shall be so arranged that whatever the pattern it shall be continuous and unbroken, on the same principles that when we cover walls with paper or floors with carpet, the design must join perfectly and be continuous, or the broken, irregular design will offend the eye. How this affects the design will be best understood by a careful study of Fig. 6;

3 and 4 are a repetition and continuation of 1 and 2, 5 and 6 a continuation of 3 and 4, and 7 and 8 of 5 and 6, and so on.

Fig. 7 illustrates the principles and construction of the vertical and transverse lines of the design paper. The vertical stripes in Figs. 4, 5 and 7 correspond with the warp threads 1 to 8 in each design; also the transverse or filling threads A to H correspond in Figs. 4, 5 and 7.

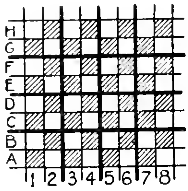


Fig. 6.

If point paper were ruled after the manner of Fig. 7, it would be difficult to see a pattern at a glance, as the many lines would be confusing. To overcome this, the paper is ruled without the spaces between the threads as shown in Fig. 7, but the spaces are represented with the faint lines as in Fig. 1. Fig. 8 shows the section of the first pick A of Fig. 6. We must understand that the lines do not represent threads but indicate the *divisions* between the threads, and it is this that enables an accurate plan of cloth to be made. When this stripe arrangement is fully understood, the first difficulty of textile design has been overcome.

Points to be remembered.

First, That light lines represent places of intersection.

Second, A mark, cross or dot on one of the small squares indicates that the thread is raised — the filling is under and the warp on the surface.

Third, An empty space or unmarked square shows that the filling is on the surface, thereby covering the warp.

Fourth, That the heavy dark line surrounding a series of small squares is for convenience in counting.

Fifth, That the design must be continuous and unbroken.

PLAIN CLOTH.

A plain cloth makes a very strong and firm fabric, but neither very close nor heavy, because the threads are not as close or compact as they are in other weaves. In a plain fabric, if the cloth is not shrunk or fulled in the finishing processes, the fabric is perforated more or less, according to the size and twist of yarns used. These perforations vary greatly under different conditions: if very heavy, coarse threads are used, the perforations will be large; if finer threads, the perforations will be smaller. There are also other conditions which may change the texture of the plain weave; if the threads are twisted hard, the cloth will be wirey and open. In making any fabric the twist of the yarn must be considered. For example, when two pieces of heavy rope or cord of the same twist are woven, they will interlay or become embedded with each other, but if ropes of contrary

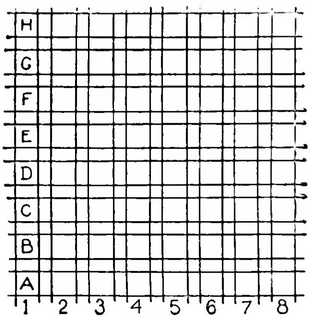


Fig. 7.

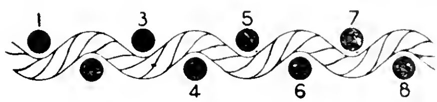


Fig. 8.

twist are used, they do not lay close or compact and the perforations are large, because the ridges of the twist cannot become compact.

TWILLS AND DIAGONALS.

After the plain weave is thoroughly understood, the next step is the study of twill weaves. These are weaves in which the intersections of the warp and filling threads are such that they produce lines diagonally across the fabric, either from right to left or from left to right, at an angle of 45 degrees. The simplest twill weave that can be constructed is one for three harnesses, variously known as the 3-harness twill, prunella twill, and 3-harness doeskin. These names vary according to the nature of the material or the relation of warp and filling employed in the construction of the particular kind of fabric.

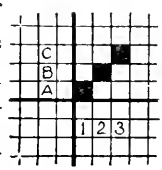


Fig. 9.

Fig. 9 is an illustration of this simple twill weave. It shows the three different positions of the threads to form the twill and, as in plain cloth, whenever the warp is raised an indication is made in the corresponding small square on the design paper, thus denoting which thread has to be lifted when the filling pick or thread is inserted.

Fig. 10 shows an enlarged diagram of a fabric woven upon this principle. It will be noticed that the warp thread 1 is raised as indicated by the mark in the small square at the left-hand lower corner in Fig. 9. The first pick A passing under it and over 2 and 3. For the second pick, the mark is on the second thread, consequently the filling thread B passes over 1, under 2 and over 3. For the third pick, the mark is on the third thread, therefore the third filling thread passes over 1 and 2, and under No. 3.

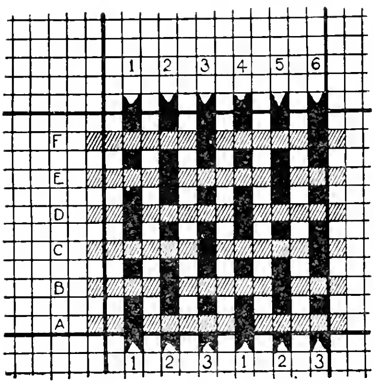


Fig. 10.

In this design (Fig. 11) the twill is complete within a given space, and if we extend the design, it will be a continuous and unbroken repetition of the first three threads, 1, 2, 3, also the first three picks as shown in design Fig. 11. Let us go one step farther and examine Figs. 12 and 13; the conditions are quite opposite; this is a simple reversal of the twill, that is, the warp

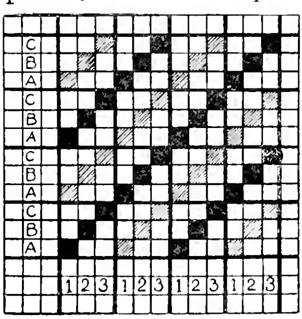


Fig. 11.

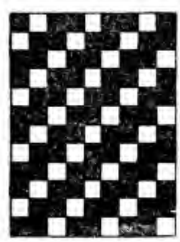


Fig. 12.

is lifted two threads, on each pick of the complete design, viz.: the first two threads are raised as indicated by black squares, while the third thread is left down or depressed,—exactly the reverse of Figs. 9, 10 and 11.

In these examples, every three threads and picks are an exact repetition of the first three, and any number of threads may be taken from one side and placed on the other side, or they may be taken from the bottom and vice-versa. The twill will be continuous and unbroken. In the absence of design paper there are other methods of indicating a weave. Take the plain weave as the

First Example. It can be stated thus $\frac{1}{\quad 1}$, or written 1 up and 1 down.

Second Example. The three-harness twill, filling flush, or $\frac{1}{\quad 2}$, or 1 up and 2 down.

Third Example. The three-harness twill, warp flush, or $\frac{2}{\quad 1}$, or 2 up and 1 down.

The word up, or figure above the line, indicates the number of threads to be raised on each pick, while the word down, or figure below the line, signifies that such threads must be depressed for the filling to pass over.

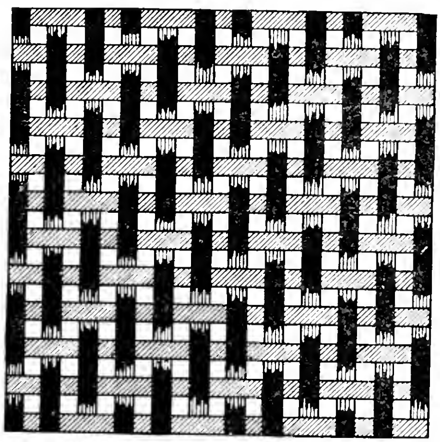


Fig. 13.

The 45-degree twills are divided into two classes, those which are even-sided and those which are uneven-sided. The even-sided twills are those in which the warps and fillings are evenly balanced. By an examination of Figs. 14 and 15, it will be noticed that the number of threads raised is equal to the number of threads depressed. Also notice that it is a four-harness twill, and that each succeeding four threads and picks are a repetition of the first four. The line of twill is continuous and unbroken. The written formula is 2 up and 2 down, or $\frac{2}{\quad 2}$. This weave is called the four-harness common twill, cassimere twill and shalloon twill.

The uneven-sided twills are of two kinds,— those that are on an even number of harnesses and those that are on an uneven number of harnesses.

Fig. 16 represents an uneven-sided twill on an even number of harnesses. This weave is called the 4-harness swansdown; it has three-fourths of the filling on the surface. Formula $\frac{1}{3}$.

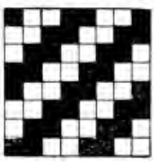


Fig. 14.

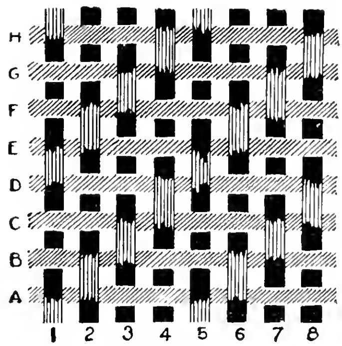


Fig. 15.

The reverse of this weave would be the $\frac{3}{1}$, and would indicate the warp surface weave, commonly called the crow weave.

Fig. 17 represents an uneven-sided twill on an uneven number of harnesses. On this weave, it will be noticed that there are only two threads raised, while there are three threads depressed; formula $\frac{2}{3}$. This weave can be reversed so that the conditions would be opposite; formula $\frac{3}{2}$.

Attention is again called to the angle of the twill. It is continuous and unbroken and at an angle of 45 degrees. In designing twills always begin at the lower left-hand corner of the design and make out angle of twill for full number of threads, both warp and filling. Thus, a full weave for an eight-harness twill would require eight threads and eight picks, requiring eight small squares each way of the design paper. The student should run out each design to fully twice the original number of threads and picks. Study each side, top and bottom, also study the termination when a design is complete. The number of

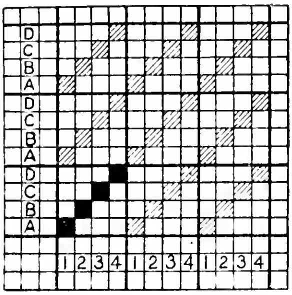


Fig. 16.

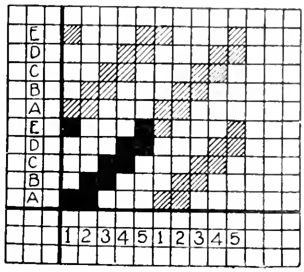


Fig. 17.

threads and picks to complete the design should be seen at a glance and to be sure that in repetition it will be continuous and unbroken.

EXERCISES FOR PRACTICE.

Copy Figs. 11, 12, 14, 16 and 17 and extend them over at least double the number of threads in each direction, taking care to work upon squares which represent the number of threads occupied by the original design, filling each in succession, and paying no attention to the thick lines upon the paper. At first, do not be in a hurry to carry the design in a straight line over the whole space, but work strictly in the squares as shown in the above examples.

1. Make all the 45° twills possible upon four threads, and repeat them after the manner shown in Figs. 11 and 12, to be certain that the pattern will be complete and continuous for an indefinite length.

2. Make all the 45° twills possible upon 5, 6 and 7 threads respectively, after the manner suggested in No. 1.

NOTE. In working out these Exercises the chief objects are *first*, to determine when a pattern is complete, and, to be certain that this is the case, the student might cut a portion from one side and place it on the opposite side, to see if the design really fits together. A little practice in comparing one side with the other will soon enable him to discern this without cutting. The *second* object is to ascertain the number of threads in the design when complete, to prepare for the lessons in drafting, and drawing the warp threads through the heddles, in order to weave

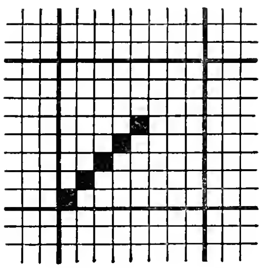


Fig. 18.

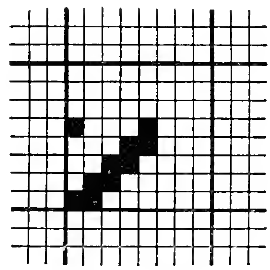


Fig. 19.

with the fewest number possible. The comparison of designs is of great importance, as a knowledge of their relations will be required in subsequent work.

FANCY 45 DEGREE TWILLS.

The student must not confine himself to what are commonly known as simple twills, but should find out how many designs

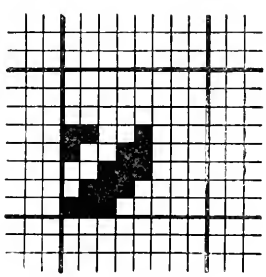


Fig. 20.

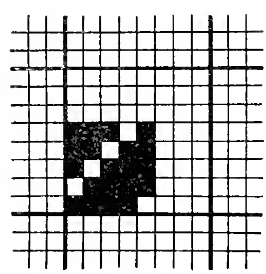


Fig. 21.

and what variety he can produce upon a given number of threads. The best plan in going about this work — and this holds good in every branch of the work is to proceed in the most systematic manner.

For instance, take five threads as a base and work out as many regular twills as possible. These are given in Figs. 18, 19, 20, 21, 22 and 23, which show the full limit in producing what are commonly known as "regular twills" on five harnesses.

This expression "regular twills" must be understood, as it is in the trade, to apply to twills running at an angle of 45 degree, and with no fancy figure accompanying it.

It should be noticed that all 45-degree twills move or advance 1 thread to the right until the full repeat of the weave has

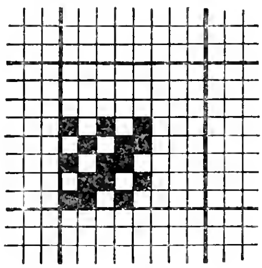


Fig. 22.

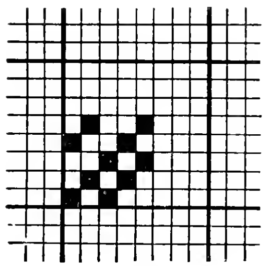


Fig. 23.

been obtained and can be worked out from a written formula, thus, Fig. 18, $\frac{1}{\quad 4}$: Fig. 19, $\frac{2}{\quad 3}$: Fig. 20, $\frac{3}{\quad 2}$: Fig. 21, $\frac{4}{\quad 1}$; Fig. 22, $\frac{2 \quad 1}{\quad 1 \quad 1}$: Fig. 23, $\frac{1 \quad 1}{1 \quad 2}$. These examples refer to the first pick of each design which is a 45-degree twill, but when the twill is irregular there must be another method of indicating the weave.

For instance, Fig. 18 is on 5 harnesses and could be indicated $\frac{1}{\quad 4}$ or 1 + 1 + 1 + 1 + 1 or 1, the move number, or $\frac{1}{\quad 4}/1$.

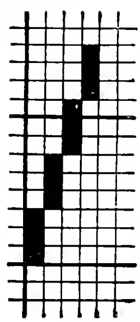


Fig. 24.

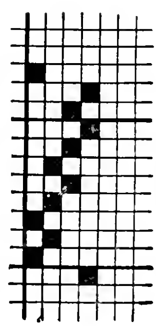


Fig. 25.

The weave on 4 harnesses as shown at Fig. 24 is known as the 70-degree steep twill, the written formula is 1 + 0 + 0.

The terms 1 + 0 + 0, etc., refer to the position of the points in a base with reference to one another, counted horizontally in the example given. Thus, in Fig. 24 the mark on the first pick is placed in the first point or small square, that on the second pick moved in position 0, *i. e.*, in the same position; that on the third pick moved 0, that on the fourth moved 1 and so on throughout.

Fig. 25.	weave commencing on 1st pick.
1 + 1	2nd pick moves 1 forward.
1 + 1 — 1	3rd pick moves 1 in opp. direction.
1	4th pick moves 1 forward.
1 + 1	5th pick moves 1 forward.
1 + 1 — 1	6th pick moves 1 in opposite direction, and so on

until the weave begins to repeat. Similarly 3 + 3 — 5 may be commenced at any point as shown at Fig. 26; weave on 9 harnesses

+ 3	1st thread and 1st pick.
— 5	moves 5 in opposite direction.
+ 3	moves 3 forward.

Take Fig. 26 as an example. The weave is on 9 threads, therefore the counting or moving must be worked from 1 to 9. Commencing at the first thread a point is placed on the 1st square, the 2nd pick is marked — 5 or 5 in the opposite direction, or, 9, 8, 7, 6, 5, hence the next point is on thread 5. The 3rd pick is marked + 3 or 3 forward, or 6, 7, 8, the third point on the 8th third; the fourth pick is marked + 3 or 3 forward, then 9, 1, 2, fourth point on 2nd thread, 5th pick is marked — 5 or 5 in opposite direction, then, 1, 9, 8, 7, 6, fifth point on 6 thread and so on throughout until the weave repeats.

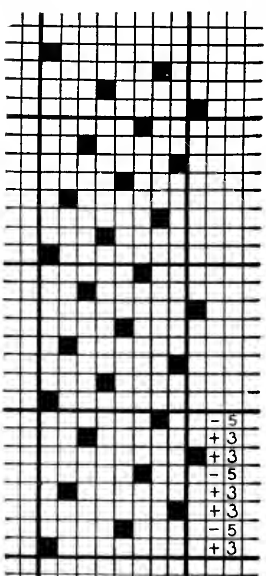


Fig. 26.

The next step in the work is to produce as many designs as possible upon any given number of threads, and in doing so proceed systematically, as in the five-harness examples, first with 1 point, then with 2, and so on, until a complete series of simple lines as in Figs. 18 to 23 has been run through, and, according to the number of threads, open out the space between the lines of twill. Make light and heavy lines and vary them until there is no further room for variation, observing the repetitions of the pattern in the reverse order, both in the

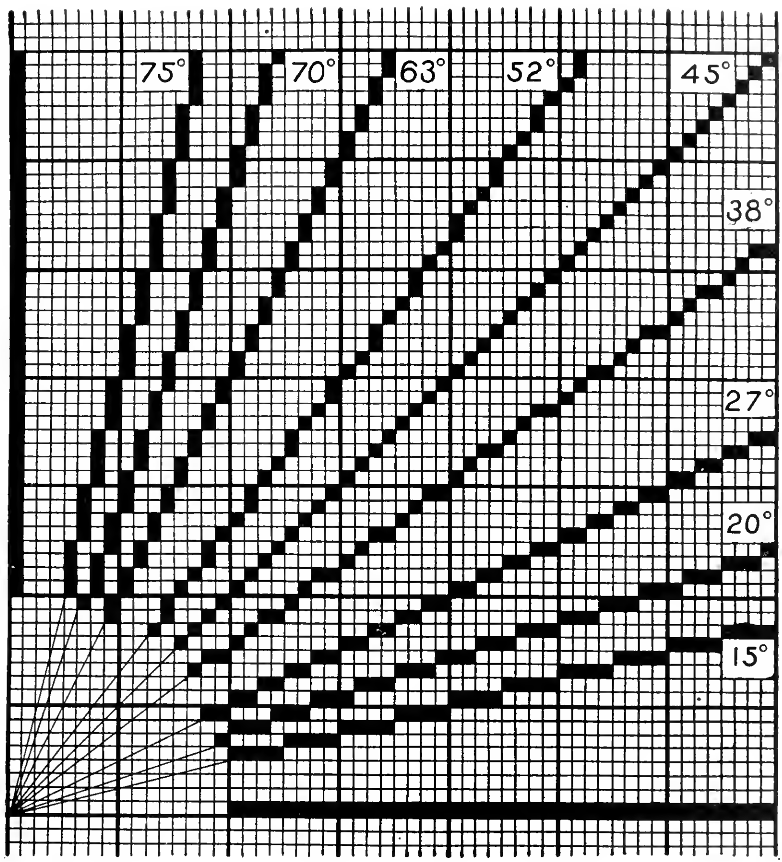


Fig. 27.

quantity of material which comes to the surface, and in the position of the twill.

Diagrams for illustrating the construction of reclining and steep twills are shown in Fig. 27.

Steep and Reclining Twills.

The	15°	reclining	twill is formed by moving	4 points,	Fig. 28
"	20°	"	" " " " "	3 "	" 29
"	27°	"	" " " " "	2 "	" 30
"	38°	"	" " " " "	1+2 "	" 31
"	45°	Regular	" " " " "	1 "	" 32
"	52°	Steep	" " " " "	1+1+0	" 33
"	63°	"	" " " " "	1+0	" 34
"	70°	"	" " " " "	1+0+0	" 35
"	75°	"	" " " " "	1+0+0+0	" 36

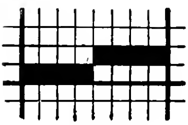


Fig. 28.

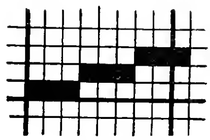


Fig. 29.

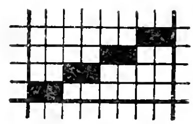


Fig. 30.

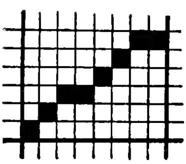


Fig. 31.

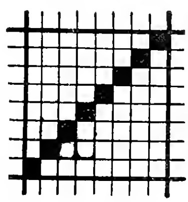


Fig. 32.

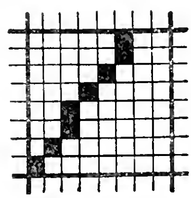


Fig. 33.

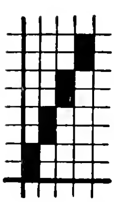


Fig. 34.

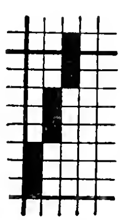


Fig. 35.

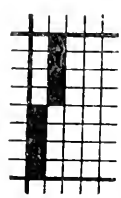


Fig. 36.

Any of the intermediate degree twills can be formed according to the requirements of design.

INTERSECTIONS, INTERLACING, AND CUT SECTIONS.

What is the meaning of intersecting, interlacing, and interweaving? Take the plain weave for an example, $\frac{1}{\quad 1}$. If we have a number of threads and lift the 1st, 3rd, 5th, 7th, etc., and depress or sink the 2nd, 4th, 6th, 8th, etc., and between these sets of threads we introduce a pick of filling, we should be interlacing or interweaving the warp threads. What would be the result? Fig. 37 illustrates the section of 8 warp threads in a

Fig. 37. Cut Section.

plain cloth, interwoven with one pick of filling, A. We have 1st thread up, then an intersection of filling, 2nd thread down, then an intersection of filling. In Fig. 37 there are 8 warp threads and 8 intersections of filling. = 16 units.

The answer to the above question is: Interlacing and interweaving is inserting the filling between two or more systems of warp threads, while the intersection is the space occupied by the warp or filling between any number of threads, warp or filling.

Fig. 38. Cut Section.

On the design paper the spaces represent the warp and filling, while the lines represent the intersections.

Take the next example, the three-harness $\frac{1}{\quad 2}$ twill: one thread up and one intersection, two threads down and one intersection, threads 2 and 3 lying close together and no intersection. Fig. 38 shows 3 threads and 2 intersections = 5 units.

We will now examine the cassimere or shalloon twill $\frac{2}{\quad 2}$. (See Fig. 15.) We notice that the filling thread interweaves alternately over and under two warp threads as shown in Fig. 39, and in the same order the warp threads interlace over and under two filling threads, (Fig. 40); but by studying Fig. 15, we find that each succeeding filling thread does not pass over the same two warp threads, nor does each consecutive warp thread interlace over or under the same two filling threads, nor are they alternate as in plain cloth, but they change in regular consecutive

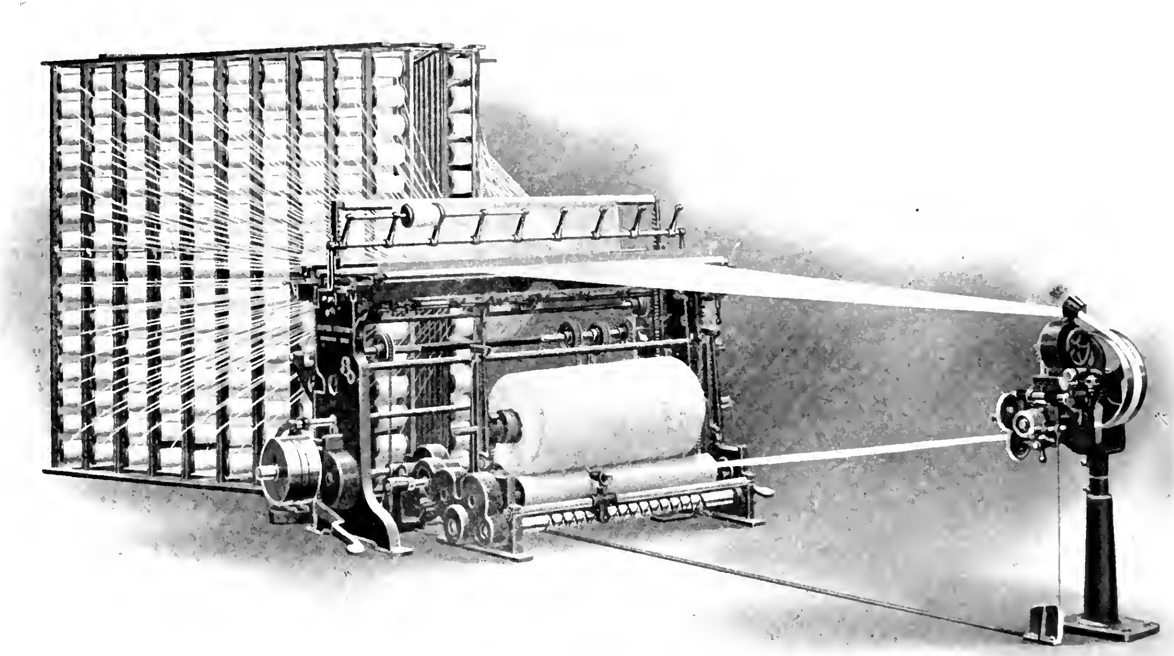
Fig. 39. Cut Section.

order. That is, if the 1st pick, A, interweaves over the threads Nos. 1 and 2, and under Nos. 3 and 4; the 2nd pick, B, will pass under Nos. 1 over 2 and 3 and under 4; the 3rd pick, C, will pass under 1 and 2, and over 3 and 4; the 4th pick, D, will pass over 1 under 2 and 3, and over 4. The 5th pick, E, is a repetition of No. 1, and so on. The design is continuous and unbroken, each thread and pick advancing one before it rises to the surface or passes to the back of the fabric. It is this order of interlacing that gives the effect of producing in the cloth distinct twills or diagonal lines at an angle of 45 degrees. This mode of interweaving is called the even, or balanced system. There are, as in the plain weave, as many of each system of threads on the face of the cloth as there are on the back. The longer the floats or intervals that we interweave and interlace the warp and filling, the greater the amount of material that can be introduced the greater the gain in weight and substance.

Fig. 46.

We will now examine the three weaves under consideration. Plain weave one up and one intersection, one down and one intersection or two threads and two intersections.

We have already learned in studying the plain weave that when constructed on the truest principles, warp and filling of the same size or counts, number of threads and picks being equal, it will make a cloth more or less perforated according to the material used. The fabric would be built to withstand wear and tear and friction, but we could not obtain bulk and compactness.



WARPER WITH CREEL AND BALLING MACHINE ATTACHMENT
The Draper Company

Now let us examine the three-harness twill, $\frac{1}{2}$, Fig. 41. We have two intersections in every three threads, as one up and one intersection, two down and one intersection, therefore, allow-

Fig. 41. Cut Section.

ing threads 2 and 3 to lie close together without any perforations.

In the four-harness cassimere or shalloon twill, $\frac{2}{2}$, Fig. 42, we find that there are only two intersections on every four threads; two threads up and one intersection, and two threads

Fig. 42. Cut Section.

down and one intersection, thus giving still more opportunity to gain weight and compactness of texture, as an examination of Fig. 42 will show. On the first pick the first and second threads are lying close together, then an intersection; third and fourth threads lying together, then an intersection, and so on, consecutively and continuously.

Fig. 43. Cut Section.

The three weaves on twelve threads, their intersections and units stand as follows:

Plain weave Fig. 43, 12 threads and 12 intersections = 24 units. Three-harness twill Fig. 41, 12 threads and 8 intersec-

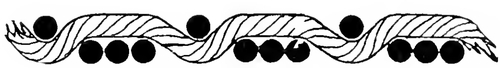


Fig. 44. Cut Section.

tions = 20 units. Four-harness twill Fig. 42, 12 threads and 6 intersections = 18 units.

Take another example, Fig. 44: The four-harness filling-flush twill, commonly called the swansdown weave; one up and three down, or the warp-flush twill Fig. 45; one down and three up, commonly known as the crow weave.

In these two weaves there are only two intersections on four

Fig. 45. Cut Section.

threads, and there are three warp threads lying close together, either on the face or back of the cloth. These weaves give us more liberty to use heavier material or a greater number of threads in the warp or filling, according to the weave used.

These intersections, units and warp or filling flushes are items that must be considered when designing textile fabrics.

The following will show how an examination question or exercise should be answered.

Question. Write in your own words an explanation of the use of design paper. What do you mean by the dots placed upon it and how does it convey your ideas to others?

Answer. Design paper is used to represent woven cloth as follows: The series of squares running vertically represent the warp threads in the loom and the series of squares running horizontally represent the filling, weft, woof or pick threads inserted by the shuttle. If the warp threads are to show on the face of the cloth, the filling or weft threads must go under them. A dot or cross placed in a square indicates that the warp thread is on the surface and vice versa a blank square means that the filling or weft is on the surface and the warp under the filling.

Suppose the warp threads are black and those to be put in by the shuttle are white. A black and white design, or fabric to be woven, is shown on the design paper by indicating by a cross or dot placed in the square what warp threads are to show on the surface. Imagine that each small square on the design paper is reduced so small that it can contain only a needle point. It is then readily seen that a design is traced by a succession of minute dots. The design paper thus used will give a very good imitation of a woven fabric.

MOVE NUMBERS FOR ALL REGULAR WEAVES UP TO 10 THREADS.

No. of threads		Single move nos.					Double move nos.							Treble move nos.											Irregular
2	Number of picks	1 2					1+0 4							1+0+0 6											
3	Number of picks	3					6							1-1+1 9	1+1+0 9										
4	Number of picks	4	2				2-1 8	2+0 4						2-1+0 2-2+1 12	2+0+0 2-1+1 6										2+1+2-1 4
5	Number of picks	5	5				10	10	2+1 10					15	2-2+2 15	2+1+0 2+2-1 15	2+1+1 2+2+0 15	2+2+1							
6	Number of picks	6		3			3-2 12	3-1 6	3+0					3-1-1 3-2+0 3-3+1 -3+2+2 18	3-1+0 3-2+1 3-3+2 9	3+0+0 3-1+1 3-2+2 6	9	18							3+1+1+3-1-1 3-1+2+1+2-1 3+2+2+3-2-2 6
7	Number of picks	7	7	7			14	14	14	3+1 14	3+2 14			21	21	3-3+3 21	3+1+0 3+2-1 3+3-2 21	3+1+1 3+2+0 3+3-1 21.	3+2+1 3+3+0 21	3+2+2 3+3+1	3+3+2 21				
8	Number of picks	8		8	4 2		4-3 16	4-2 8	4-1 16	4+0	16			4-2-1 4-3+0 4-4+1 -4+3+2 24	4-1-1 4-2+0 4-3+1 4-4+2 -4+3+3 12	4-1+0 4-2+1 4-3+2 4-4-3 24	4+0+0 4-1+1 4-2+2 4-3+3 6	24	12	24					4+2-1+2+4-2+1-2 4+2-3+2+4-2+3-2 4+1+1+1+4-1-1-1 4-1+3-1+4+1-3+1 4+1+2-1+4+1-2-1 3-1-1+3+3-1-1+3 8
9	Number of picks	9	9		9		18	18		18	4+1 18	4+2	4+3 18	27	27	9	4-4-4 27	4+1+0 4+2-1 4+3-2 4+4-3 27	4+1+1 4+2+0 4+3-1 4+4-2 9	4+2+1 4+3+0 4+4-1 27	4+2+2 4+3+1 4+4+0 27	4+3+2 4+4+1	4+3+3 4+4+2 27	4+4+3 27	
10	Number of picks	10		10		5 2	5-4 20	5-3 10	5-2 20	5-1 10	5+0 4	10	20	5-2-2 5-3-1 5-4+0 5-5+1 -5+4+2 -5+3+3 30	5-2-1 5-3+0 5-4+1 5-5+2 -5+4+3 15	5-1-1 5-2+0 5-3+1 5-4+2 5-5+3 5+4+4 30	5-1+0 5-2+1 5-3+2 5-4+3 5-5+4 15	5+0+0 5-1+1 5-2+2 5-3+3 5-4+4 6	15	30	15	30		30	5+1+1+1+5-1-1-1 5-3+2+2-3+5+3-2-2+3 5+3-1-1+3+5-3+1+1-3 5-1+2+2-1+5+1-2-2+1 10

SELECTED ORDERS FOR WEAVING ON 2 TO 10 THREADS.

Number of threads	For all move nos.					For double move nos. only		For treble move nos. only	
2	$\frac{1}{1}$								
3	$\frac{1}{2}$								
4	$\frac{2}{2}$					$\frac{2}{2}$ & $\frac{11}{11}$		$\frac{2}{2}$ & $\frac{11}{11}$ & $\frac{2}{2}$	$\frac{11}{11}$ & $\frac{2}{2}$ & $\frac{11}{11}$
5	$\frac{2}{3}$	$\frac{11}{12}$				$\frac{2}{3}$ & $\frac{11}{12}$		$\frac{2}{3}$ & $\frac{11}{12}$ & $\frac{2}{3}$	$\frac{11}{12}$ & $\frac{2}{3}$ & $\frac{11}{12}$
6	$\frac{3}{3}$	$\frac{21}{12}$				$\frac{3}{3}$ & $\frac{21}{12}$	$\frac{21}{12}$ & $\frac{21}{21}$	$\frac{3}{3}$ & $\frac{21}{12}$ & $\frac{3}{3}$	$\frac{21}{12}$ & $\frac{3}{3}$ & $\frac{21}{21}$
7	$\frac{3}{4}$	$\frac{21}{13}$	$\frac{21}{22}$	$\frac{111}{112}$		$\frac{21}{13}$ & $\frac{21}{31}$	$\frac{21}{13}$ & $\frac{21}{22}$	$\frac{21}{13}$ & $\frac{21}{22}$ & $\frac{21}{31}$	
8	$\frac{4}{4}$	$\frac{22}{13}$	$\frac{31}{13}$	$\frac{211}{121}$	$\frac{211}{112}$	$\frac{31}{13}$ & $\frac{31}{31}$	$\frac{22}{13}$ & $\frac{211}{121}$	$\frac{31}{13}$ & $\frac{22}{13}$ & $\frac{31}{31}$	$\frac{211}{112}$ & $\frac{211}{121}$ & $\frac{211}{211}$
9	$\frac{4}{5}$	$\frac{22}{23}$	$\frac{221}{211}$	$\frac{1111}{1112}$		$\frac{31}{32}$ & $\frac{31}{23}$		$\frac{31}{14}$ & $\frac{22}{23}$ & $\frac{31}{41}$	
10	$\frac{5}{5}$	$\frac{41}{14}$	$\frac{32}{23}$	$\frac{221}{122}$	$\frac{1121}{1112}$	$\frac{41}{14}$ & $\frac{41}{41}$		$\frac{221}{113}$ & $\frac{311}{131}$ & $\frac{212}{311}$	

EXERCISES IN PLAN MAKING.

Work out weaves from the following:

(1) $\frac{2}{3}\frac{2}{1}\frac{2}{2}\Big/1$ (2) $\frac{3}{2}\frac{2}{1}\frac{2}{2}\Big/5$

(3) $\frac{1}{1}\frac{2}{2}\frac{3}{3}\Big/1$ (4) $\frac{1}{1}\frac{2}{2}\frac{3}{3}\Big/5$

(5) $\frac{2}{1}\frac{2}{1}\frac{2}{4}\Big/1$ (6) $\frac{2}{1}\frac{2}{1}\frac{2}{4}\Big/5$

(7—12) $\frac{3}{1}\frac{1}{1}\frac{3}{3}\Big/$ 1, 2, 3, 4, 5, 6.

(13—17) $\frac{2}{1}\frac{2}{1}\frac{2}{3}\Big/$ 1, 2, 3, 4, 5.

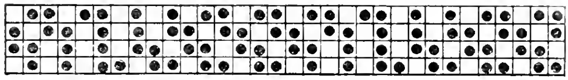
(18) $\frac{3}{1}\frac{3}{2}\frac{1}{2}\Big/5$ (19—21) $\frac{4}{2}\frac{1}{2}\frac{1}{2}\Big/$ 1, 2, 3.

(22—25) $\frac{2}{1}\frac{2}{1}\frac{2}{4}\Big/$ 1, 2, 3, 4.

(26—29) $\frac{3}{2}\frac{2}{1}\frac{2}{2}\Big/$ 1, 2, 3, 4. 3—2+2, 4—3+2, 4—2+1.

(30—33) $\frac{2}{3}\frac{2}{2}\frac{2}{1}\Big/$ and $\frac{2}{3}\frac{2}{1}\frac{2}{2}\Big/$ 2+0, 3—1, 4—2, 5—3.

MAKE ONE COMPLETE REPEAT OF EACH OF THE FOLLOWING DESIGNS.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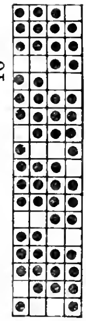
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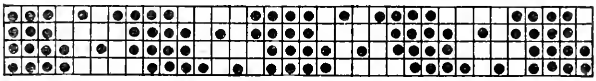
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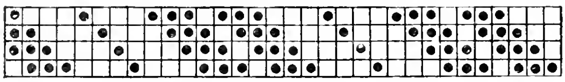
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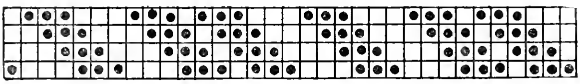
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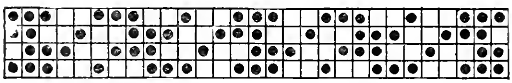
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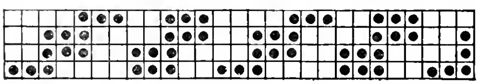
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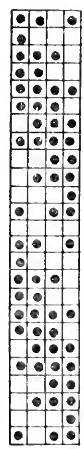
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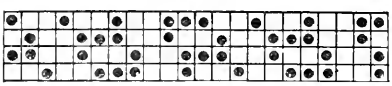
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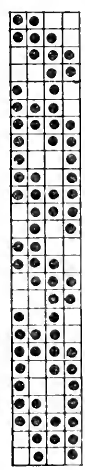
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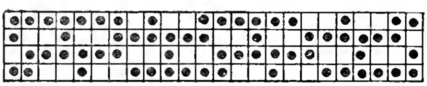
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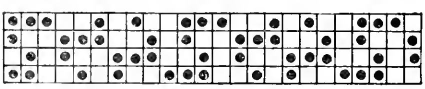
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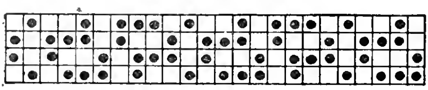
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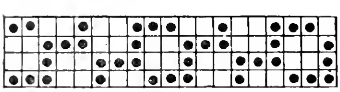
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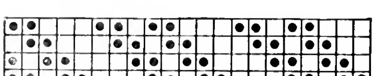
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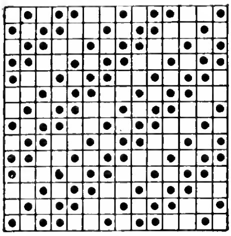
MAKE ONE COMPLETE PATTERN WITHOUT REPEAT OF EACH OF THE FOLLOWING.



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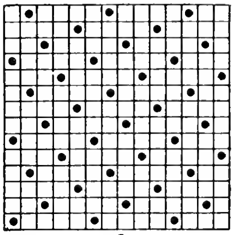

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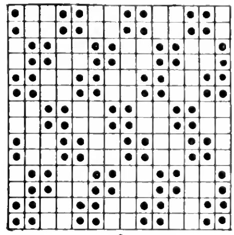

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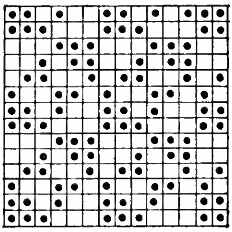

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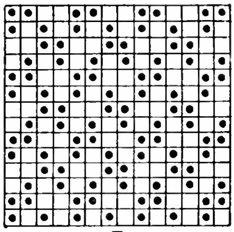

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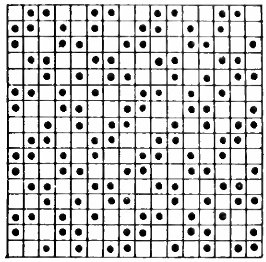

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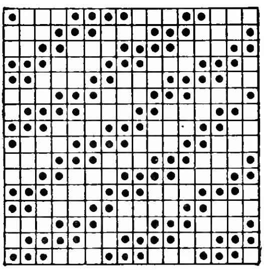

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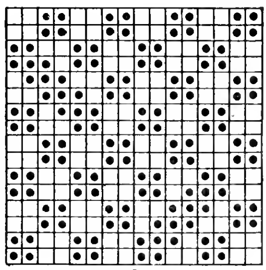

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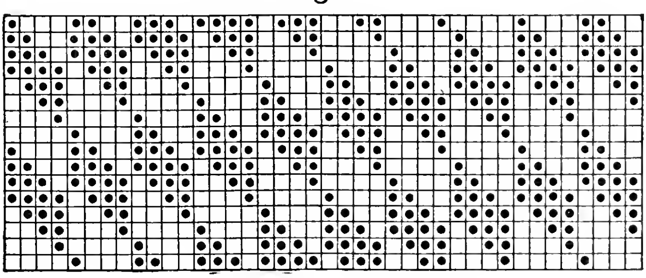

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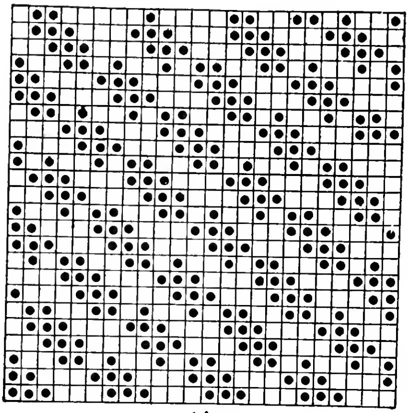

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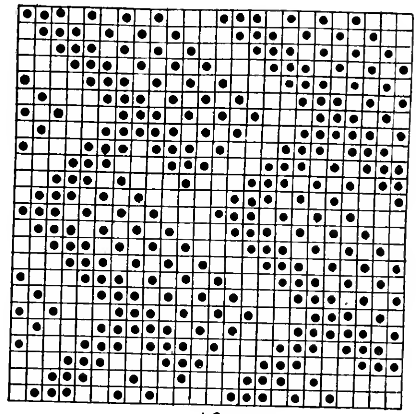

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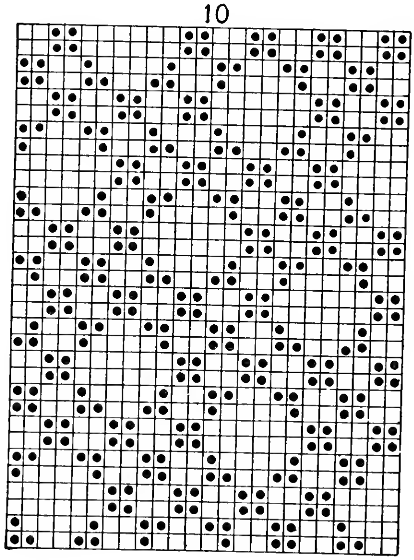

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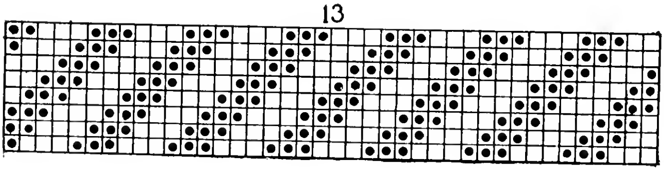
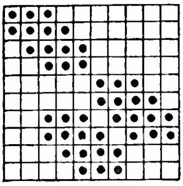


30 EXERCISES IN SPOT WEAVES.

COMPLETE THE WEAVES FROM THE ACCOMPANYING PORTIONS.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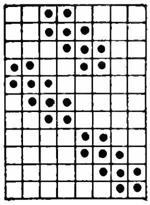
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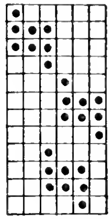
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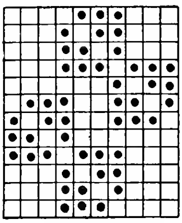
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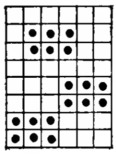
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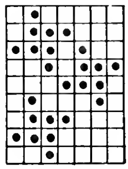
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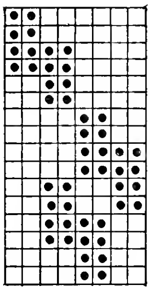
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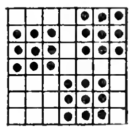
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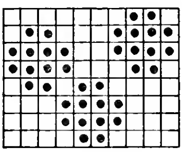
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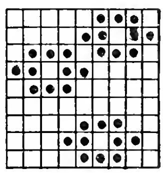
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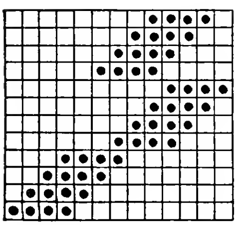
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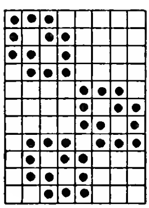
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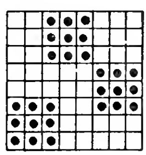
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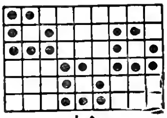
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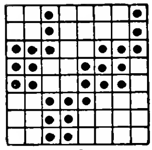
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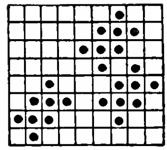
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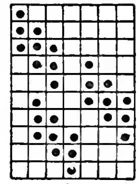
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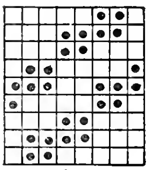
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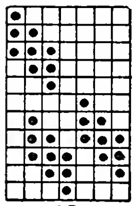
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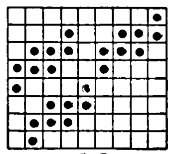
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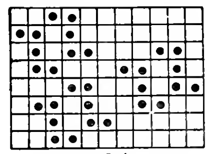
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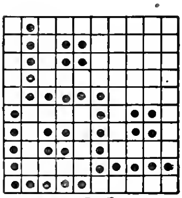
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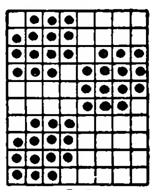
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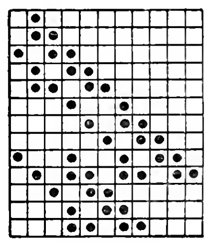
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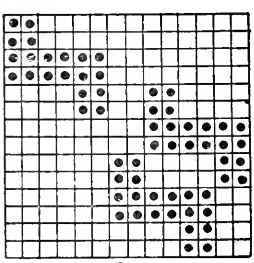
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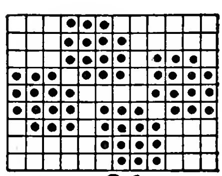
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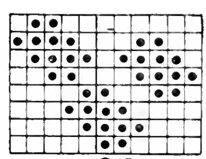
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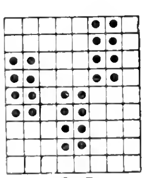
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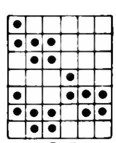
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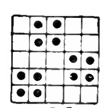
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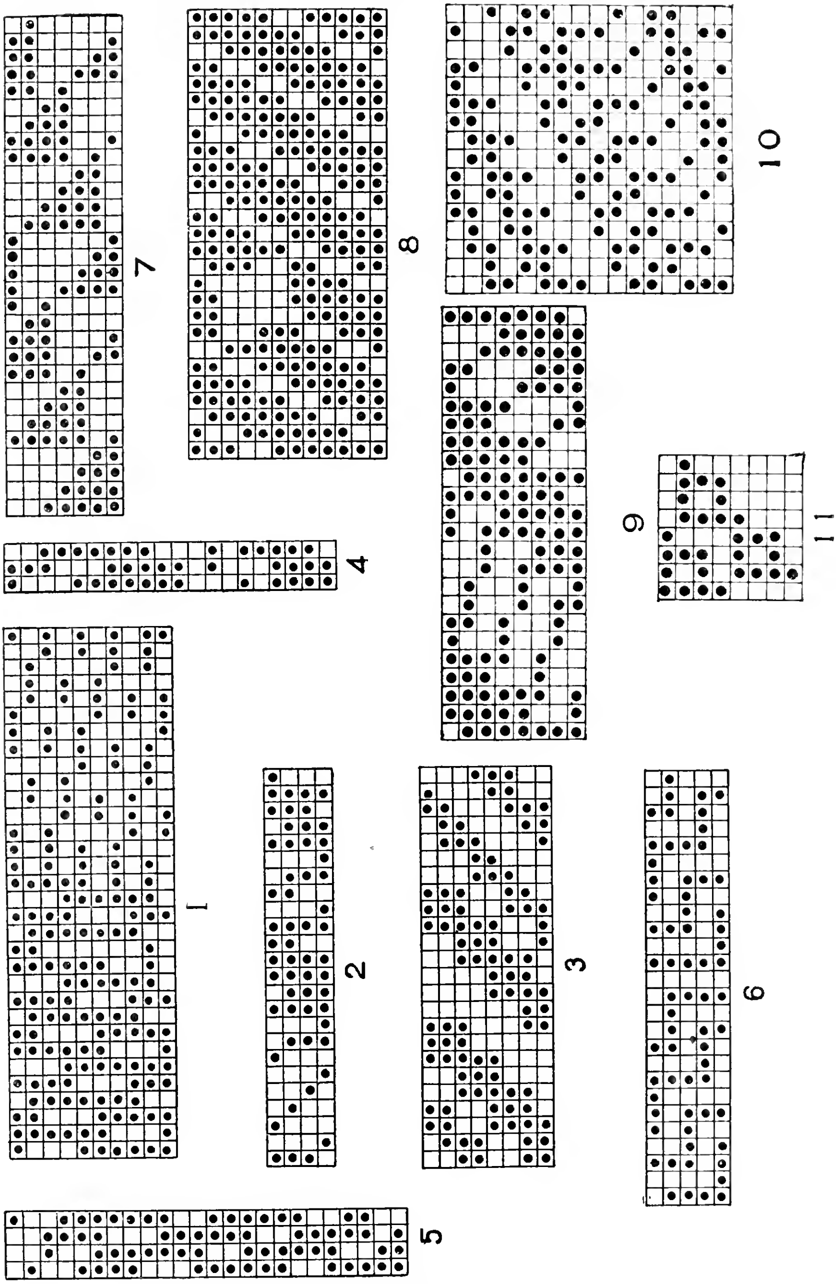
MAKE ONE COMPLETE REPEAT OF EACH OF THESE DESIGNS.



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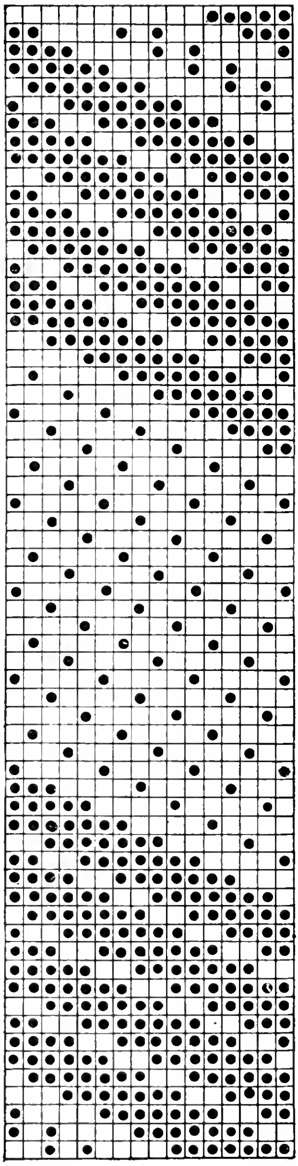

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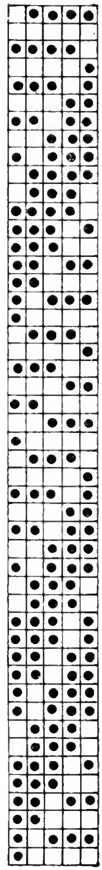

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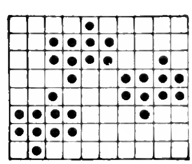

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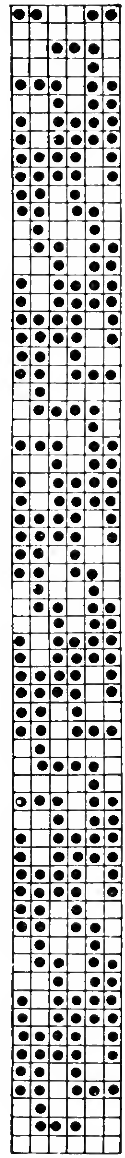


15

COLOR EFFECTS.

Influence of Color on Weaves, or the Application of Color to Fabrics.

The great variety of patterns produced in all lines of fabrics, are many of them made on the same weave, the change in the pattern being obtained in the arrangement of the colors in the warp and filling. To understand how this change is made, it is only necessary to bear in mind that where warp is raised that color will appear, and where filling is on the surface that color will appear. These changes are called color effects, and the simplest form which can be designed is the common hair-line, which shows in the pattern one thread of a light color and one thread of a dark color, running lengthwise of the fabric. It is made on the plain weave. By careful study the method will be learned quickly, so that any number of effects can be produced.

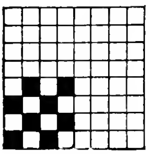


Fig. 46.

These color effects are made to get an idea of the appearance after weaving of any arrangement of colors on a certain weave. In making these color patterns, decide what weave is to be used. To commence, we will use the plain weave, Fig. 46. Next indicate the weave on the design paper by a small dot or faint mark, Fig. 47, which will serve as a guide which thread must

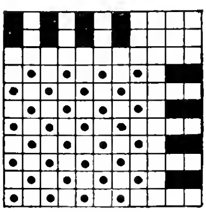


Fig. 47.

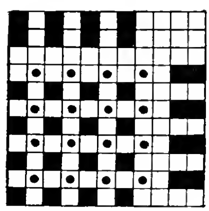


Fig. 48.

be raised. Then indicate at the top, and right-hand side of the design, the arrangement of colors (see Fig. 47) which we will assume to be one thread red and one thread green in the warp, and one thread green and one thread red in the filling. After having indicated the weave and the arrangement of colors, the next operation is to mark where the warp is raised as indicated by a small dot, the mark or square to be filled with such color as indicated by the color on the top of design as shown in Fig. 48. When this has been done, mark every filling pick as indicated by the squares being left blank, which indicates the warp down, with such color as represented on right-hand side of design, Fig. 49.

This pattern in color is called "The Hair-line." The simplest change from this hair-line pattern is to produce the line effect across or in the width of the fabric; this effect is made on

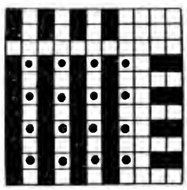


Fig. 49.

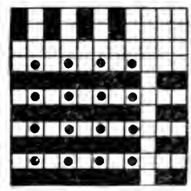


Fig. 50.

the same weave and arrangement of color in the warp, the only change being in the filling, which is one of red and one of green (see Fig. 50). The chief characteristic of such hair-lines and stripes, is that each color must cover its own or like color, that is, if red warp is down a red filling must cover it.

These color effects are the most important in designs for dress goods and in cotton, woolen and silk fabrics. Constant practice in making them will be of great assistance to the student, as an excellent experience will be obtained in regard to the various effects, and by the use of several colors the effect as in the cloth will be obtained.

Explanation of Fig. 47. The design is 8 threads by 8 picks, all plain or cotton weave. The small dots indicate which warp threads must be on the surface, the marks on the top indicate the color of such threads in the warp which must appear on the surface of the fabric. In this instance we will suppose the warp is dressed 1 thread black and 1 thread white all the way across. The marks on the right-hand side of Fig. 47 indicate the color of the weft or filling which must appear on the surface of the fabric.

Explanation of Fig. 48. Fig. 48 is like Fig. 47, with the warp threads lifted, squares filled out, showing the colors which are on the surface. In Fig. 47, the first thread and first pick is represented by ⊡ which indicates such thread to be lifted, and in Fig. 48 the corresponding square is filled up black, which is the color on the surface of the fabric, the 2nd thread and 1st pick is represented by □ , which indicates such thread to be down, and would be covered by the filling and the surface of the cloth would be the color of the filling. The second pick: the 1st thread is represented as down □ , this would be covered by the filling; the second thread on second pick is represented by ⊡ , which indicates the thread to be on the surface. The color mark over the second thread in Figs. 47 and 48 is white, therefore, white will be on the surface of the cloth.

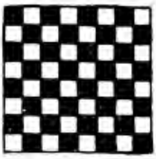


Fig. 51.

Explanation of Fig. 49. This is like Figs. 47 and 48, but interwoven with the filling as shown at the right-hand side.

Detail: 1st pick white: under black and over white alternately.
2nd pick black: over black and under white alternately.
3rd pick like the 1st, 4th pick like the 2nd, and so on, thus forming the "Hair-line" pattern, one dark line and one light line down the cloth. In the hair-line design black covers black and white covers white.

Explanation of Fig. 50. The particulars for the warp colors and weave are identical with Figs. 47, 48 and 49, but the interweaving of the filling is important.

The first pick is black in place of white. The second pick is white in place of black, or black covers white and white covers black, thus making the dark line across the fabric as shown in Fig. 50.

Explanation of Fig. 51. This shows the effect of the plain weave, warp solid black, filling solid white.

Fig. 52 is an example of the plain weave on 8 threads and 8 picks, arranged in the following manner:

$$\text{1st section, 4 threads}\left\{\begin{array}{l} \text{4 threads and 4 picks, plain weave } \frac{1}{1}. \\ \text{4 " " } \frac{4}{8} \text{ " " " } \frac{1}{1}. \end{array}\right.$$

2nd section, 4 threads:
- 4 threads and 4 picks, plain weave $\frac{1}{1}$.
- 4 " " $\frac{4}{4}$ " " " $\frac{1}{1}$.

Explanation: 1st section consists of 4 threads, 8 picks high divided into two parts, 4 threads and 4 picks regular $\frac{1}{1}$ plain weave

1st pick	— 4 threads,	1st up, 2nd down, 3rd up, 4th down.
2nd "	— 4 "	1st down, 2nd up, 3rd down, 4th up.
3rd "	— 4 "	1st up, 2nd down, 3rd up, 4th down.
4th "	— 4 "	1st down, 2nd up, 3rd down, 4th up.

This is the first part of 1st section. See the first 4 threads and picks 1 to 4 and picks A to D, Fig. 52.

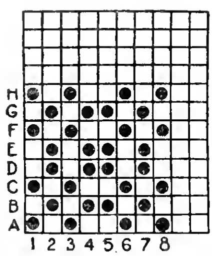


Fig. 52.

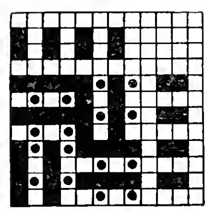


Fig. 53.

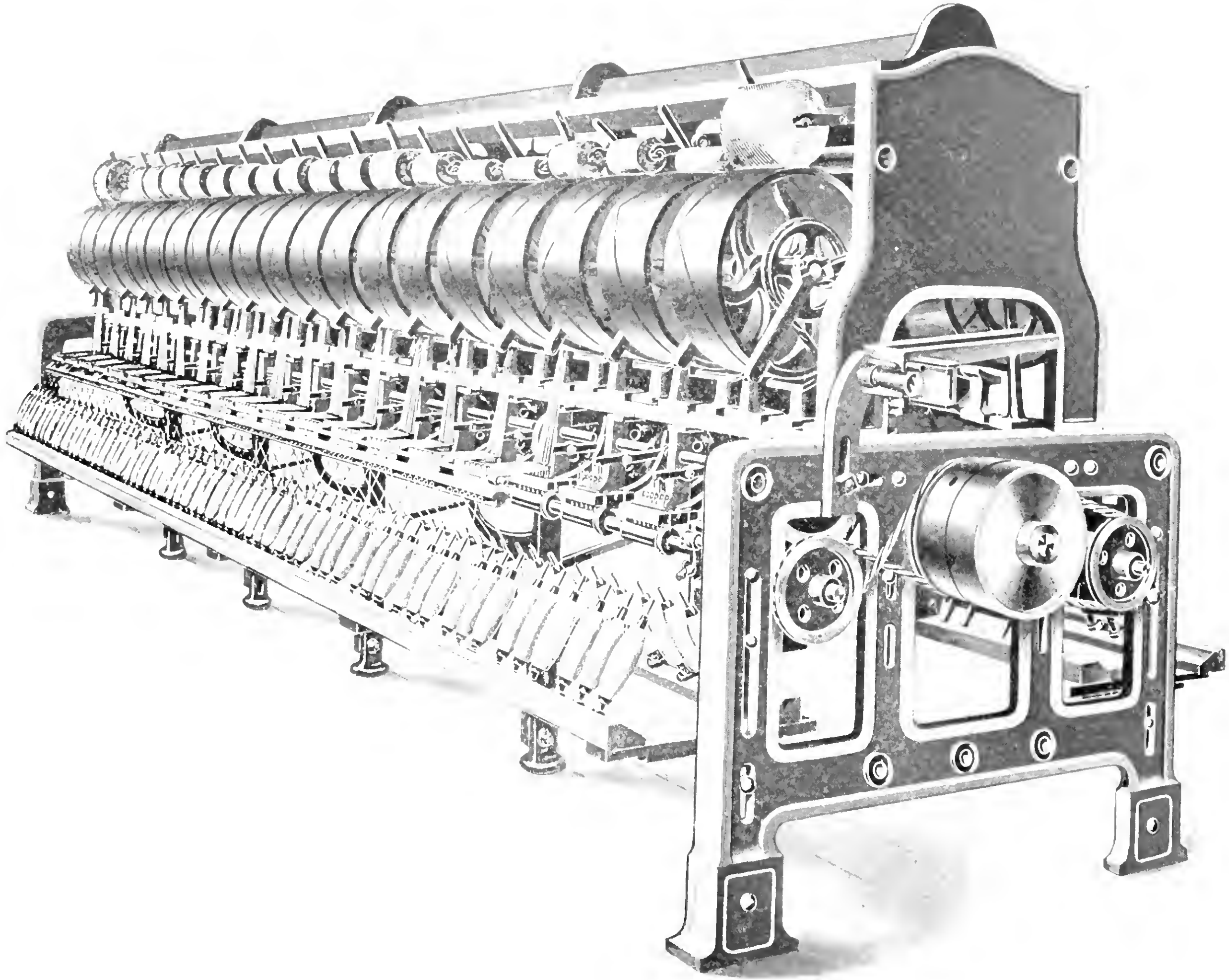
Second part of 1st section reads, 4 threads and 4 picks, plain weave, commencing with the second thread of the plain weave, which will read on the design paper:

1st section, 4 threads:

5th pick	4 threads	1st down, 2nd up, 3rd down, 4th up.
6th "	4 "	1st up, 2nd down, 3rd up, 4th down.
7th "	4 "	1st down, 2nd up, 3rd down, 4th up.
8th "	4 "	1st up, 2nd down, 3rd up, 4th down.

See Fig. 52. Threads 1 to 4 and picks E, F, G, H. This completes the first section, 4 threads and 8 picks.

Now take the second section of 4 threads, Nos. 5, 6, 7 and 8, in Fig. 52. First part reads 4 threads and 4 picks, plain weave, commencing with the second thread of the plain weave, which will read on the design paper:



THE MULLER PATENT TRAVERSE WINDING FRAME

1st pick — 5th thread down, 6th up, 7th down, 8th up.
2nd " — 5th " up, 6th down, 7th up, 8th down.
3rd " — 5th " down, 6th up, 7th down, 8th up.
4th " — 5th " up, 6th down, 7th up, 8th down.

Second part of section 2 reads 4 threads and 4 picks, plain weave, which reads on the design paper:

5th pick — 5th thread up, 6th down, 7th up, 8th down.
6th " — 5th " down, 6th up, 7th down, 8th up.
7th " — 5th " up, 6th down, 7th up, 8th down.
8th " — 5th " down, 6th up, 7th down, 8th up.

Fig. 53 is the same weaving plan as given in Fig. 52.
The warp is dressed 1 black and 1 white.
The filling is interwoven 1 white and 1 black.

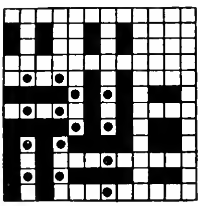


Fig. 54.

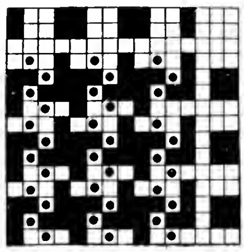


Fig. 55.

Fig. 54. The design is on 8 threads and 8 picks all plain weave, $\frac{1}{1}$.

The warp is dressed 1 black, 1 white, 1 black, 2 white, 1 black, 1 white, 1 black; = 8 threads.

The filling is interwoven, 1 white, 1 black, 1 white, 2 black, 1 white, 1 black, 1 white; = 8 picks.

Fig. 55. This design is shown on 12 threads and 12 picks, all plain weave.

The warp is dressed 1 black, 2 white, 2 black, 2 white, 2 black, 2 white, 1 black: = 12 threads.

The filling is interwoven, 1 white, 2 black, 2 white, 2 black, 2 white, 2 black, 1 white; = 12 picks.

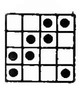
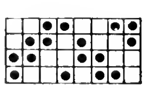
EXERCISES FOR PRACTICE.

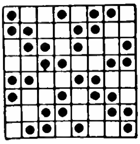
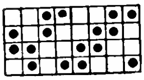
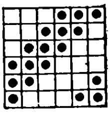
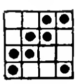
All on the Plain Weave.

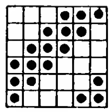
	WARP.		FILLING.	
1.	1 Red 1 Black	16 Threads.	1 Black 2 Red	16 Picks.
2.	1 Red 1 Black	16 Threads.	1 Red 1 Black	16 Picks.
3.	1 White 1 Black 2 White 1 Black	20 Threads.	1 Black 1 White 1 Black 2 White	20 Picks.
4.	2 White 1 Black	12 Threads.	2 White 1 Black	12 Picks.
5.	2 Black 2 Green	16 Threads.	2 Black 2 Green	16 Picks.

EXERCISES FOR PRACTICE.

Sketch on point paper the effect produced by the following weaves and colorings.

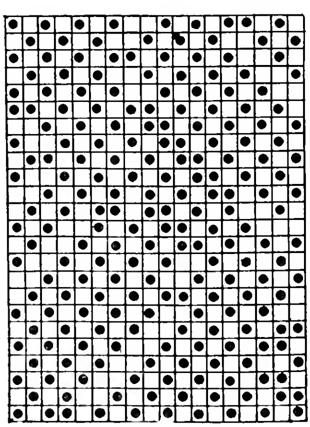
WEAVE.	WARP.	FILLING.
(1) 	Color— 1 Ground—1 } =2	as warp
(2) same as (1)	Color— 2 Ground—2 } =4	as warp
(3) same as (1)	Color— 2 Ground—2 } =4	as warp
(4) same as (1)	Color— 4 Ground—4 } =8	as warp
(5) same as (1)	Color— 2 2 Ground—1 3 } =8	Color— 1 3 Ground—4 . } =8
(6) 	Color— 4 Ground—4 } =8	as warp

WEAVE.	WARP.	FILLING.
(7) 	Color— 1 1 Ground—2 . } =4	as warp
(8) same as (6)	Color— 1 1 Ground—2 . } =4	Color— . 1 Ground—1 . } =2
(9) 	Ground—2 2 Color— 4 . } =8	Ground—3 1 Color— 4 . } =8
(10) 	Ground— .1 No. 1 Color—1 No. 2 Color—2 } =4	as warp
(11) same as (10)	Ground—1 1 Color— 2 . } =4	as warp
(12) same as (10)	Ground—3 Color— 3 } =6	Color— 3 Ground—3 } =6
(13) same as (10)	Ground—3 Color— 3 } =6	Ground—1 Color— 1 } =2
(14) same as (10)	Ground—. 1 Color— 2 . } =3	Ground—1 Color— 1 } =2
(15) same as (10)	Ground—. 1 Color— 2 . } =3	Ground—. 3 Color— 2 1 } =6
(16) same as (10)	Ground—1 1 3 2 Color— 1 1 3 . } =12	Ground—1 3 3 Color— 1 3 1 } =12
(17) same as (10)	Ground—. 1 3 Color— 1 1 . } =6	Ground—. 1 Color— 2 . } =3
(18) same as (10)	Ground—2 1 Color— 1 2 } =6	as warp
(19) 	No. 1 Color— 1 3 No. 2 Ground—1 1 } =16 4 times twice	No. 2 Ground—All
(20) same as (19)	No. 1 Color— 1 1 1 2 2 No. 2 " 1 1 1 2 2 No. 3 Ground— 2 2 2 2 2 } =24	No. 3 Ground—All
(21) same as (19)	No. 1 Color— 1 1 1 2 2 No. 2 " — 1 1 1 2 2 No. 3 Ground—2 2 2 2 2 } =24	No. 2 Color— 1 1 No. 3 Ground—2 . } =4
(22) same as (19)	No. 1 Color— 2 2 No. 2 Ground—1 3 } =8	No. 1 Color— . 4 No. 2 Ground—1 3 } =8

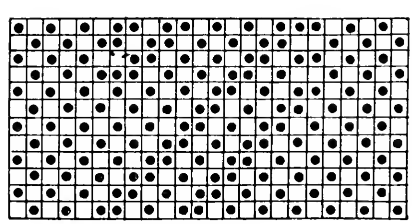
WEAVE.	WARP.	FILLING.
(23) 	No. 1 Color— 1 2 . . 2 No. 2 " 1 . 1 1 . No. 3 Ground—1 1 2 2 1 } =24 4 times	No. 1 Color— 1 No. 3 Ground—2 } =3
(24) same as (23)	No. 1 Color— 1 3 No. 2 Ground—1 3 } =36 6 times 4 times	No. 1 Color— 2 No. 2 Ground—1 } =3
(25) same as (23)	No. 1 Color— . 1 1 3 No. 2 Ground—1 1 3 2 } =12	No. 1 Color— . 1 3 1 No. 2 Ground–1 3 3. } =12
(26) plain	Ground— 1 1 1 1 1 No. 1 Color 3 . 1 1 . } =40 4 times 4 times	
(27) same as (26)	Ground— 1 1 1 No. 1 Color— 1 1 . } =20 4 times 4 times	
(28) same as (26)	Ground— 1 1 1 No. 1 Color— 1 1 . } =5	
(29) same as (26)	Ground— 1 1 1 1 1 No. 1 Color—2 . 1 2 . } =24 3 times twice	

Sketch on point paper the effects produced by weaves 30 and 31 warped and picked 1 color

$\frac{1}{2}$ ground



30



31

Design from a written formula. Suppose a design is required similar to Fig. 56. The first question is; how many threads and picks are necessary to form the full design? Second: how many threads and picks are necessary for the large body square at the lower left-hand corner? Third; how many threads and picks are necessary for the small border squares? Fourth: what weave will be the most suitable for the required fabric?

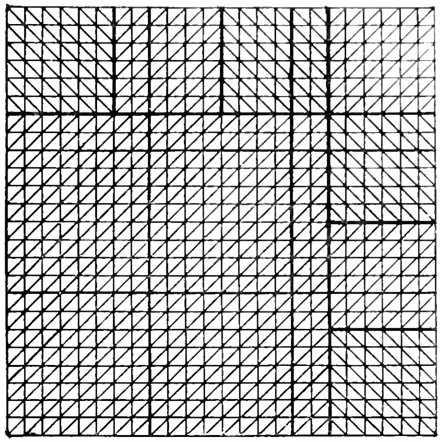


Fig. 56.

A design should never be made without taking into consideration the requirements of each operation and the effect to be produced. In the main body square of Fig. 56 the twill is running at an angle of 45°, and in the small squares the twill is running to the right and left in alternate squares. We will make our first design on 24 threads × 24 picks in one repeat of the design.

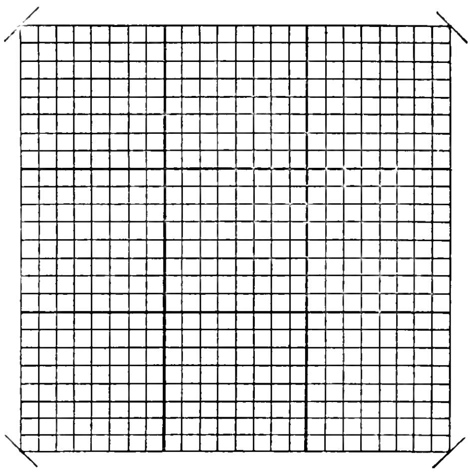


Fig. 57.

First. Mark off design paper to the required dimensions.

Second. How many threads and picks are necessary for the large body square A at the left-hand lower corner? In this instance 18 × 18 are required. Mark off the design paper to the required number of threads and picks (See Fig. 58).

Third. How many threads and picks are necessary for the small border squares B and C? In this case we will divide the border into four parts of 6 threads × 6 picks each way (See Fig. 59).

Fourth. On examination of the skeleton design of Fig. 59, we notice that it can be divided into four sections, 1, 2, 3, 4, as shown in Fig. 60.

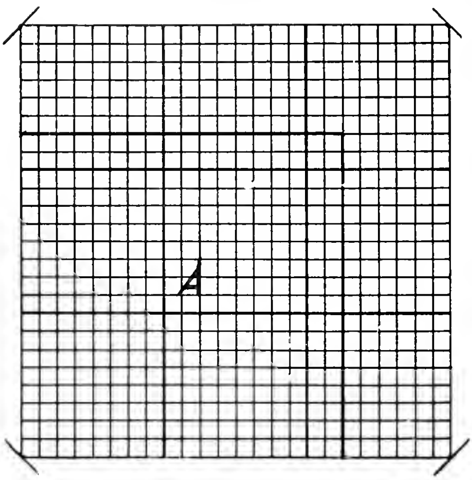


Fig. 58.

Fifth. Decide what weaves will be most suitable for the required fabric. This design Fig. 56 shows a fine twill or diagonal, therefore we will use the 3-harness twill, filling flush $\frac{1}{2}$ to right and which we will call class weave "B1," also the 3-harness twill, warp flush $\frac{2}{1}$ to left, and which we will call class weave "B2."

Now to construct the design from a written formula or problem.

PROBLEM. **Dress Goods Design.**

24 threads and 24 picks.

Section 1.	6 threads ×	18 picks	B1.	See first section Fig. 60, 61
	6 "	6 "	B2.	
		24		
Section 2.	6 "	24 "	B1.	See second " " " "
Section 3.	6 "	18 "	B1.	See third " " " "
	6 "	6 "	B2.	
		24		
Section 4.	6 "	6 "	B2.	See fourth " " " "
	6 "	6 "	B1.	
	6 "	6 "	B2.	
	6 "	6 "	B1.	
		24		

Harness, Heddles and Eyes or Mails. At this point the student should begin to examine into the practical carrying out of his designs at the loom. The first step in this direction is to deal with the arrangement of the warp threads in the heddles on the harnesses, or, as it is termed, "warping and dressing:" and the next will be the method of actuating the harnesses by means of a chain, or order to produce the required pattern.

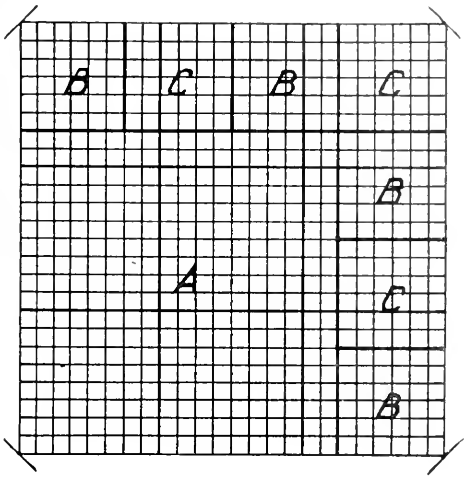


Fig. 59.

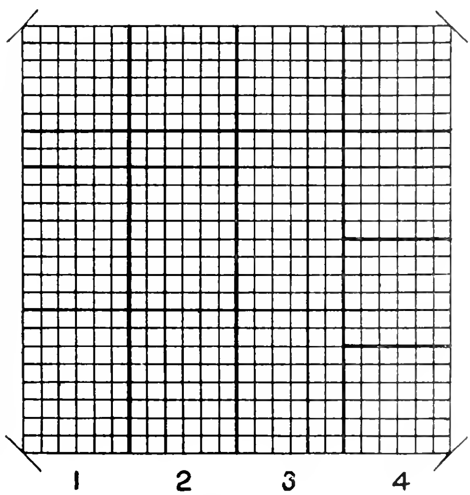


Fig. 60.

In this, as in all other work, there must be some recognized means of conveying or indicating the order in which the threads must be drawn through the harness.

When the weaver is standing in front of the loom, whether hand or power, the harnesses are in front of him, as in Fig. 62, which represents a common hand loom, such as is adapted for plain weaving. It consists of four wooden posts framed together at the top by two long cross pieces. The two long pieces C C are called the capes of the loom. Between the two pairs of posts, forming the ends of the loom, are placed two cylindrical beams: the beam A being the warp beam, upon which the warp is wound, and B the cloth beam, upon which the cloth is wound as it is woven.

The warp threads are placed parallel to each other, as before described, and are carried from the warp beam A and attached to the cloth beam B. This is done by threading the knotted ends of the threads upon a small rod, and wedging it into the slot or groove formed in the beam for that purpose, as shown at X in Fig. 63.

In order to keep the threads in their relative positions and parallel to each other, two rods D D are inserted between the warp threads in such a manner that each thread passes over one of the rods and under the other alternately, as shown. Thus a cross or leese is formed by the threads between the two rods, which not only keeps the threads in proper order, but enables the weaver to detect with ease the proper position of any broken thread that he may have to repair. This arrangement of the threads is formed during the process of warping or warp dressing and slashing.

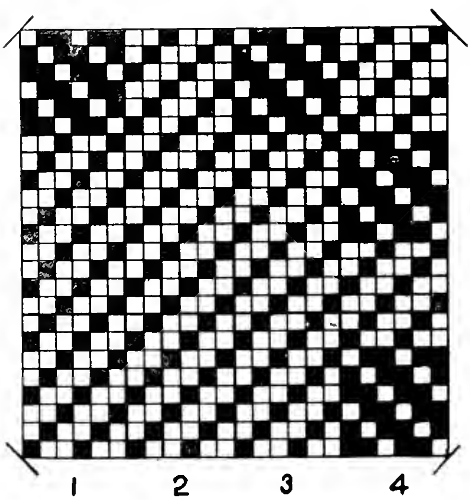


Fig. 61.

After the warp has passed the leese it is then passed through the heddles, as shown at H in Figs. 62 and 63. The heddles are composed of a number of threads or wires threaded between laths or harness shafts. Each wire or thread has a loop in the middle, or, instead, an eye called a mail or heddle eye is threaded upon it, through which the warp thread passes. There are two heddles shown at H H, one of which receives every alternate thread of the warp, and the other receives the remainder. Consequently, if either of them be raised, it will also raise the warp threads which have been threaded through the heddle eye or mails.

The arrangement of the warp threads, and the various parts of the loom which operate them may be best understood by referring to Fig. 64, which is a diagram showing each warp thread separately.

In Fig. 64 the harness shafts are shown connected and balanced by cords passing over pulleys, P P, and the lower part attached to the treadles T. The right treadle is shown depressed, consequently it raises the other treadle and the harness. Thus

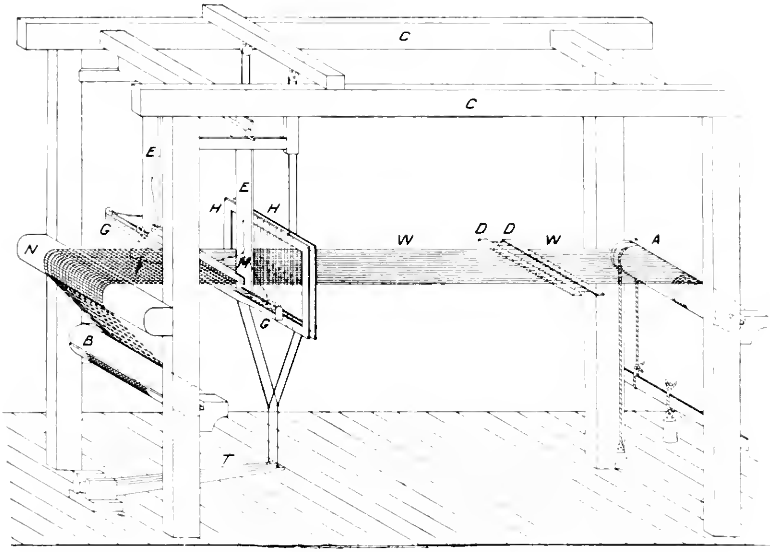


Fig. 62.

half of the warp can be alternately raised for the passage of the shuttle.

The warp is kept in tension by means of weights connected

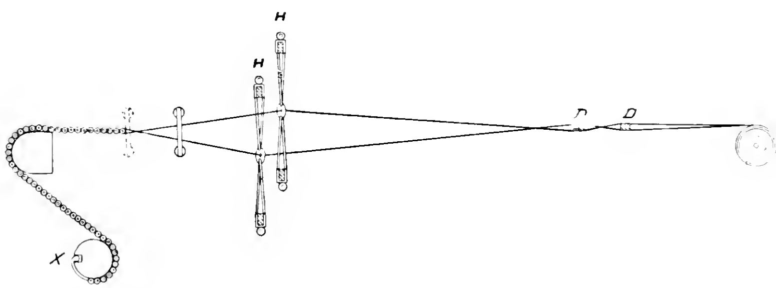


Fig. 63.

to a rope passing once or twice round the warp beam. The cloth beam is provided with a ratchet wheel and pawl M, also with a handle Z, for winding on the cloth as it is woven.

In Fig. 64 only one each of the leeses is shown, but as there must be one to each pair of warp threads, the required number must be provided for. Thus, if there are five hundred threads per inch in the width of the cloth, there must be 250 leeses per inch in the warp, or 250 threads per inch on each harness. But as the heddles are composed of material much

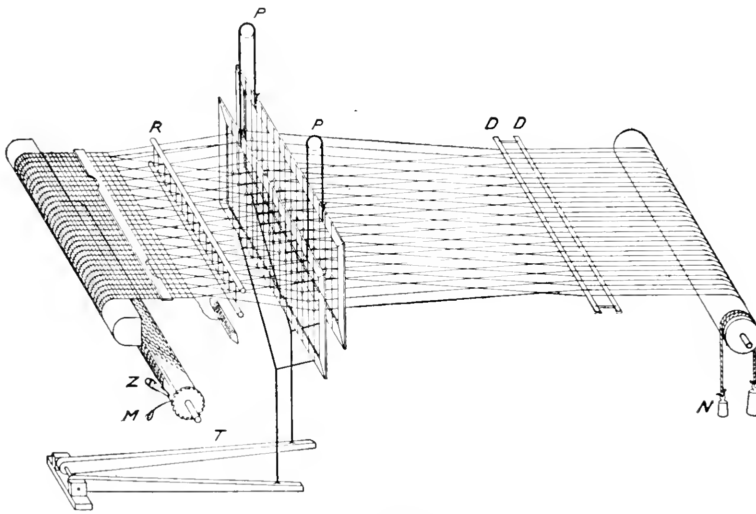
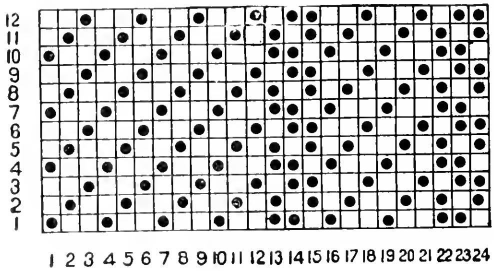
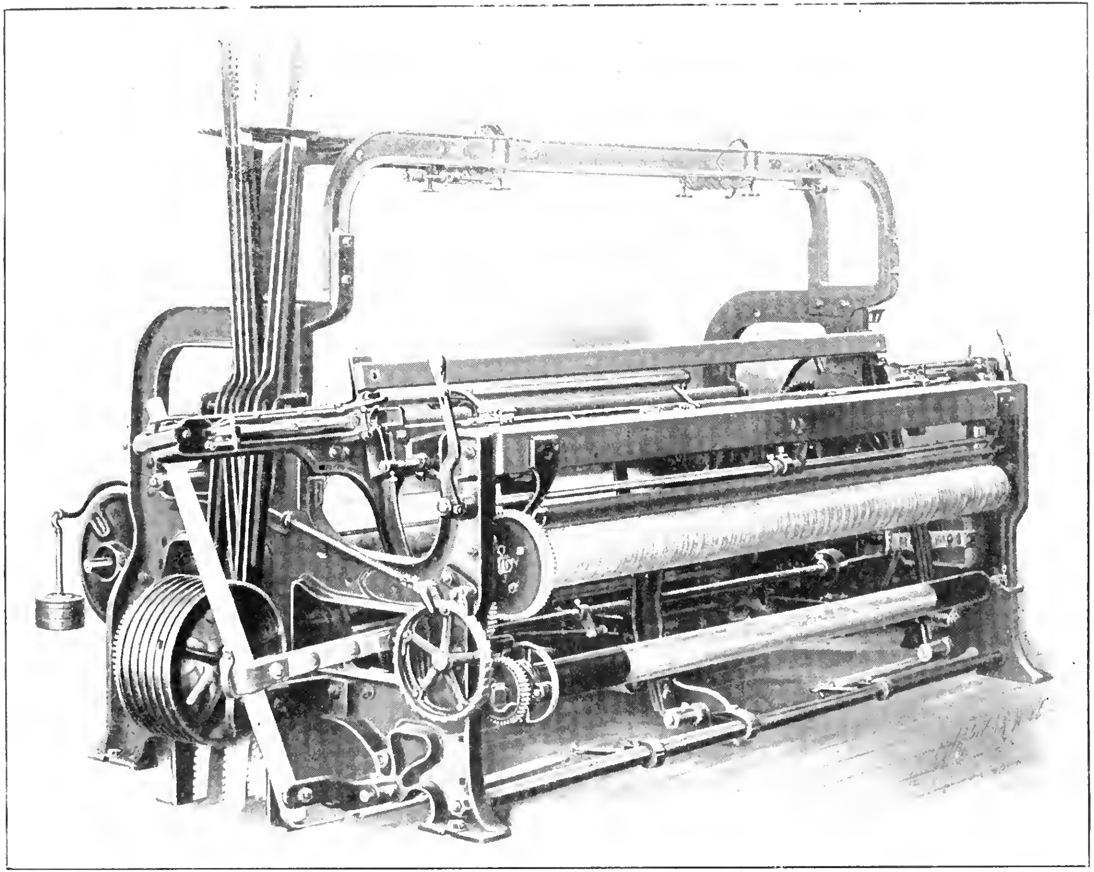


Fig. 64.

thicker than the warp threads, they necessarily take up more room, and could not be placed upon one pair of harnesses in weaving fine warps. In such cases more harnesses are used, each having its share of the threads, and half of them are raised at once so as to raise one-half of the warp threads.



Problem 1 of the Examination Paper carried out to its full extent, called one repeat of the design.



KNOWLES CLAY TWILL LOOM WITH 80-INCH REED SPACE
Crompton & Knowles Loom Works

TEXTILE DESIGN.

PART II.

ACTUATING THE HARNESSES.

Drafting and Reduction. This is an important part of designing, and necessary for the production of extended patterns on a limited number of harnesses.

Although presenting no great difficulty to those wishing to understand the operation, yet it is surprising that so much ignorance exists in reference to it, even by those conversant with other aspects of the art of weaving. In the design for the pattern, drafting deals with 2 or more threads which are found to be always working alike, that is, always up and always down together, throughout the weaving operation. This unites them in one motion or harness, instead of employing separate harnesses for each individual thread. By this means a great variety of effects may be obtained, and large patterns produced in looms having the simplest appliances. Especially is this the case in the weaving of stripes, in looms capable of allowing only a limited number of harnesses, and with only one shuttle. But for the production of checks and stripes requiring a large number of picks and threads before the pattern repeats, the Dobby head or an equivalent motion is necessary. For this reason, although a design may be drafted so as to employ but few harnesses, yet the number of picks cannot be reduced, but must be fully carried out to the extent of the design.

Fig. 65.

For the purpose of representing the harnesses, draw horizontal lines after the manner of Fig. 65, and then adopt a system of indicating the warp threads. A good, neat method is shown in Fig. 66. Here the horizontal lines represent the harness shafts, and the vertical lines the warp threads. The point at which the vertical line stops indicates the heddle through which the warp thread is drawn. This form indicates at a glance the order of the draft. Another method is shown in Fig. 67, but as will be presently shown, this is not as convenient, and it is better to employ this manner of marking for another purpose. A third form (see Fig. 68) employs numbers instead of the vertical lines; this form is commonly used, and is very convenient. A still more convenient method is to use design paper; this will be resorted to later on, but, for the beginner, it is better to work on the plan shown in Fig. 66. When he has thoroughly mastered the system of drafting, he can resort to whatever method he finds most convenient.

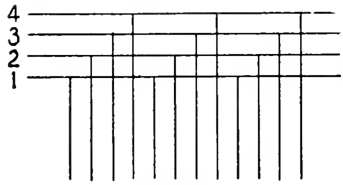


Fig. 66.

Let us turn to the actuating of the harnesses to produce the design. It will be most readily dealt with by following the method employed by hand-loom weavers, as this will enable the question of drafting and the actuating of the harnesses to be considered at the same time. Suppose a plain cloth is to be woven. Where every alternate thread is alike, as explained under the head of plain cloth, there would be only 2 harnesses required, one to actuate the first, third, fifth, etc., and the other to actuate the second, fourth, sixth, etc., threads.

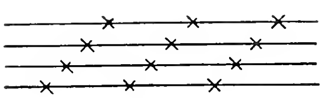


Fig. 67.

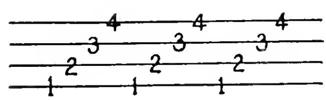


Fig. 68.

The draft and treading plan as made for the hand-loom weaver is shown in Fig. 69. The horizontal lines represent the harnesses; the vertical lines at the left the warp threads; the vertical lines at the right the hand-loom treadles; the cross at each intersection indicates the harness to be raised by the treadle; and the numbers upon the vertical lines at the right indicate the order in which the treadles are to be depressed. In this case the weaver depresses his right foot for the first pick, his left for the second, and so on. For a plain cloth this is exceedingly simple, more especially when only 2 harnesses are employed, but sometimes 4 or more are used.

It will be well to examine the drafts for the use of 4 or more harnesses, as it will be the simplest means of making the subject clear and preparing the way for more advanced work.

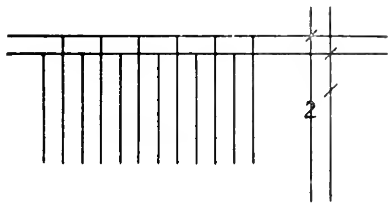


Fig. 69.

Let us turn to Figs. 70 and 71. They are both plans for weaving plain cloth upon 4 harnesses, the first by what is known as the straight draft, and the second by a cross draft. This means that in the first case the warp threads are drawn through each of the heddles consecutively, and in the other that they are crossed from the first to the third and second to fourth. Now, if the threads are to be raised alternately, the harnesses carrying the alternate threads must be raised at the same time, no matter what position they occupy in the series. This first portion must be thoroughly understood. The student must accustom himself to following the threads, and actuating the harnesses which carry them in exactly the order required.

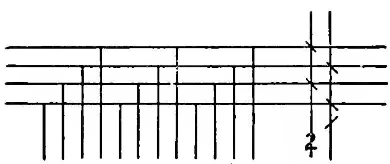


Fig. 70.

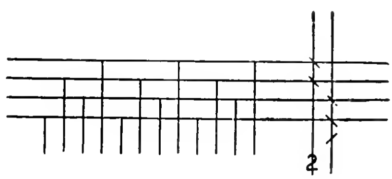


Fig. 71.

In Fig. 70, treadle No. 1 is attached to the first and third harnesses, always counting from front to back or from that nearest you. These 2 harnesses carry between them alternate threads. Treadle No. 2 is attached to the second and fourth harnesses and actuates the threads not touched by No. 1; consequently by depressing the treadles alternately, plain cloth will result. In Fig. 71, the first and second harnesses are attached to No. 1 treadle, and the third and fourth to No. 2; the reason for this will be apparent on examining the draft, for the first and second harnesses in this case carry the threads corresponding to those carried by the first and third in Fig. 70, so that the result will be the same.

An explanation must be made here to those who have some knowledge of power looms. The system of attaching jacks and vibrators of the harnesses in power looms is different from attaching the treadles in the hand loom. Thus, in making the plans, it would appear at first sight that the process in one case is exactly the reverse of that of the other. In the power loom there is a separate jack and vibrator attached to each harness, while in the hand loom each treadle is attached to as many har-

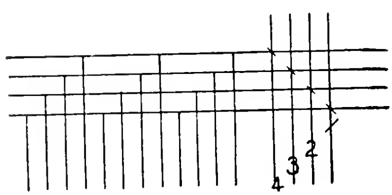


Fig. 72.

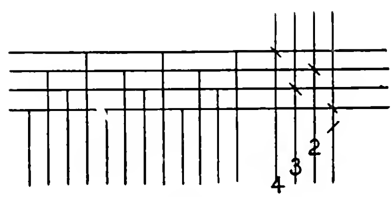


Fig. 73.

nesses as are required to be raised or depressed at once. The difference is: the hand-loom weaver depresses one treadle only for one pick, whereas the power loom depresses as many jacks or vibrators as there are harnesses to be acted upon. Thus the hand-loom treadle represents one pick of filling or one horizontal line of the design. This apparent confusion is overcome by reading horizontal for vertical, and *vice versa*. This, however, will be more fully explained later.

Now leaving the plain cloth drafting, let us consider twilled fabrics. What is known as the 3-harness or prunella twill is dealt with in the same manner as the plain weave, but 3 harnesses or sometimes 6 are employed instead of 2, thus simply doubling the number, as has been shown in the plain weave. In working 4-harness twills the same principles apply, but there is a little more complication of detail.

Take first the ordinary 4-harness $\frac{1}{3}$ twill: suppose we wish to work with the draft given in Figs. 70 and 71, because it is quite clear that as there are only 4 threads in the design it can be woven on 4 harnesses. We must now look to the order of treading, or building the harness chain, as it is termed, or raising the harnesses. To follow out the principle explained in connection with Figs. 70 and 71 it would be necessary to raise the harnesses in the order shown in Figs. 72 and 73.

It is necessary to follow each thread, and ascertain whether or not they follow in the order required.

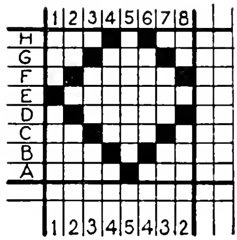


Fig. 74.

Having reduced the design to the least number of requisite harnesses, the working plan or chain is found by taking the consecutive numbers from No. 1 to the highest figure shown beneath the design and placing them side by side in their order, according to the requirements of the design, so that they shall read 1, 2, 3, 4, 5, 6, 7, 8 and so on. This will be seen in Fig. 74, which is given to show the principle of drafting and reduction in its simplest form. It is, however, the same as applied to the more elaborate patterns. The numbers beneath the design are used for the purpose of obtaining those threads that are working alike, and also to obtain the nature and extent of the draft.

Fig. 75 shows the drafting or the threads drawn through the harnesses, as taken from the design, and the numbers beneath correspond with those found under the design. The horizontal lines represent the harnesses, and the vertical lines represent the threads.

Fig. 74 represents a diamond pattern of which the design stands upon 8 threads. See numbers on top. Begin at the bottom at the left-hand corner, and note the dotted spaces of each thread, which means their manner of working, from the bottom to the top. When 2 or more threads are marked exactly alike, the same number at the bottom represents all of that kind. Thus the 1st thread is marked No. 1, and, of course, will require one harness to work it; the 2d thread is working differently from the 1st, and will require another harness, marked No. 2; the 3d, 4th and 5th threads are also different from any of the others, and so will require different harnesses for each. They are marked Nos.

3, 4 and 5. The 6th thread is marked 4 because it is working like the preceding thread marked 4, the 7th thread is marked 3 because it is like the preceding thread marked 3; and the 8th thread is marked 2 for the reason that it is working like the first thread marked 2. The numbers under the design now read 1, 2, 3, 4, 5, 4, 3, 2; therefore the highest number is 5, which means that the design requires 5 harnesses to weave it. What-

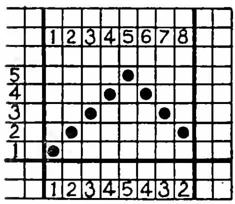


Fig. 75.

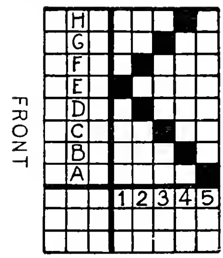


Fig. 76.

ever the highest number may be, it represents the number of harnesses required. In this instance five parallel lines are drawn for the harnesses and marked up the side 1, 2, 3, 4, 5. Now proceed to draw vertical lines to represent the threads drawn through the harnesses, indicated by the numbers under the design, and

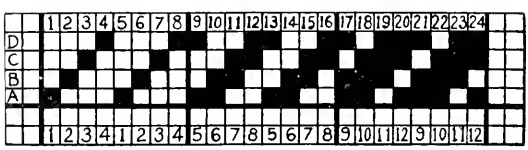


Fig. 77.

just in the order in which they stand. No. 1 is drawn upon the first harness, No. 2 upon the second, No. 3 upon the third, No. 4 upon the fourth, No. 5 upon the fifth, No. 6 again upon the fourth, No. 7 upon the third, and No. 8 upon the second. (See Fig. 75.) Having finished the draft, the next proceeding is to obtain the working plan or chain, which is a reduction of the design, so far as the threads are concerned. In this case the consecutive numbers from 1 to 5 are found together, so that the only requirement is to copy exactly the first 5 threads of the design as they stand, as shown in Fig. 76.

The next examples comprise mixed weaves and are of a more extended and practical character. For the purpose of gaining the working plan from them, use the consecutive numbers from No. 1 to the highest. These are not all together as in Fig. 74.

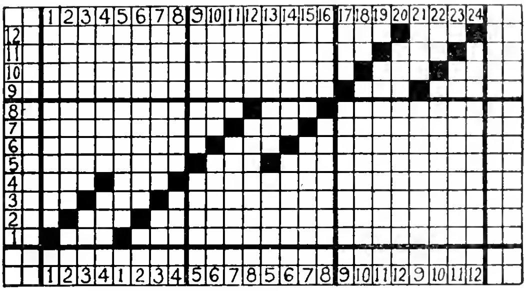


Fig. 78.

Fig. 77 consists of 24 threads and 4 picks, and is made up of three different weaves. Each weave is repeated, so that the first four numbers under each different weave must be taken for the working plan or chain, which gives the numbers consecutively, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12. Fig. 78 represents the Drawing Draft. This design requires 12 harnesses to weave it. (See the chain draft of Fig. 79.)

There is another consideration in reference to drafting which ought to be understood, and that is, that frequently the full design is not given, only the draft and working plan, so that the weave intended to be produced is not always intelligible. Many designers adopt this method for the purpose of economizing time, and in practical work in the mill it may be recommended, not only for concealment, but because the draft and working plans are all that are necessary for the pattern weaver, chain builder or loom fixer.

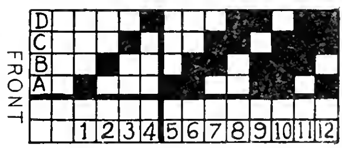


Fig. 79.

In order to obtain the full design from the reduced working plan and drawing-in draft, reverse the method adopted in the previous examples and follow the draft and chain in the same manner as with the design when making a reduction. Number the threads consecutively at the top of the drawing-in draft, so that the place for each particular thread in the extended design will be indicated. A simple illustration will explain this. In this pattern (see chain draft, Fig. 80), 6 harnesses are required,

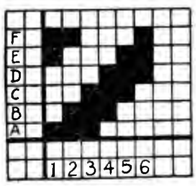


Fig. 80.

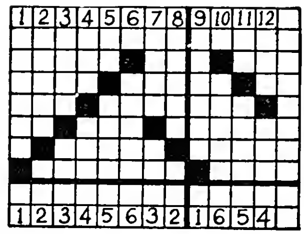


Fig. 81.

on which are drawn 12 threads to complete the pattern. (See drawing draft, Fig. 81.) Thus the working plan contains 6 threads. Another method sometimes adopted shows the working chain of the design, as in Fig. 80, but has the draft indicated by figures, and not on parallel lines. For instance, take the draft for Fig. 81, the numbers for which would read 1, 2, 3, 4, 5, 6, 3, 2, 1, 6, 5, 4. To make this clear, draw as many horizontal lines as represented by the highest number, which in this case is 6; then number the lines consecutively, and proceed to draw the vertical lines upon them according to the numbering of the threads. This gives the draft as in Fig. 81. For design represented by these drafts, see Fig. 82.

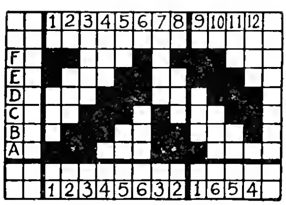


Fig. 82.

Examples. Reduce Figs. 83, 84 and 85 to the fewest possible number of harnesses.

TWILLING.

Flushes. Diagonal twills or cords that run obliquely across the cloth may vary in size according to the number of harnesses on which they may be drawn in consecutive order. This manner of drawing is technically termed a straight over-draw. Twills are generally named according to the number of threads that will complete the design. This is technically termed a repeat. Thus, weave $\frac{1}{\overline{}\,2}$ is known as a 3-harness twill, filling flush; the weave $\frac{2}{\overline{}\,1}$ is called the 3-harness twill, warp flush. It may be stated here that when practicable, the smallest number of harnesses

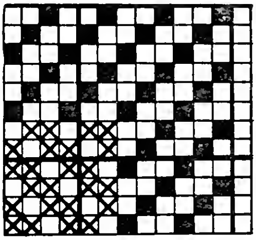


Fig. 83.

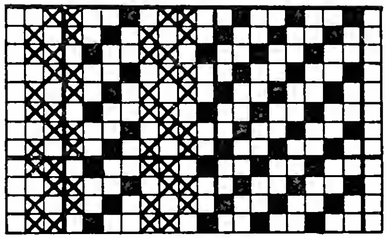


Fig. 84.

should be raised and the greatest number depressed in weaving special makes of cloth. In this manner the wear and tear of the yarn is much reduced; the only objection to this, being that in a warp flush face weave, the surface of the goods is woven face down and cannot be seen by the weaver.

The 4-harness twill, filling flush, is formed by the filling passing over 3 threads of warp and interweaving at the fourth

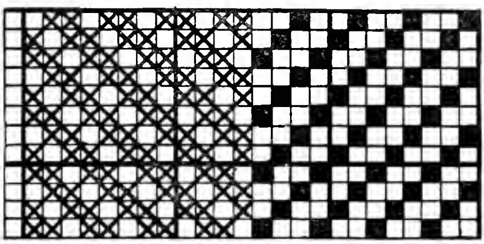


Fig. 85.

thread. The 5-harness twill, warp flush, is formed by the filling passing over only 1 thread of warp, interweaving at the second thread and passing under 4 warp threads. The 5-harness twill, filling flush, is exactly the reverse of the warp flush. Fig. 86, plain weave; Fig. 87, 3-harness twill; Fig. 88, 4-harness twill; Fig. 89, 5-harness twill; Fig. 90, 6-harness twill. It should be understood that all marks, unless otherwise explained, are risers, and all blanks or spaces are sinkers: therefore, in Figs. 87, 88, 89, 90, the fillings predominate on the face and are called respectively 3, 4, 5 and 6 harness filling flush weaves. If the weaves had been reversed, that is, if crosses or black marks had been put in the squares which are now blank, the weaves would be warp flush weaves. We now understand a regular twill to run in small diagonal lines, bars or cords, at an angle of 45 degrees or obliquely across the fabric. It may be a filling flush, warp flush, or an even-balanced twill, according to the weave used.

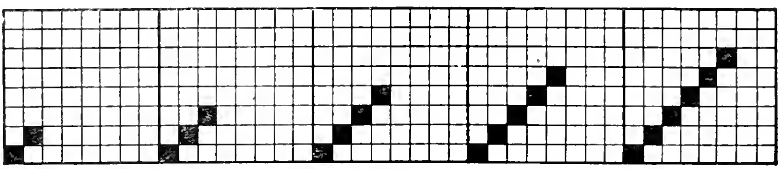


Fig. 86. Fig. 87. Fig. 88. Fig. 89. Fig. 90.

When the consecutive lifting of the harnesses or scheme of successive interlacing with filling is changed, so as to raise the harnesses at intervals of 1, 2, 3 or more from each other, the twill or diagonal stripe is said to be broken, and it will be observed that the flushing does not run at an angle of 45 degrees, but is broken according to the intervals of interlacing and the disposition of the harnesses.

We must now consider this broken effect as compared with the regular disposition of the harnesses running in consecutive order. When the harnesses can be raised regularly, at intervals of 2, 3 or more from each other, the weave is said to be a Sateen of a perfect order; but if the intervals cannot be so arranged, or the weave will not admit of this regular intermission, then the weave is not a true sateen, although we find many of these imperfect weaves forming the groundwork of many fabrics.

The smallest number of threads that can be arranged to make a true sateen is the 5-harness twill, the arrangement of which is 1, 3, 5, 2, 4. Six harnesses do not admit of such a disposition. The 7-harness twill is perfect, admitting an interval of

1 or 2 harnesses. Eight harnesses is the lowest number used in making an evenly numbered weave that can be transformed into a true sateen. By experimenting we find that by an interval of 2 we have a most perfect sateen. The 9-harness twill is perfect, each alternate harness lifting. The 10-harness twill is a good sateen, every third harness being raised. The same order of interweaving is shown by the 11-harness twill, which makes a perfect sateen. The 13-harness weave is formed by raising every third. The 15 is made by lifting every other third harness. The 16-harness sateen is made by omitting 2 or 4 threads. It may

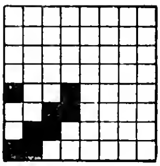


Fig. 91.

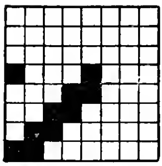


Fig. 92.

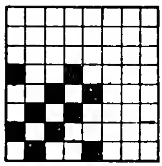


Fig. 93.

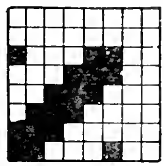


Fig. 94.

be remarked here that all twills of an uneven number, except the 3-harness twill, will produce perfect sateen arrangements. With the even numbers imperfections are often found. The preceding remarks apply either to the filling or warp flush weaves, where 1 thread is either up or down and the remaining number covered either by filling or warp.

Our next consideration will be *fancy twills*, or effects that are obtained by using any number of harnesses in any fixed weave. For instance, to make the 4-harness twill, 1 up and 3 down, into another variety or effect, we can take 2 up and 2 down. This is called the 4-harness Cassimere or Shalloon twill. With a larger twill the flushing can be varied by interspersing the weave with plain texture, as, for instance, the 7-harness changed to 1 up 1 down 1 up 1 down 2 up and 1 down, and so on.

Fancy Twills. Examples are here given (Figs. 91 to 100) of what are termed fancy twills, and it will be seen how an endless variety of patterns may be obtained from them.

Twills that run obliquely will form the groundwork for wave effects, either in the direction of the filling, across the fabric, or in the direction of the warp, that is, with the length of the fabric. Take, for example, the 4-harness twill, filling flush; draw this straight over on 4 harnesses and raise the harnesses as shown in Fig. 101. By studying this wave weave, we find that it is the common 45-degree twill for 4 picks and that it then twills to the left, thus: 1, 2, 3, 4, 3, 2, which makes a zigzag or wave effect in the direction of the warp. If we use the 4-harness $\frac{1}{3}$ twill and draw the threads through the harness, 1, 2, 3, 4, 3, 2 (see Fig. 102), which is the same order as given in the preceding example,

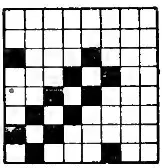


Fig. 95.

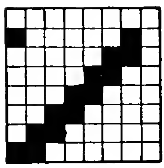


Fig. 96.

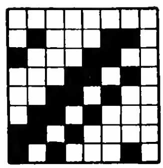


Fig. 97.

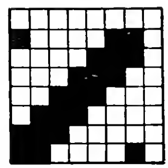


Fig. 98.

the effect or result in the fabric is a zigzag across the piece or in the direction of the filling.

Reverse Twills. In all the regular twills, as shown in Figs. 87 to 90, the filling predominates on the face of the cloth, and the warp on the back of the cloth. Take the 5-harness twill for an example; if the warp is of one color and the filling another, as there is 1 thread up and 4 threads down, it follows that four-fifths of the filling will be on the face and one-fifth on the back, thus changing the appearance of the filling from one side of the fabric to the other. This is called *reversing the twill.* It is very extensively applied in different branches of weaving, particularly in the cotton and linen trades. We will take for example the reversing of the 4-harness twill, and make a stripe of 12 threads warp flush and 12 threads filling flush. In this example (Fig. 103) we notice that it takes 4 extra harnesses, that is, 4 harness for the filling flush and 4 harness for the warp flush weaves. Patterns of this description may be extended to any width of stripe, as they are formed and regulated

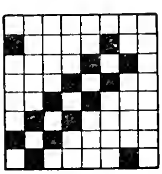


Fig. 99.

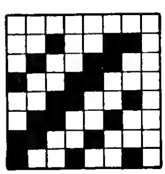


Fig. 100.

entirely by the quantity of warp drawn on each set of harnesses. These examples will be sufficient to show the nature of reversed twill stripes, the varieties of which may be increased at pleasure by means of additional harnesses, and by varying the size of one or both stripes.

The next variation of the reversed twill is to form on the same stripe, the warp flush and filling flush effect alternately. (Fig. 104.) We find that there are 12 picks filling flush weave and 12 picks warp flush weave. We will now go a little farther with these examples, combining the two systems so as to make a checker or dice board effect. In making designs of this character, attention should be drawn to the divisions of the two weaves. Where they unite, the line must be distinctly defined, that is, to make them unite in a perfect cut. This will be better understood by referring to Fig. 104, at the extreme sides of which, top and bottom, it will be found that the raising marks of

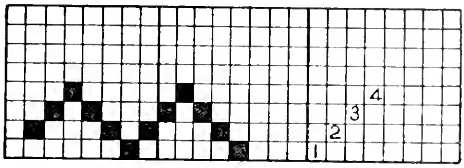


Fig. 101.

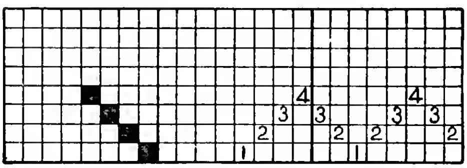


Fig. 102.

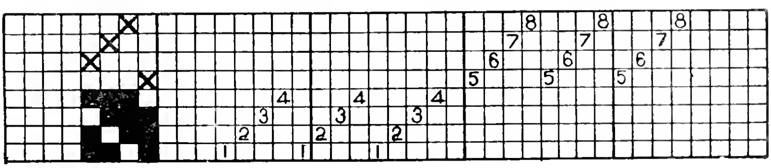


Fig. 103.

one division fall exactly on the sinking marks of the other compartment. This figure represents a perfect cut.

DIAPER WORK AND POINT DRAWS.

Damask. From what has been said in regard to fancy twills, and from examples that have been worked out, it will not be difficult to understand the drafting of the cloth known as Damask. Instead of straight-over drafts, damask designs are usually woven by means of what is termed a diamond draft; that is, a draft that runs from the front harness to the back harness and then returns to the front in the opposite order, thus forming a zigzag figure on the harness. Sometimes there are patterns of a more complex character woven on this system of drafting. This will be explained under the head of double, triple and alternate diamond drafts.

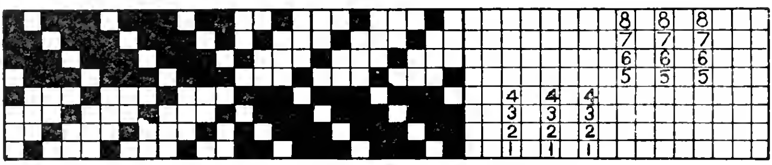


Fig. 104.

The length or number of picks in the repeat of the design is worked out on the same principle as the draft for the warp. (See Fig. 105.) Whatever variety, therefore, is adopted for the ground work or plan, according to the foregoing explanations, the result of the extended pattern will be nearly double the number of

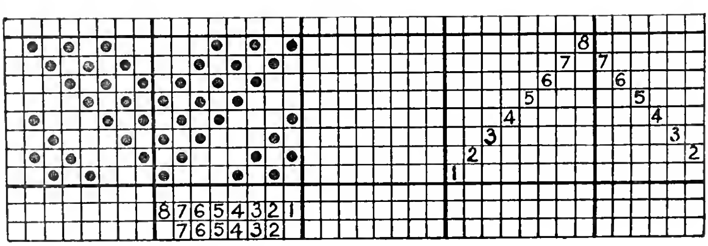


Fig. 105.

ends in the warp. The additional threads and formation of twill will be in direct opposition to the original ground plan. As the filling is also carried out on the same principle as the warp, the design is nearly doubled by the picks, the resulting design or twill being run in the opposite direction. Thus a square or diamond figure is commonly produced. It must be particularly noticed that there is only one thread drawn on the first and last harness, and that the filling returns on the same scheme, so the whole design will be nearly four times the original figure.

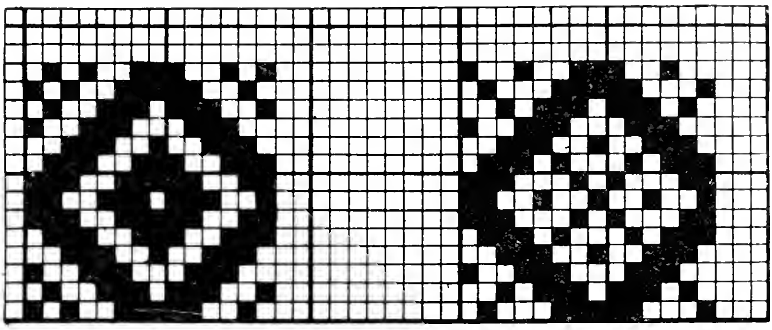


Fig. 106. Fig. 107.

The smaller weaves of this kind produce only a limited number of figures, generally a small diamond with a dot in the center, which gives the resemblance of an eye; hence this variety of design is called a Bird's-eye. But when we use 8 harnesses or more, they admit of considerable diversity in flushing, twilling and the addition of plain texture, thus deviating from the formal

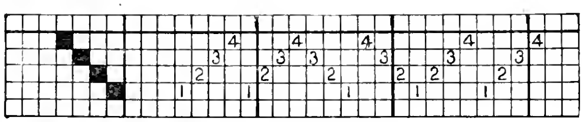
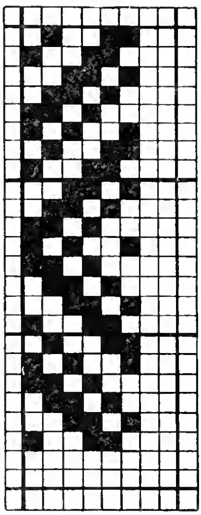


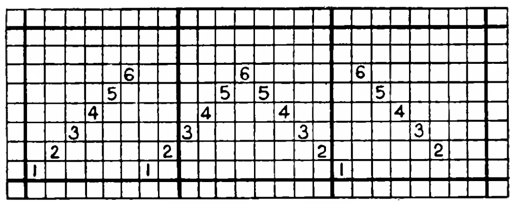
Fig. 108. DOUBLE DRAFT.

Bird's-eye. The design now assumes the appearance of damask work.

Double Draft. These examples show what a great variety of figures can be woven on the damask work principle, especially those of a large ground or original figure. All of these figures are produced by the extension of the diamond draft. As the resources of fancy weaving are inexhaustible, various other changes can be effected by merely diversifying the order or succession of the draft independently of the position of the filling.

As every extension of the draft in this manner enlarges the figure in a duplicate proportion, that is, as the square of the number of threads in one set of the draft, such patterns, when the harnesses are numerous, will occupy a considerable space on design paper. In all double drafts it should be understood that the filling or picks are extended in the same order as the warp draft.





DOUBLE DRAFT.

Fig. 109.

The double draft, Figs. 108 and 109, with any system that may be adopted, always produces two square or diamond effects. These are formed one within the other, and are again surrounded by others of the same character.

Triple Drafts. Fig. 110. A triple draft enlarges the dimensions of these patterns still further, producing three similar designs, one within the other. These figures are generally termed concentric designs. From this example it will appear that any number of concentric figures may be formed by repeating the draft any number of times straight over the harnesses in one direction, and by returning in the opposite direction an equal number of times.

Alternate Drafts. Fig. 111. Another method of diversifying the drafts of lined work patterns is by dividing the harnesses into two sets. Take 10 harnesses, for example, which, when divided, should form 2 sets of 5 each. On either set we can make a diamond point, double or triple draft. This arrangement throws the group of small figures produced by each set of harnesses into alternate squares, somewhat resembling the draft-board pattern, each square again being composed of diaper or damask work. The

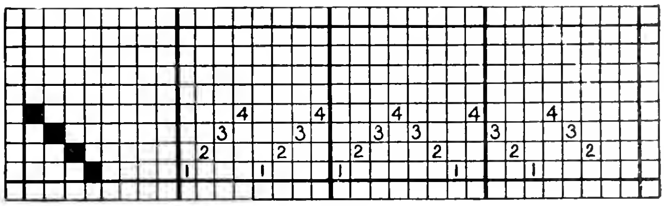


Fig. 110. TRIPLE DRAFT.

following draft is an explanation in itself. To find the number of harnesses required for any lined work design, either from the fabric or design paper, count the threads from the center of one figure to the center of the surrounding figure. This will give the number of harnesses. If a square be formed of which this is a diagonal, and is repeated four times, but inverted so that any one

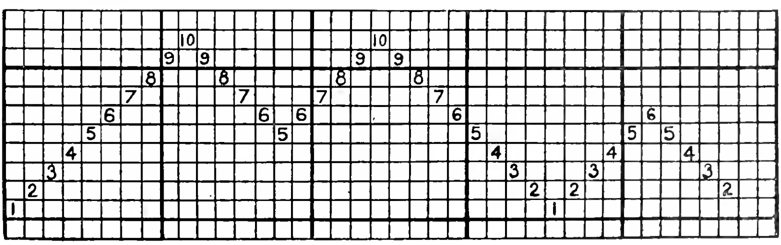


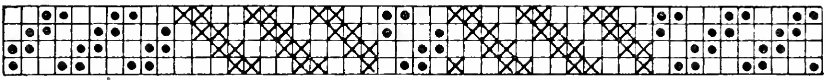
Fig. 111. ALTERNATE DRAFT.

corner of the design may be a common center, and allowing only one thread for each of the points, both by the warp and filling it will give one complete set of the design.

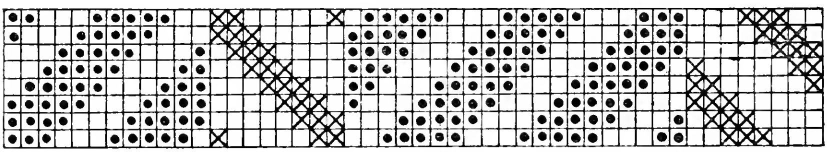
Damask work designs are used to considerable advantage in the linen trade, and also to some extent in cottons. This class of work makes good designs for the shawl trade, provided the warp is of one color and the filling of some darker shade of another color.

EXERCISES ON DAMASK PATTERNS.

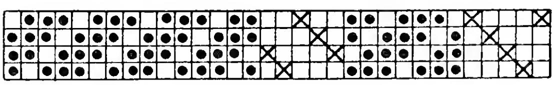
1. Form a check from the accompanying damask stripes *a b c d e f*.



c

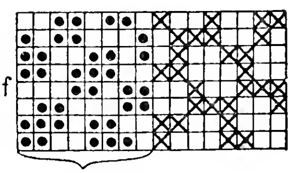


e

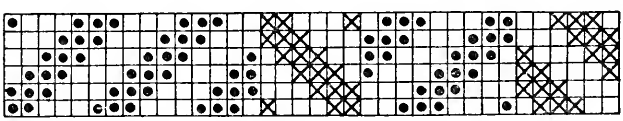


a

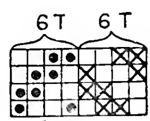
f



5 TIMES



b

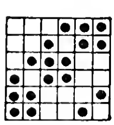


d

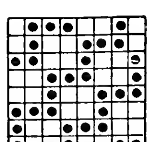
2. Make damask stripe designs on 48 ends from weaves *g* and *h*.

3. Make check designs from three stripes (Question 2).

4. Make two original damask stripe and corresponding check designs.



g



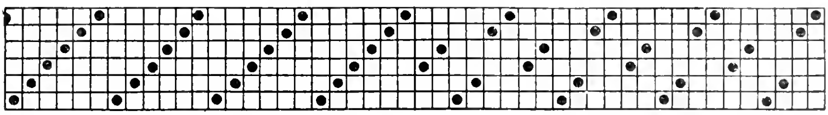
h

EXERCISES FOR PRACTICE.

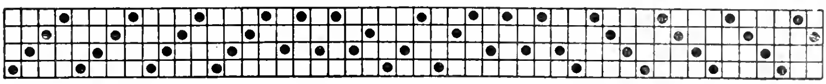
1. Work out the designs from the following drafts and chain plans.

2. Work out the designs obtained by using chain plan M with drafts G, H, K, L.

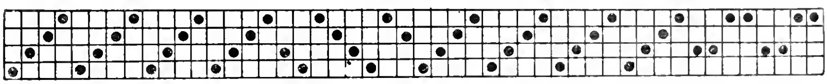
3. As No. 2, but with chain plan N.



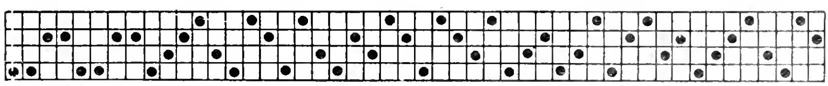
A



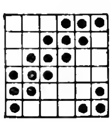
B



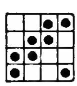
C



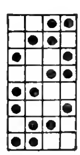
D



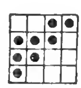
A



B

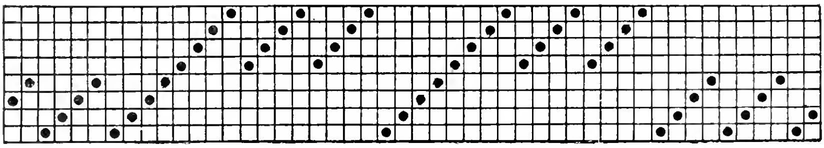


C

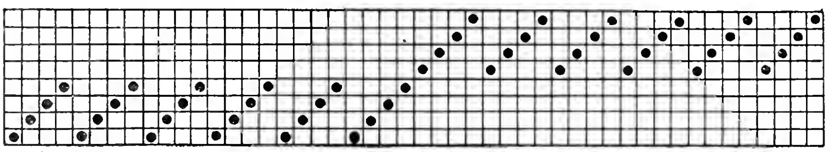


D

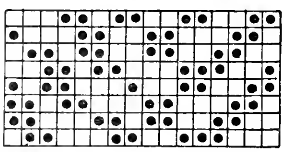
(Continued on next page.)



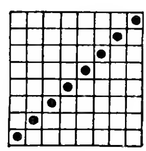
L



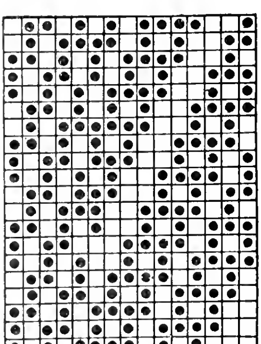
K



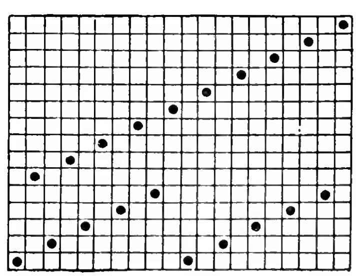
E



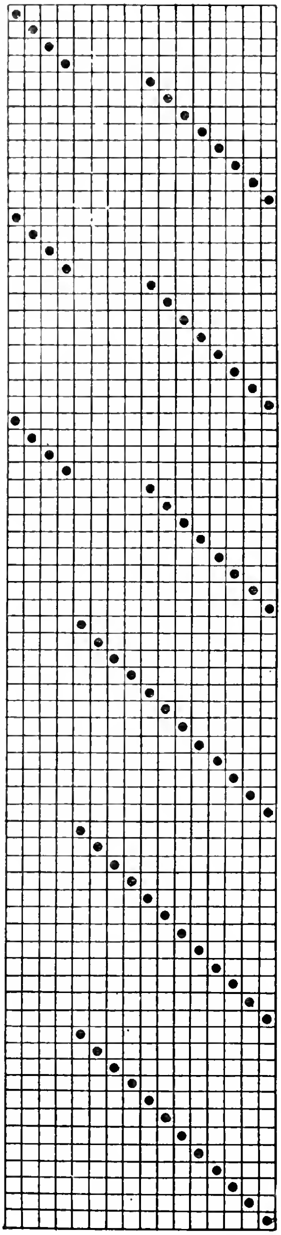
G



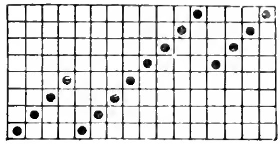
F



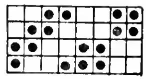
F



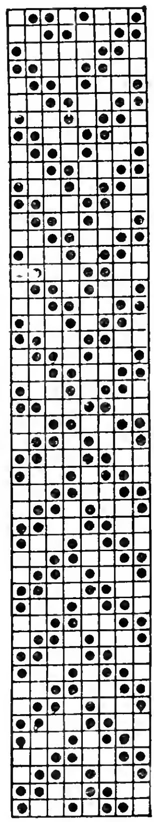
E



H



M



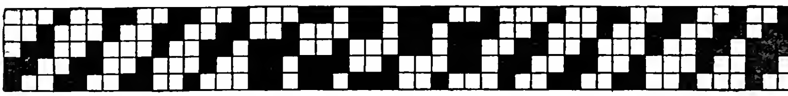
N

EXERCISES IN DRAFTING.

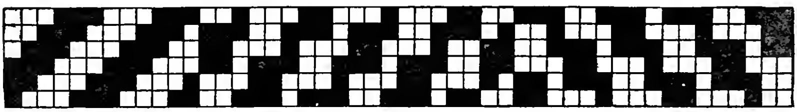
Reduce each of the following designs to weave on the fewest possible number of shafts, giving draft and chain.

1

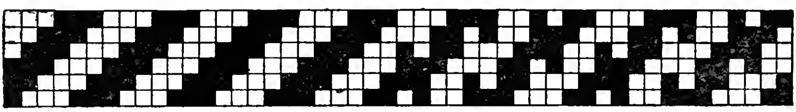
2



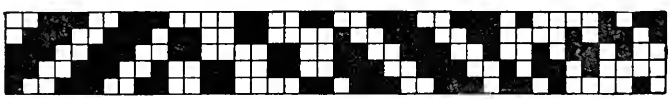
4



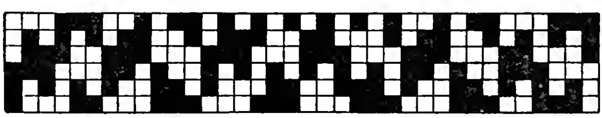
6



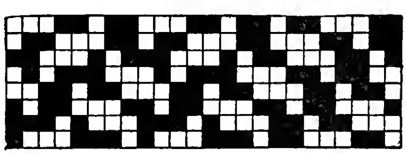
7



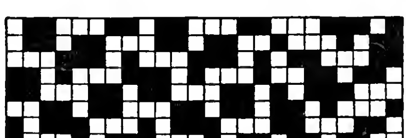
3



5



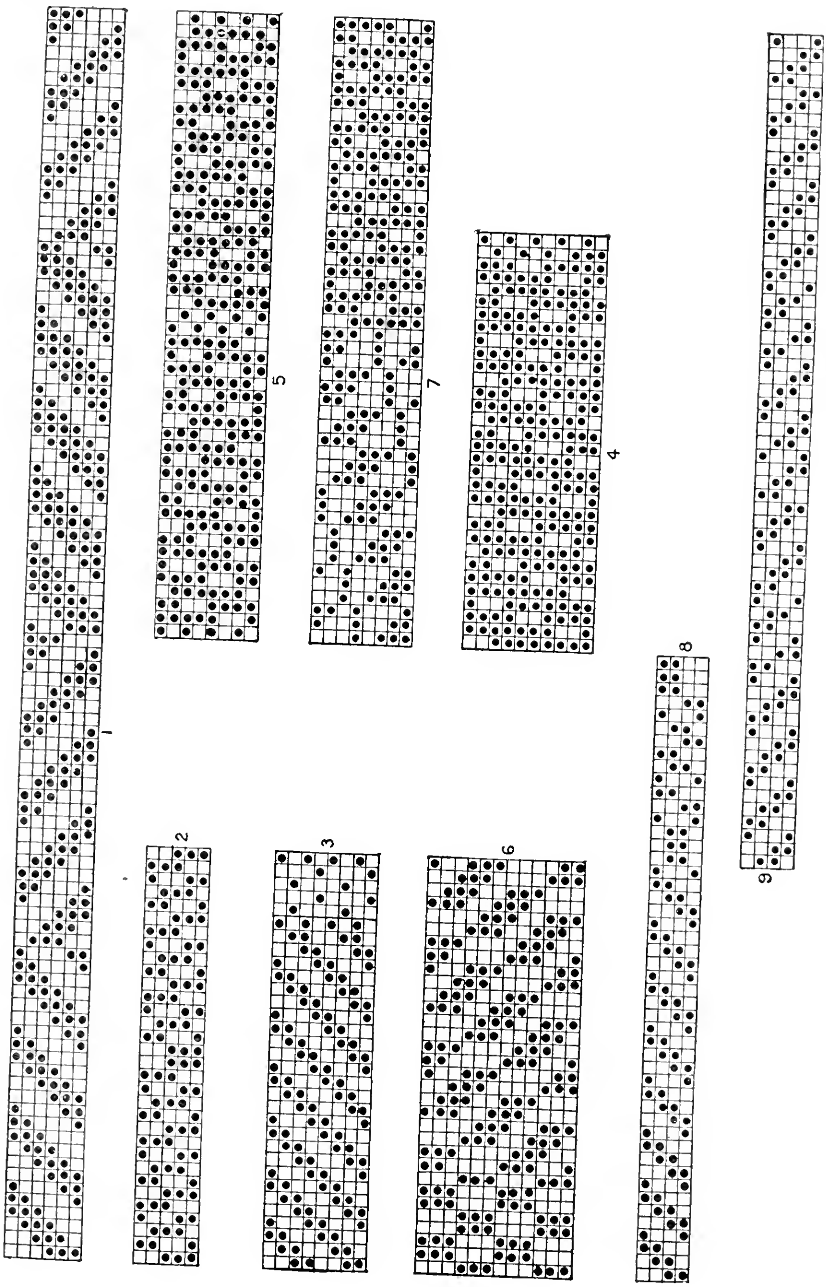
8



9

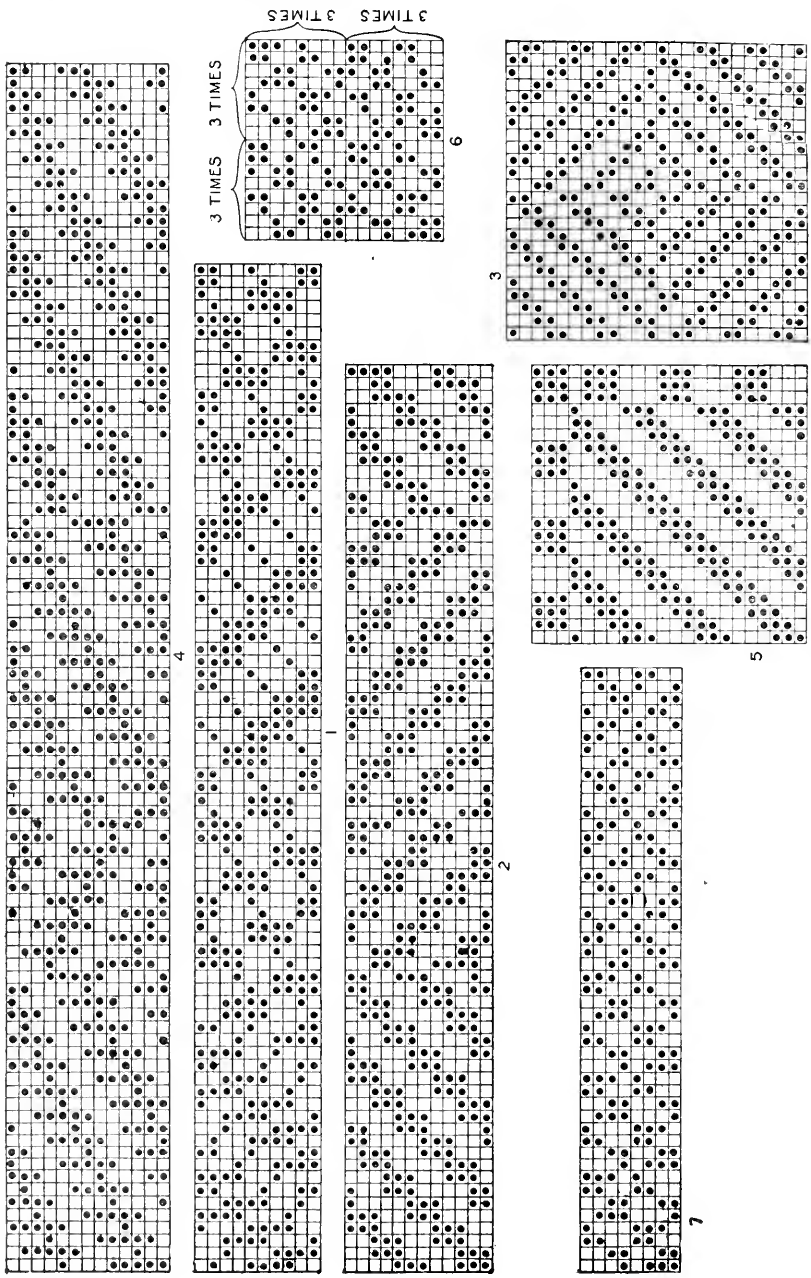
EXERCISES FOR PRACTICE.

Draft each of the following designs on fewest possible shafts and give chain.



EXERCISES FOR PRACTICE.

Make draft and chain plan for each of the following designs, giving good workable drafts.

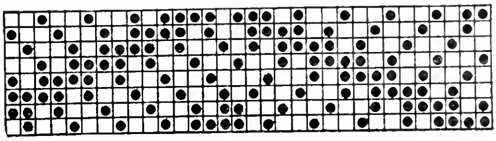


EXERCISES FOR PRACTICE.

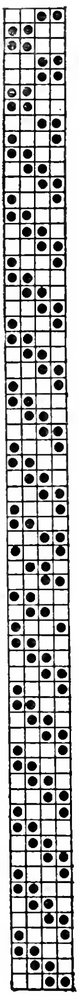
1. Make good working drafts and chain plans for designs A and B and supply chain plans for two original designs to weave in the same draft.

2. Make one draft to work the two accompanying designs C and D and give the chain plan for each.

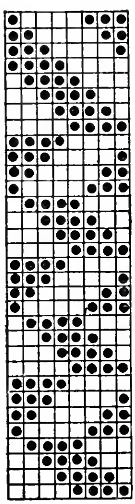
3. Run out the accompanying design E until complete, then draft on 28 shafts and give chain plan.



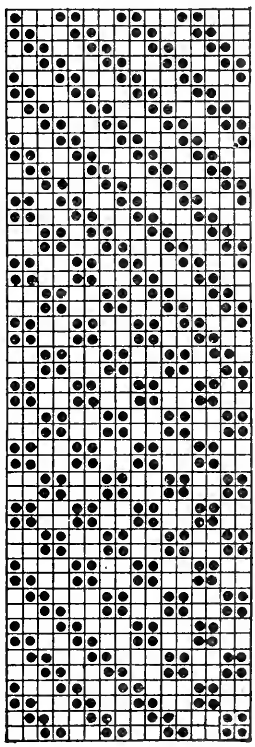
A



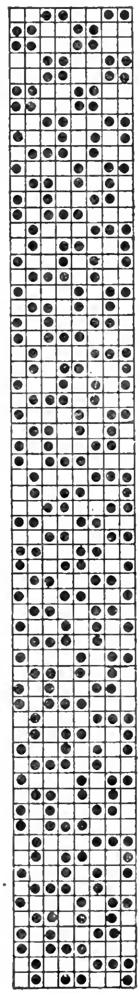
C



B



E

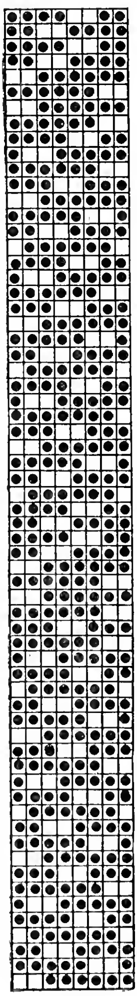


D

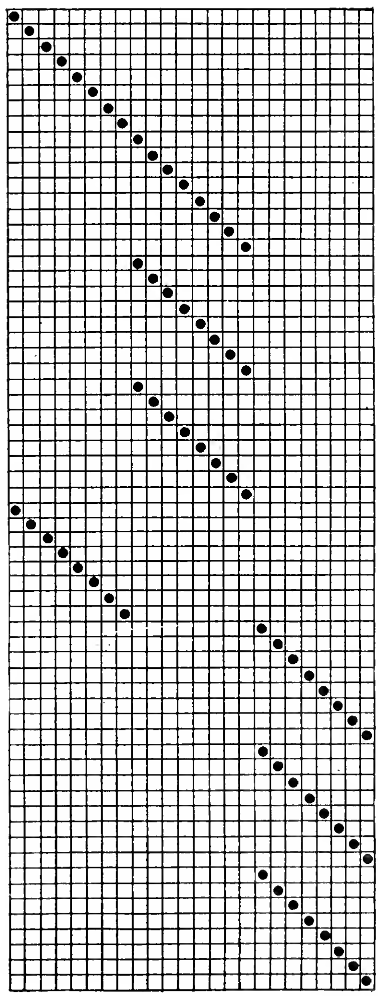
4. Give draft and chain plan to weave design F on the fewest possible shafts; also give chain plan to weave it with draft G.

5. Give two original designs and chain plans to weave with draft G.

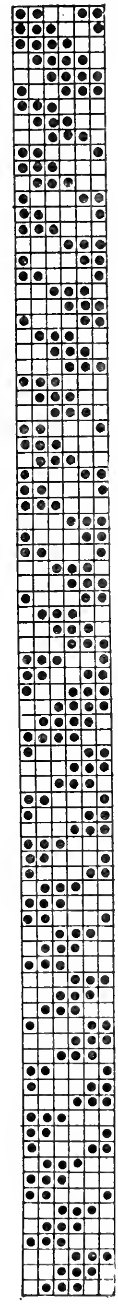
6. Give chain plan to weave design H with draft G.



F



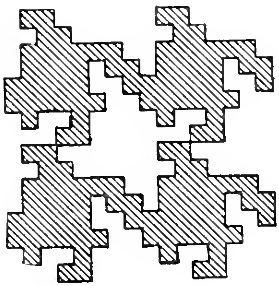
G



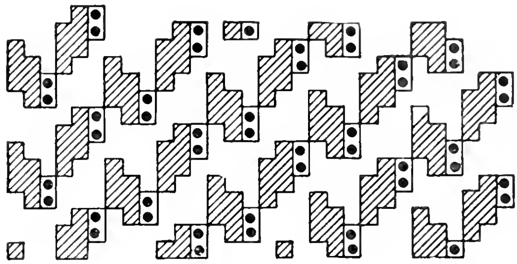
B

EXERCISES FOR PRACTICE.

Give designs and warping and wefting plans to produce the following effects in single cloth.

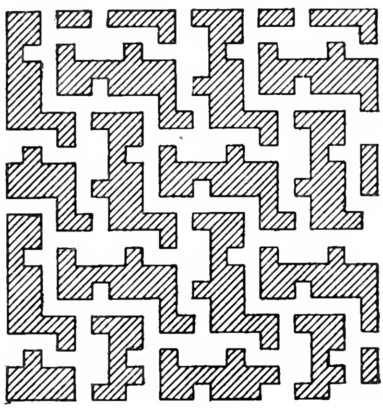


A

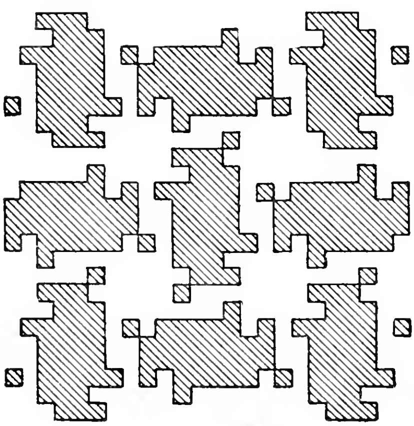


B

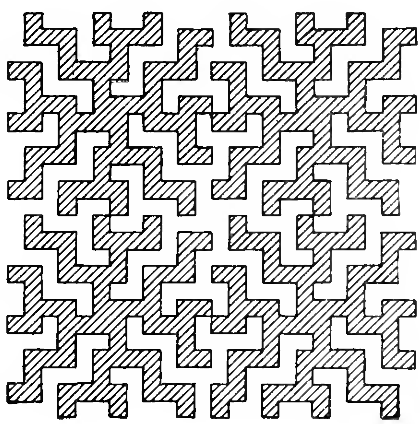
C

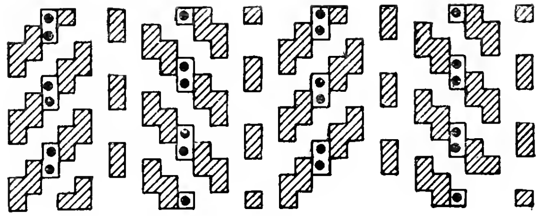


D



E





F

EXERCISES FOR PRACTICE.

1. Make designs, drafts and chain plans for two-stripe patterns, thus:

1. 39 ends of plan "*a*," 13 ends of plan "*a*" reversed in twill
   13 ends of plan "*a*," 13 ends of plan "*a*" reversed in twill
2. 24 ends of plan "*b*," 12 ends of plan "*b*" reversed in twill
   24 ends of plan "*b*," 48 ends of plan "*b*" reversed in twill

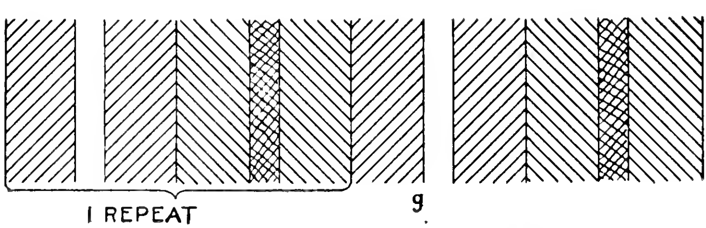
2. Make designs, drafts and chain plans for two-stripe patterns, thus:

1. 24 ends of plan "*c*," 12 ends of plan "*c*" reversed back to face
   24 ends of plan "*c*," 12 ends of plan "*c*" reversed back to face
2. 8 ends of 2 and 2 twill, 16 ends of plan "*d*"
   8 ends of 2 and 2 twill, 8 ends of plan "*d*"
   16 ends of plan "*d*" reversed back to face, 8 ends of plan "*d*"

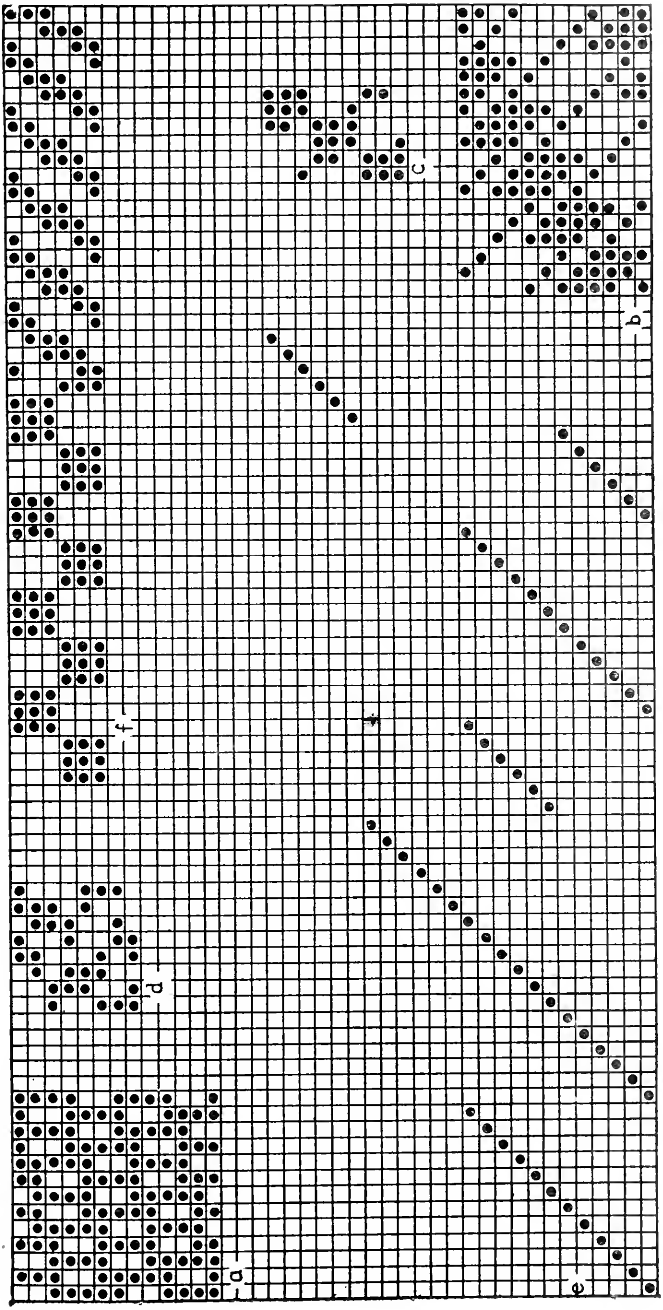
3. Give designs and chain plans for three-stripe figures to weave in the accompanying draft "*e*," supplying your own weaves.

4. Do you consider that the following combination "*f*" would give a perfect cloth? If not, give two perfect combinations introducing one of these weaves in each.

5. Give design, draft and chain plan to produce a stripe figure similar to the accompanying suggestion "*g*," supplying your own weaves.



g



83

EXERCISES FOR PRACTICE.

1. Fill in the accompanying Fig. 1 with the following weaves: A: 2 and 2 twill to right. B: 2 and 2 twill to left. C: 2 and 2 hopsack. Make clean cuts at the joinings and give draft and chain plan for your design.

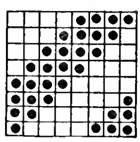
2. Make a design with draft and chain-plan to produce the accompanying Fig. 2, using your own weaves.

3. Make a check figure by a combination of plans A, B, C, giving draft and chain plan for your design.

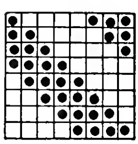
4. Make a design for a check figure to weave in same draft and to be composed of same weaves as accompanying stripe design D.

5. As No. 4, but with stripe design E.

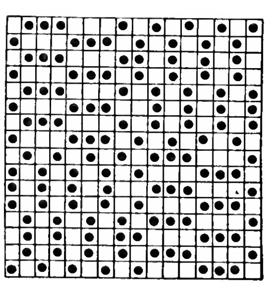
6. Make one check and one stripe design to weave in the accompanying draft F and to have the same weaves.



A



B



C

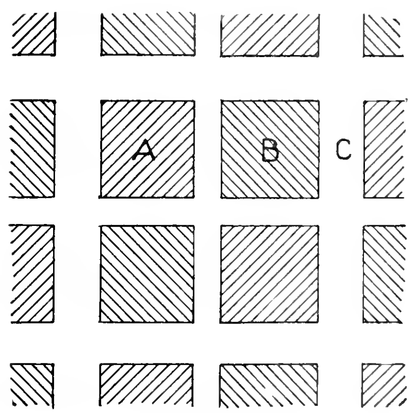


Fig. 1.

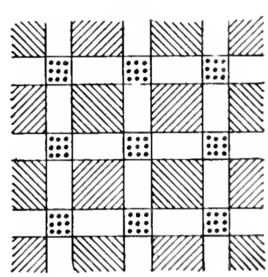
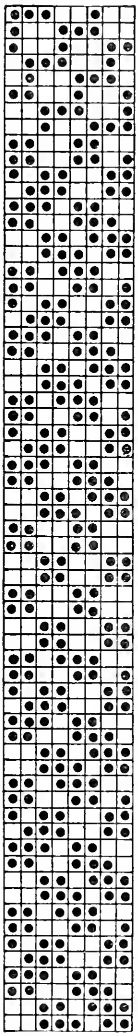
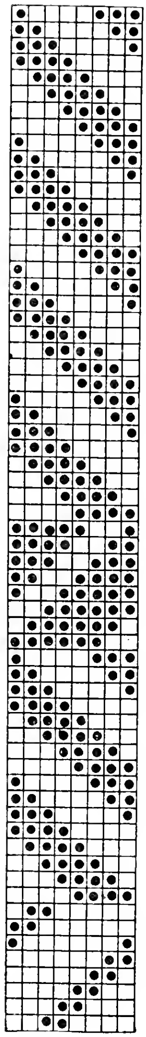


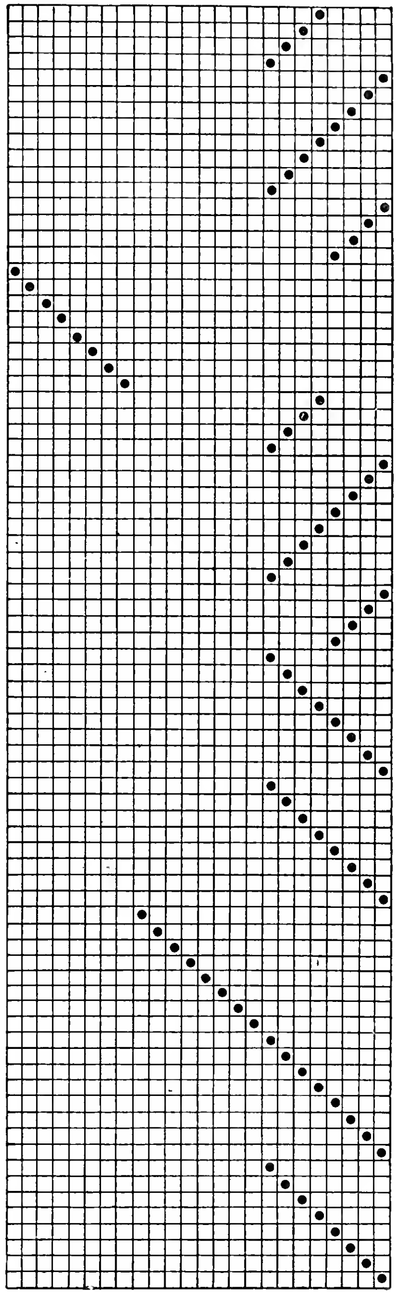
Fig. 2.



D



E



F

EXERCISES FOR PRACTICE.

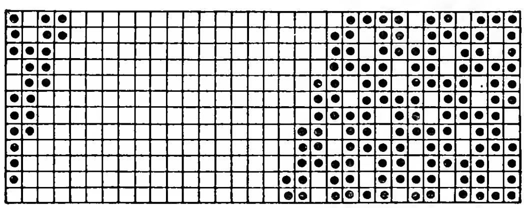
1. Fill up the vacant space in plan B with weave A, joining equally at both edges, and run out to form a diagonal figure.

2. Make two designs for diagonal figures, using plan C as the basis for each.

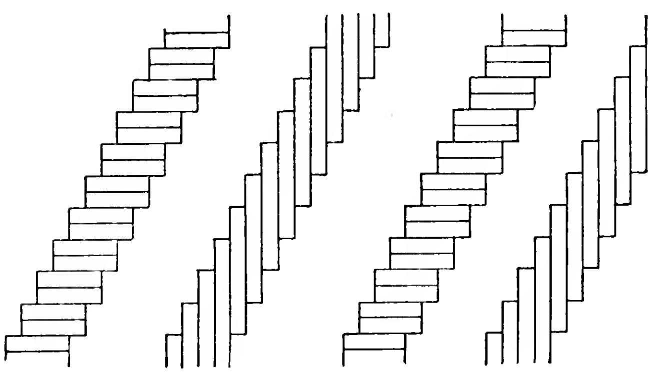
3. Make a design to produce a diagonal figure on 24 ends and 48 picks by a combination of weaves D and E.

4. Give design to produce diagonal Fig. F, supplying your own weaves.

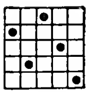
5. Make an original design for diagonal figure to weave on 36 threads.



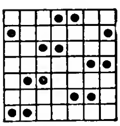
B



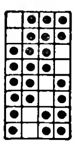
F



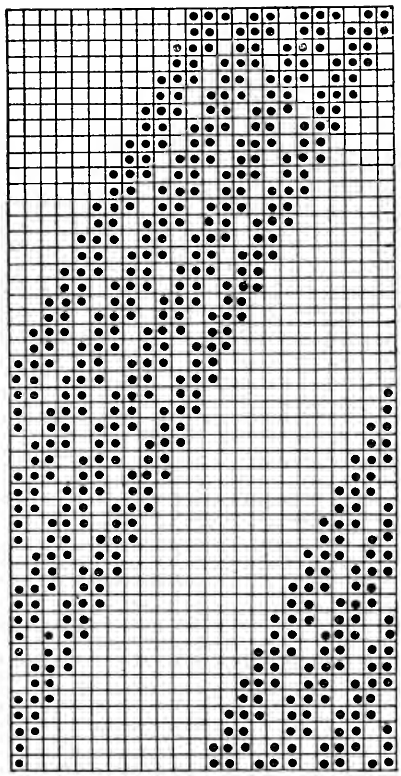
A



D



E



C

SATEEN WEAVES.

Satin. Real satin is a silk fabric in which the warp is allowed to float over the filling in such a manner as to cover it entirely and present a smooth, lustrous face.

Satinet is a mixture or union cloth in which the face shows only a woolen filling, the cotton warp being covered by it. Fig. 113 is the weave for a cheap imitation satin, known in some districts as "Kentucky Jean."

These weaves produce what their name implies, a satin effect. They are very extensively used in cotton, linen and silk goods, also in woolen and worsted fabrics. In the manufacture of

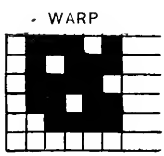


Fig. 112.

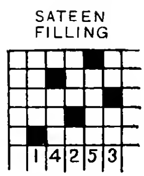


Fig. 113.

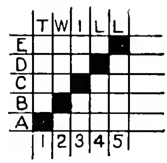


Fig. 114.

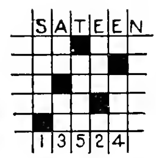


Fig. 115.

damask and linen table-covers they form nine-tenths of the product. In cotton goods they are used for making stripes, and in woolen goods they form such cloths as venetians, doeskins, beavers and kerseys. They are constructed usually from a twill weave, and this principle of interweaving is sometimes employed where the object is partly ornamental, as in satins that are used largely for trimmings and for ladies' dress goods. In such cases the first object is to produce a highly lustrous surface, perfectly smooth and showing no pattern.

If we take one class as typical, in order to show the peculiar arrangement and its effects upon the fabric, it may serve as a guide to us when dealing with patterns for ornamentation. These weaves are of two distinct classes; those in which the warp predominates on the face, called the warp flush sateen, and those in which the filling predominates on the face, known as the filling flush sateen.

The peculiarity of this kind of weave is that the order of interweaving the two sets of threads does not follow consecutively, but at definite intervals; especial care is taken that they do not follow consecutively at any point.

An example of the simplest kind, and one most commonly employed, is derived from the 5-harness common twill (Fig. 114), where the filling predominates on the face and runs to the right at an angle of 45 degrees. Consecutively this is 1, 2, 3, 4, 5, but by changing this weave over to a sateen weave (see Fig. 115), it will be observed that the order of interweaving is at set intervals.

To obtain the combination from which to design a sateen, take the number of harnesses of the original twill weave on which it can be woven, and divide it into two parts. These must be neither equal nor must one be the multiple of the other, nor should they be divisible by a third number. In constructing the weave (Fig. 115) in accordance with the rule, the number of harnesses on which the twill (Fig. 114) is woven, in this case five, is divided into two parts, thus giving two and three.

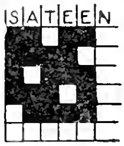


Fig. 116.

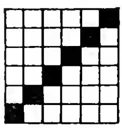


Fig. 117.

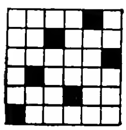


Fig. 118.

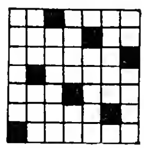


Fig. 119.

The method of constructing sateen by means of these two figures is to use either the two or the three as the number with which to count. If we use three as the number, it will be found that the picks of the twill would be used in the following order: A, D, B, E, C., which produces the sateen weave shown in Fig. 115. This is a filling flush sateen weave and the reverse of the warp flush weave (Fig. 116). This latter is constructed after the same manner as the filling flush weave, except that the one down and four up warp flush weave is used.

From a 6-harness twill no regular sateen can be made, the number of harnesses not being divisible according to the rule. An irregular weave can be produced, but it is not desirable, as there will be two threads or two picks running consecutively in some parts of the weave. The best combination is made by using the threads of the twill in the following order: 1, 3, 5, 2, 6, 4. (See Figs. 117 and 118.)

The 7-harness sateen can be obtained according to rule. (See Figs. 119 and 122.)

As a further demonstration, let us take the 8-harness filling flush twill, 1 up and 7 down. (Fig. 120.)

According to the rule the numbers in this case are 3 and 5. Four and 4 would be equal, 6 and 2 would be divisible by a third number; consequently they would not be correct. Take 3 as the number for counting. The first pick of the sateen is the first pick of the twill; the second pick is found by adding 3 to the first pick, which makes it the fourth pick of the regular twill; then add 3 to 4, which makes it the seventh pick of the twill; to this 7, 3 is added, which shows that the fourth pick of the sateen is the tenth of the twill, but as the twill repeats on 8 picks, the second corresponds to the tenth and is the fourth of the sateen; to the second pick 3 is added, which makes it the fifth of the twill and also the fifth of the sateen; to the fifth pick 3 is added, which makes the eighth of the twill the sixth of the sateen; to the eighth 3 is added, which makes 11; the third pick is equivalent to the eleventh and seventh of the sateen; to the third 3 is added, so that the sixth of the twill is the eighth of the sateen. If 3 is again added, the first pick of the twill will be the next one to be used, thus showing that the repeat of the weave has been obtained. The 8-harness sateen is formed by using the picks of the twill in the following order: 1, 4, 7, 2, 5, 8, 3, 6. (See Fig. 121.)

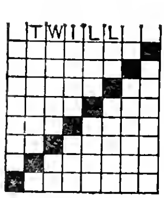


Fig. 120.

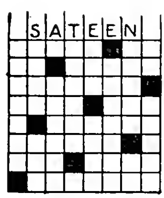
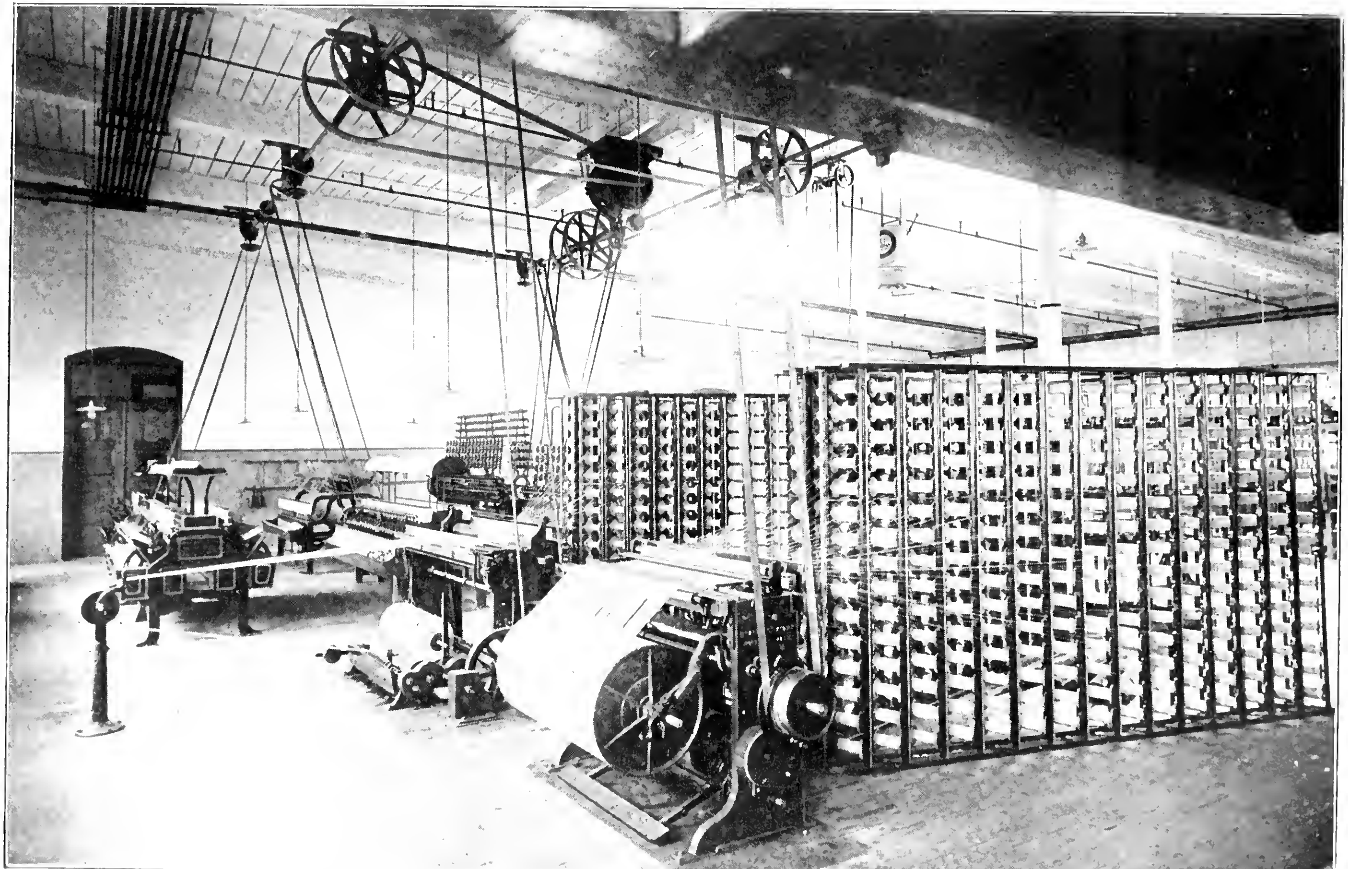


Fig. 121.

In laying out a cloth of this description the number of threads in both the warp and filling is of the greatest importance. The warp threads in a warp flush weave should be placed as close together as their diameters will permit, and as the filling is inserted, one thread will be withdrawn from the surface of the fabric and will bend around the filling at the back. As the next pick is inserted, another thread will be withdrawn, the first one



VIEW IN WARPING AND SPOOLING DEPARTMENT, BRADFORD-DURFEE TEXTILE SCHOOL

returning to its original position. As the threads are not withdrawn in regular or consecutive order, the filling does not bend around the warp in a great degree, but remains straight, the warp only being drawn out of its course. Under this condition the filling threads cannot be made to lie close together, but are always separated from each other by at least the diameter of the warp thread; therefore, in this class of fabric, we should always have a greater number of warp threads per inch than filling picks.

If the fabric is to be durable, we must take care that the material which is present in least quantity, whether it be filling or warp, shall be of sufficient strength to compensate for the absence of quantity, otherwise the fabric will be able to bear strain in one direction only, whereas by proper attention to the strength of the material employed we may make it able to bear the requisite strain in both directions. If it is desired to produce on the fabric a smooth, unbroken surface with no visible pattern, the warp threads may be placed so closely together that as one is withdrawn to bend around the filling, those on each side of it will close over the vacancy and completely hide the point where it has interwoven with the filling.

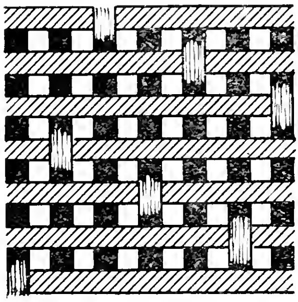


Fig. 122.

In that case the number of warp threads should be increased in proportion to the number in the filling, and consequently the fabric will be capable of bearing an increased strain upon the warp, but a decreased strain in the direction of the filling. Exactly the same principle will apply to fabrics where a filling surface is desired; the warp threads are then set such a distance apart as will permit of the filling threads passing readily between and bending around them. The filling threads are inserted as closely as their diameters will allow, and in some cases pass over and hide the point where the filling has bent around the warp; and again, in many cases, they are inserted so closely that the filling is compressed and loses its cylindrical form. In such fabrics the greatest strength is in the direction of the filling just in proportion to the quantity of material employed.

EXERCISES IN SATEEN WEAVES.

(*A*) Work out weaves from the following:

(1) $\dfrac{3\quad 2\quad 3}{2\quad 1\quad 1}\Big/1$ (2) $\dfrac{2\quad 2\quad 2}{2\quad 1\quad 2}\Big/5$ (3) $\dfrac{1\quad 2\quad 3}{1\quad 2\quad 3}\Big/1$

(4) $\dfrac{1\quad 2\quad 3}{1\quad 2\quad 3}\Big/5$ (5) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 4}\Big/1$ (6) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 4}\Big/5$

(7) $\dfrac{3\quad 3\quad 1}{3\quad 2\quad 2}\Big/1$ (8) $\dfrac{3\quad 3\quad 1}{3\quad 2\quad 2}\Big/2$ (9) $\dfrac{3\quad 3\quad 1}{3\quad 2\quad 2}\Big/3$

(10) $\dfrac{3\quad 3\quad 1}{3\quad 2\quad 2}\Big/4$ (11) $\dfrac{3\quad 3\quad 1}{3\quad 1\quad 2}\Big/5$ (12) $\dfrac{3\quad 3\quad 1}{3\quad 2\quad 2}\Big/6$

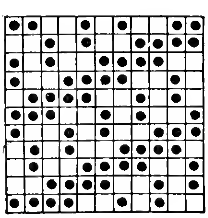
(13) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 3}\Big/1$ (14) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 3}\Big/2$ (15) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 2}\Big/3$

(16) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 3}\Big/4$ (17) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 3}\Big/5$ (18) $\dfrac{3\quad 3\quad 1}{1\quad 2\quad 2}\Big/5$

(19) $\dfrac{3\quad 1\quad 1}{2\quad 1\quad 2}\Big/3$ (20) $\dfrac{4\quad 2}{2\quad 2}\Big/2$ (21) $\dfrac{3\quad 1\quad 1}{1\quad 3\quad 1}\Big/-3$

(22) $\dfrac{3\quad 3}{2\quad 4}\Big/-5$ (23) $\dfrac{3\quad 3}{2\quad 4}\Big/2$ (24) $\dfrac{3\quad 3}{2\quad 3}\Big/-3$

(*B*) Write the order of weaving, and move numbers for each of the following weaves 25—30, both warp way and filling way.



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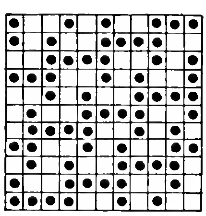

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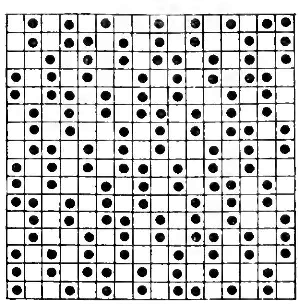
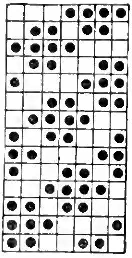


27

(Exercise continued on next page.)



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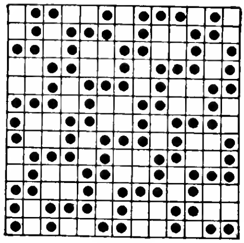

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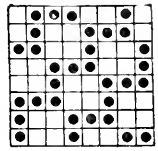
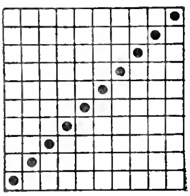


30

(*C*) Make plans with bases 31—33 and order of weaving $\dfrac{4\quad 2\quad\ }{\quad 2\quad 2}$ and with bases 34—38 and order of weaving $\dfrac{4\quad 1\quad 1\quad\ }{\quad 1\quad 3\quad 1}$.



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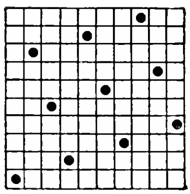

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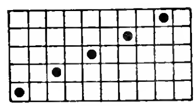

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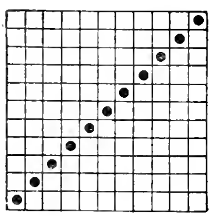

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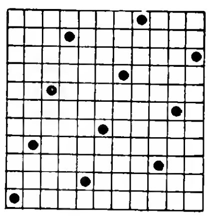

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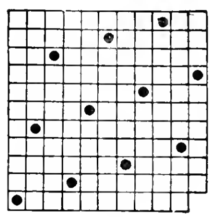

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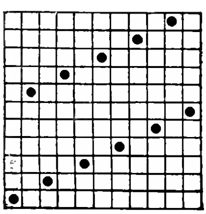

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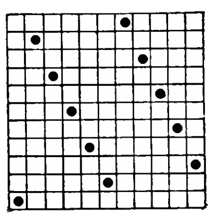
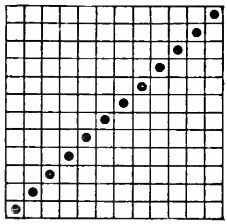


38

(Exercise continued on next page.)

(*D*) Make two plans on each of the accompanying bases 39—41.



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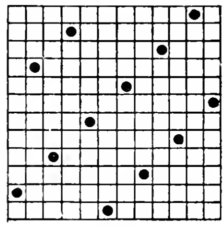

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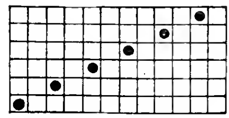
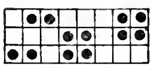
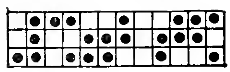


41

(*E*) Run out plans 42—45 to one complete pattern of each.



42



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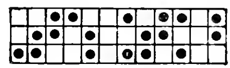

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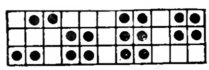


45

(*F*) Give two bases on 13 threads and run out two plans on each base.

(*G*) Make plans as follows:

(1) $\dfrac{4\quad 1\quad 1}{2\quad 2\quad 2}\Big/ 3 - 1$ (2) $\dfrac{4\quad 1\quad 1}{2\quad 2\quad 2}\Big/ 4 - 2$

(3) $\dfrac{4\quad 1\quad 1}{2\quad 2\quad 2}\Big/ 5 - 3$ (4) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 4}\Big/ 2 + 0$

(5) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 4}\Big/ 3 - 1$ (6) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 4}\Big/ 4 - 1$

(7) $\dfrac{2\quad 2\quad 2}{1\quad 1\quad 4}\Big/ 5 - 3$ (8) $\dfrac{3\quad 2\quad 2}{2\quad 1\quad 2}\Big/ 5 - 1 - 1$

(9) $\dfrac{3\quad 2\quad 2}{2\quad 1\quad 2}\Big/ 3 - 2 + 2$ (10) $\dfrac{3\quad 2\quad 2}{2\quad 1\quad 2}\Big/ 4 - 3 + 2$

(*II*) Give order of weaving and move of the following plans

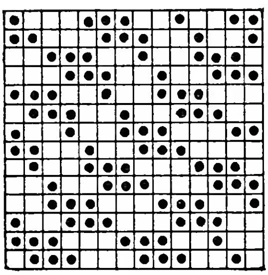
(11) $\frac{3\quad 2\quad 2}{\quad 2\quad 1\quad 2}\Big/ 4-2+1$ (12) $\frac{2}{\quad 2}\Big/ 0+2$

(13) $\frac{3}{\quad 3}\Big/ 0+0+3$ (14) $\frac{3}{\quad 3}\Big/ 0+3$

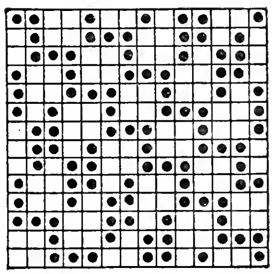
(15) $\frac{3\quad 1\quad 1}{\quad 1\quad 3\quad 1}\Big/ -1+3$ (16) $\frac{3\quad 1\quad 1}{\quad 1\quad 3\quad 1}\Big/ -3+5$

(17) $\frac{4\quad 1\quad 1}{\quad 2\quad 2\quad 2}\Big/ 5-1-1$ (18) $\frac{3\quad 2\quad 1}{\quad 3\quad 2\quad 1}\Big/ 5-1-1$

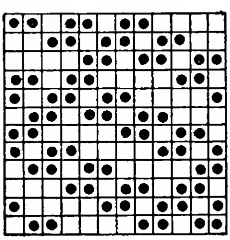
(19) $\frac{2\quad 2\quad 2}{\quad 1\quad 1\quad 4}\Big/ 5-1-1$ (20) $\frac{1\quad 3\quad 1}{\quad 1\quad 1\quad 5}\Big/ 5-1-1$



A



B



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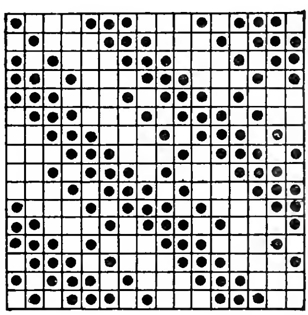
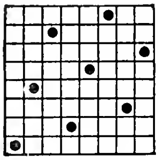


D

(Exercise continued on next page.)

(*I*) Make two plans on each of the accompanying bases 31—40.



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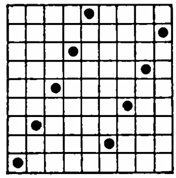

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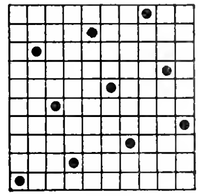

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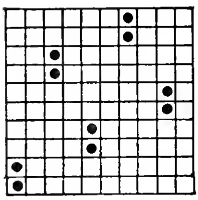

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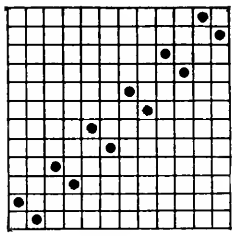

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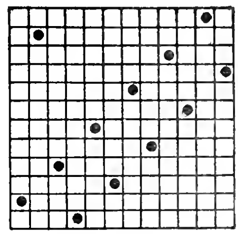

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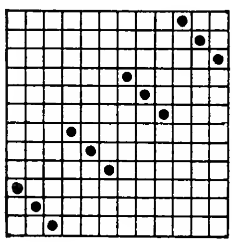

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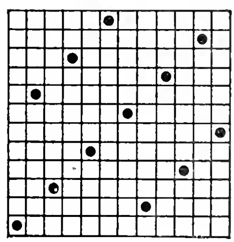

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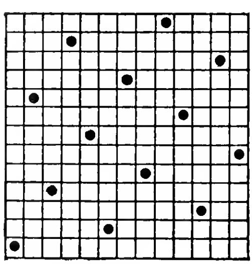

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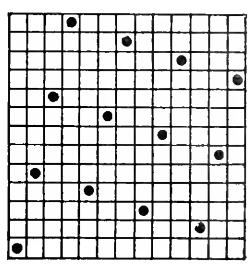

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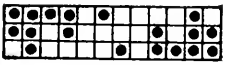
(Exercise continued on next page.)

(*J*) Run out plans 41—46 until complete.



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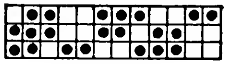

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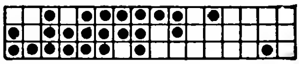

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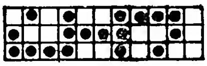

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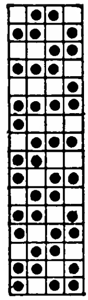

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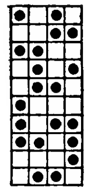

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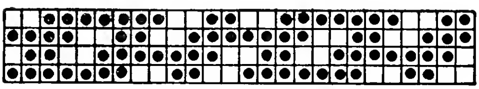
(*K*) Give one complete repeat of plans 47—53 and write order of weaving and move number for each.



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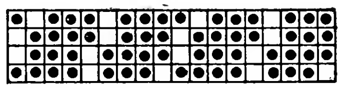

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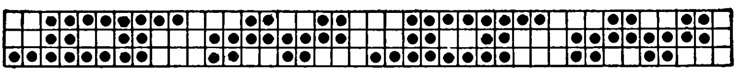

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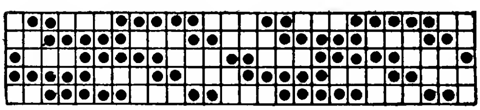

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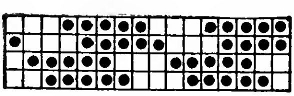

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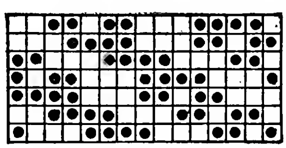

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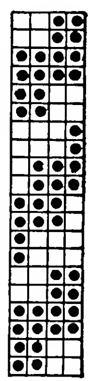

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SATEEN STRIPES.

In designing fancy fabrics for the white cotton trade the designer is frequently compelled to depend almost entirely upon the weave to obtain different effects. When the warp and filling are both white, this becomes a necessity. There is another method, however, and it is one that is often useful, namely, the manner in which the warp is reeded. In some patterns it is necessary to have some parts of the warp reeded in greater numbers than in other sections, that is, in some parts of the reed each dent contains 2 threads, while in other sections the reed may contain 3, 4, 5 or even 6 in one dent. Six is generally considered the highest number, but in some rare cases even 8 or 10 threads are put in the same dent.

Nearly all the fancy white goods that are made have for the body or groundwork of the fabric the regular plain or cotton weave, 1 up and 1 down. The stripe in the warp will be either a twill, broken twill, or sateen weave, warp flush, and the overcheck will be a sateen weave, filling flush. The sateen weave is generally combined with other weaves to make stripes and checks.

Stripes consist of bands or lines, varying in width and color, running lengthwise of the cloth, viz., in the direction of the warp. The distinctive character of this make of goods is its line-like composition. All patterns of this order are nothing more than a blend of lines of various shades and weaves. They are of varying widths and extend from one end of the fabric to the other. Athough this form of pattern is well adapted to trouserings, shirtings and some styles of dress and mantle cloths, it is not suitable for coatings and even suitings when extended beyond a very minute stripe of the hair line description.

The variety of these stripes is very extensive, both as to shade and color, commencing with the single thread hair line, and increasing in size until a stripe or band several inches wide is obtained.

The prominence of the different weaves employed, the bands or lines of color, their distinctness, solidity, their intermittent character, and their subdued tone aspect, are all qualities depending on the structure of the fabric and its weave composition.

The pattern in striped styles is principally a warp product and the filling in such cases only of secondary consideration. The filling is employed, first, to bind the warp threads together and thus form a wearable fabric; second, to constitute an appropriate groundwork on which the warp colorings may be correctly exposed.

Proper emphasis of the colors composing the stripes is acquired by employing a suitable shade of filling, and by adopting that system of crossing or interweaving which will, in addition to yielding the requisite strength and firmness of fabric, sufficiently interfere with the continuity of the fancy shades introduced into the warp.

Some are mere lines, no wider than the diameter of the threads employed, while others are several inches wide. Two colors may be introduced to form stripes of different widths; for example, black and a dark mix may be combined to give stripes of many descriptions.

We could use 1 thread of black and 1 thread of dark mix, which would make a stripe of the hair-line description, using the plain weave for the intercrossing; or 2 threads of black and 1 thread of dark mix, using the 3-harness twill for the interweaving. Thus we might continue on these principles and form sets of stripes of variable widths or sizes. The character of these styles to a very great extent is governed by the class of texture in which they appear. Examples of this occur in the various fabrics produced by the loom. Take, for example, stripes for trouserings, which are generally small to medium size, softly and neatly toned in coloring. In dress goods, mantlings and ulsterings are found much broader effects, more elaborate in arrangement, and which require much greater force of coloring.

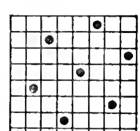
In cotton shirtings small, neat styles are considered the best, but in cotton dress goods there appears to be no definite limit, either as to the width of the stripe or to the radical plan of coloring. For aprons, children's dress goods and such fabrics as tickings and awnings, stripes are used to a considerable extent. To form a practical idea of what is meant by a sateen stripe the following particulars should be thoroughly understood.

Sateen Tick Stripe. When the name "Sateen Tick" is used, the general impression is that of a line of goods or a fabric which in some way resembles a sateen. But a sateen tick is in no way like a satin, being used for an entirely different purpose. These goods are made entirely of cotton, and are used for upholstery; the name "Sateen Tick" being taken from the weave, which is a sateen weave.

There is quite a demand for this fabric, but the manufacture of it is chiefly in the hands of a few large mills, which monopolize the industry. In many mills in which this fabric has been attempted a 2-ply yarn has been used for the warp, and this has made the goods harsh in feeling, and unfit for this purpose. The only proper way to make them feel soft is to use combed cotton yarn for the warp and the same stock for the filling, but having the filling twisted harder than the warp. The best fabrics on the market have 98 threads to the inch of single 7's and about 52 picks of single 14's. The weave which is used, and from which the fabric obtained its name, is the sateen weave, warp flush, which throws the warp entirely on the face. It makes a smooth face, free from twill lines, with the points of intersection evenly distributed. The 5 harness sateen is the simplest kind. As before stated (see page 37) these weaves are constructed by taking the number of harnesses to be used for the sateen, and dividing it into two parts, neither of which are equal, nor one a divisor of the other; still further, neither divisible by a third number.

The stitching for the weave, or the interlacing of the warp, is obtained in the following manner:

The first intersection will be on warp thread No. 1; the next intersection will be either on the third or fourth warp thread, according to whether the weave is counted by twos or by threes. If counted by twos the intersections will be as follows: 1, 3, 5, 2, 4. Almost all of these goods are woven on this weave, but in some cases the 8-harness sateen shown in Fig. 121 is used. The intersections are as follows: 1, 4, 7, 2, 5, 8, 3, 6. This is constructed on the same principle as the 5-harness sateen, but there are fewer intersections of the warp; consequently this allows more picks and makes a heavier fabric. These sateens are very desirable



8 H. Sateen.

goods, as they may be woven easier and faster on account of the weave. The line of colors should be as simple as possible, because the fewer the colors the less the expense. The following is a line of colors in use in one of the largest mills in the country: black, white, red, very light tan, medium tan, dark blue, brown and light brown. These colors, if made in light shades, can be combined in a great variety of effects and produce innumerable patterns.

The following will give good results and splendid combinations, and will also give the size and style of the stripes. An attractive effect having a very broad stripe can be produced by 120 threads of red, 10 white, 60 light tan, 4 dark blue, 10 medium tan, 4 dark blue, 10 medium tan, 4 dark blue, 10 medium tan, 4 dark blue, 60 light tan and 10 white.

This can be varied and will make another very effective style by using 120 threads of dark blue in place of red, the rest remaining the same. Another good coloring is made as follows: 10 threads red, 10 dark blue, 88 red, 10 dark blue, 10 red, 50 white, 6 dark blue, 10 dark tan, 6 dark blue, 10 dark tan, 6 dark blue, 10 dark tan, 6 dark blue, 50 white, 2 dark blue, 16 red, 2 dark blue, 50 white.

In all these dressings the color can be varied; the number of threads may also be increased or decreased at pleasure. The principle effect desired is contrast of color, combined with harmony. There is no limit in the range of design.

COTTON SATEEN STRIPE.

The yarn used for this class of fabric varies from 40's to 70's, although a large proportion is between 50's and 60's. There are also large quantities of 2-ply, 4-ply and sometimes 6-ply yarn used in cotton cords and stripes. The filling for such goods will range from 60's to 90's.

The texture of the fabric in the plain part, that is, the part between the sateen stripes, will vary from 60 threads × 60 picks to 96 threads x 80 picks. The width of the goods is generally from 27 to 28 inches, though goods made especially for aprons will run from 40 to 42 inches.

For an illustration let us make a cloth 28 inches wide, having for the design a sateen stripe, with plain stripe ground for 1 inch; sateen or broken 6-harness twill, $\frac{1}{4}$ inch; plain ground, $\frac{1}{4}$ inch; broken twill, $\frac{1}{4}$ inch. Total width of stripe to be $1\frac{3}{4}$ inches.

28 inches ÷ 1.75 inches = 16 repeats or designs across the cloth. Suppose we make the body of the warp, or what we have already called the plain or ground work, 80 threads to the inch. Then we have:

¼ inch broken twill
¼ inch groundwork
¼ inch broken twill
1 inch groundwork

It is to be divided into a reed with 40 dents to the inch, or as is usually understood, a 40's reed; 2 threads in one dent = 80 threads per inch. When making a pattern with one part of the design larger than the other, divide the larger portion into two parts, so that the design will commence at one side of the cloth and will be equal to the design at the extreme edge or other side of the cloth. Our typical design has one inch of plain or ground which we divide into two equal parts.

The way to lay out this piece of cloth will be as follows:

½ inch plain	20 dents	2 threads in one dent = 40 threads
¼ inch stripe	10 dents	6 threads in one dent = 60 threads
¼ inch plain	10 dents	2 threads in one dent = 20 threads
¼ inch stripe	10 dents	6 threads in one dent = 60 threads
½ inch plain	20 dents	2 threads in one dent = 40 threads
	70	220

Thus it will be seen that one pattern occupies 70 dents, and as we have already decided that there are to be 16 repeats of the pattern, we shall require 16 × 70 = 1,120 dents exclusive of selvedge. Add 10 dents on each side for selvedge, this making total of 1,140 dents.

1,140 dents ÷ 40 = $28\frac{1}{2}$ inches.

The reed must be $28\frac{1}{2}$ inches wide.

Two hundred and twenty threads in one pattern × 16 = 3,520 threads. The selvedge is composed of 20 double threads, 2 in a dent on each side.

Left selvedge 20 double threads =	40
Body of warp =	3,520
Right selvedge 20 double threads =	40
Total number of threads =	3,600

Fig. 123 represents a good weave for a 6-harness broken twill. This weave is especially recommended for this purpose.

The next thing to make is the drawing-in draft, or harness draft and chain.

Also leave for selvedges 10 empty heddles on the right and left sides of the 4 front harnesses.

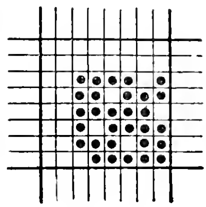


Fig. 123.

The first 40 threads on the 4 front harnesses, which are forming a plain weave; the second section of threads which are drawn on the 6 back harnesses, and are weaving a 6-harness broken twill; the third section of the threads, which are drawn on the 4 front harnesses; the fourth section of threads, which are drawn on the 6 back harnesses: and the last section of 40 threads on the 4 front harnesses, make one repeat of the pattern or 220 threads. This operation is repeated 16 times, and when finished will have completed the body of the warp, or 3,520 threads. Now

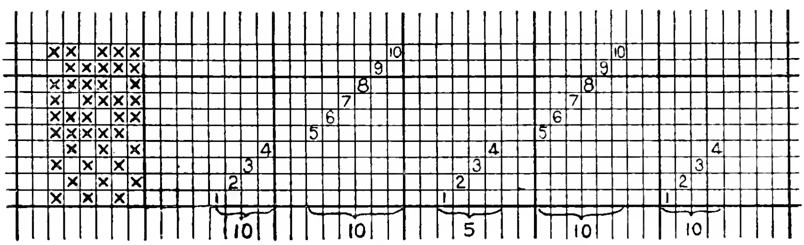


Fig. 124. Fig. 125.

draw in the double threads for the selvedges on each side of the warp. The foregoing is a systematic way of obtaining the lay-out of a design, chain, and harness draft; but in some mills the drawing-in or harness draft would be laid out as follows:

	10 double threads on 1. 2. 3. 4.		for selvedges
Repeat 16 times	40	threads on 1. 2. 3. 4.	for plain weave
	60	threads on 5. 6. 7. 8. 9. 10	for broken twill
	20	threads on 1. 2. 3. 4.	for plain weave
	60	threads on 5. 6. 7. 8. 9. 10	for broken twill
	40	threads on 1. 2. 3. 4.	for plain weave
	220 x 16		
	10 double threads for 1. 2. 3. 4.		for selvedges

There is another very important matter to which particular attention must be paid; that is, the question of how many wires or heddles must be placed on each harness shaft, thus preventing any possibility of overcrowding the wires or heddles on any or all of the harnesses. Take our previous example for illustration.

On the 1st harness	25 threads × 16 patterns =	400 heddles
On the 2nd harness	25 threads × 16 patterns =	400 heddles
On the 3rd harness	25 threads × 16 patterns =	400 heddles
On the 4th harness	25 threads × 16 patterns =	400 heddles
On the 5th harness	20 threads × 16 patterns =	320 heddles
On the 6th harness	20 threads × 16 patterns =	320 heddles
On the 7th harness	20 threads × 16 patterns =	320 heddles
On the 8th harness	20 threads × 16 patterns =	320 heddles
On the 9th harness	20 threads × 16 patterns =	320 heddles
On the 10th harness	20 threads × 16 patterns =	320 heddles
		3,520 heddles
Also on the 4 front harness 5 extra for selvedges		20 heddles
	Total	3,540 heddles

In this cloth we will suppose there are 72 picks per inch.

In weaving this class of fabric, there is often much trouble caused by filling kinks. The filling is apt to catch on the sateen stripe, and unless the shed is perfect and clear there will be trouble of this kind. Under these circumstances it is necessary that the harnesses are properly hung, and that they are making a clear, even, open shed. Almost all mills engaged in weaving this class of goods use a head motion known as the dobby. The Crompton, Knowles and Stafford being the most popular. As the goods are woven with one shuttle the looms can be run at a very high rate of speed, for which the dobby or head motion is especially adapted. These dobbies are made to fit any kind of loom, and it is quite common for mills to put them on their plain looms, to be used thereafter for fancy weaving. But as the loom can weave with but one shuttle, it is confined to striped goods.

Overchecks. In making patterns for plaids, proceed in the same manner as with the stripes to find the number of warp threads. It is the filling check or overplaid that will give most of the trouble in these patterns.

To get the stripe or overcheck in the filling of the same density as the broken twill or sateen stripe in the warp, the take-up motion must be prevented from working, so that the filling threads may be beaten up closely, to correspond with the broken twill in the warp. To accomplish this a wire is attached to the pawl that pushes or pulls the ratchet gear, and is fastened at the other end to one of the levers that work the harnesses. Wherever the take-up motion should stop, a pin is inserted in the chain at the proper place. The pin, in lifting the lever, pulls the wire that is fastened to the pawl, thus lifting it up and thereby stopping the take-up motion.

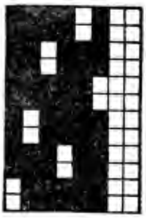


Fig. 126.

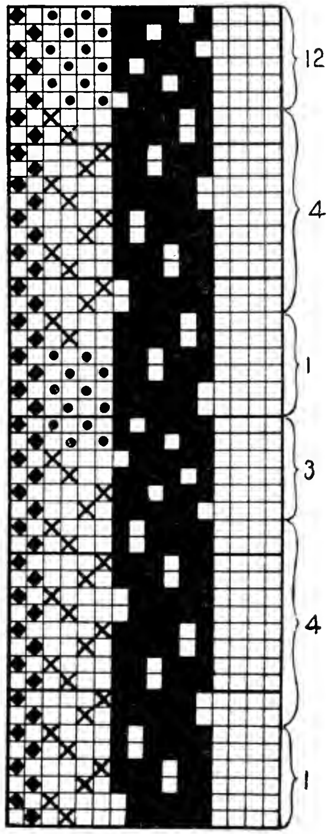


Fig. 127.

The question now arises of how often the take-up motion should be stopped while weaving the check.

We will again take our example: to make the filling compare with the warp, there will need be as many picks in $\frac{1}{4}$ inch as there are in the corresponding stripes in the warp, which is 60. It will be found, however, in practice, that 54 will be sufficient. Supposing there are 72 picks per inch, in $\frac{1}{4}$ of an inch there would be 18, but the overplaid calls for 54. The ratchet gear is taking up 1 tooth every 2 picks, thus moving 9 teeth for every $\frac{1}{4}$ of an inch of cloth woven; therefore, to get 54 picks in that space, there must be 6 picks for every tooth taken up, so it follows then that out of every 6 bars in the pattern chain, 4 of them will have to contain pins in order to stop the take-up motion.

The best weave for the stripe or overplaid, when there are an even number of threads in a dent, is the 4-harness broken twill, or Crowfoot weave. In making the design for a filling stripe of this description, and in order to have the warp stripe pass smoothly over the filling check, the weave must be made double what it is in the plain part; if we are using a 5 up and 1 down weave, it must be made to run exactly double, that is, 10 up and 2 down, when it comes to the filling stripe. Fig. 126 will explain.

There must be 2 extra harnesses allowed for selvedges on patterns of this nature, otherwise there will be a bad selvedge where the filling stripe is being woven. Fig. 127 shows the harness chain complete for weaving a plaid from the stripe pattern just explained.

PLAIN AND IRREGULAR RIB WEAVES.

After the plain, twill, and sateen weaves have been studied, the next class is the derivative weaves, or those which are designed by using one of the foregoing weaves as a basis. The simplest class of these weaves is the ribbed. This is formed by using the plain or cotton weave as a foundation.

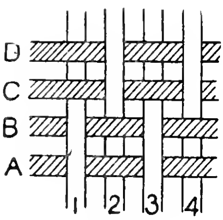


Fig. 128.

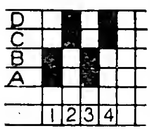
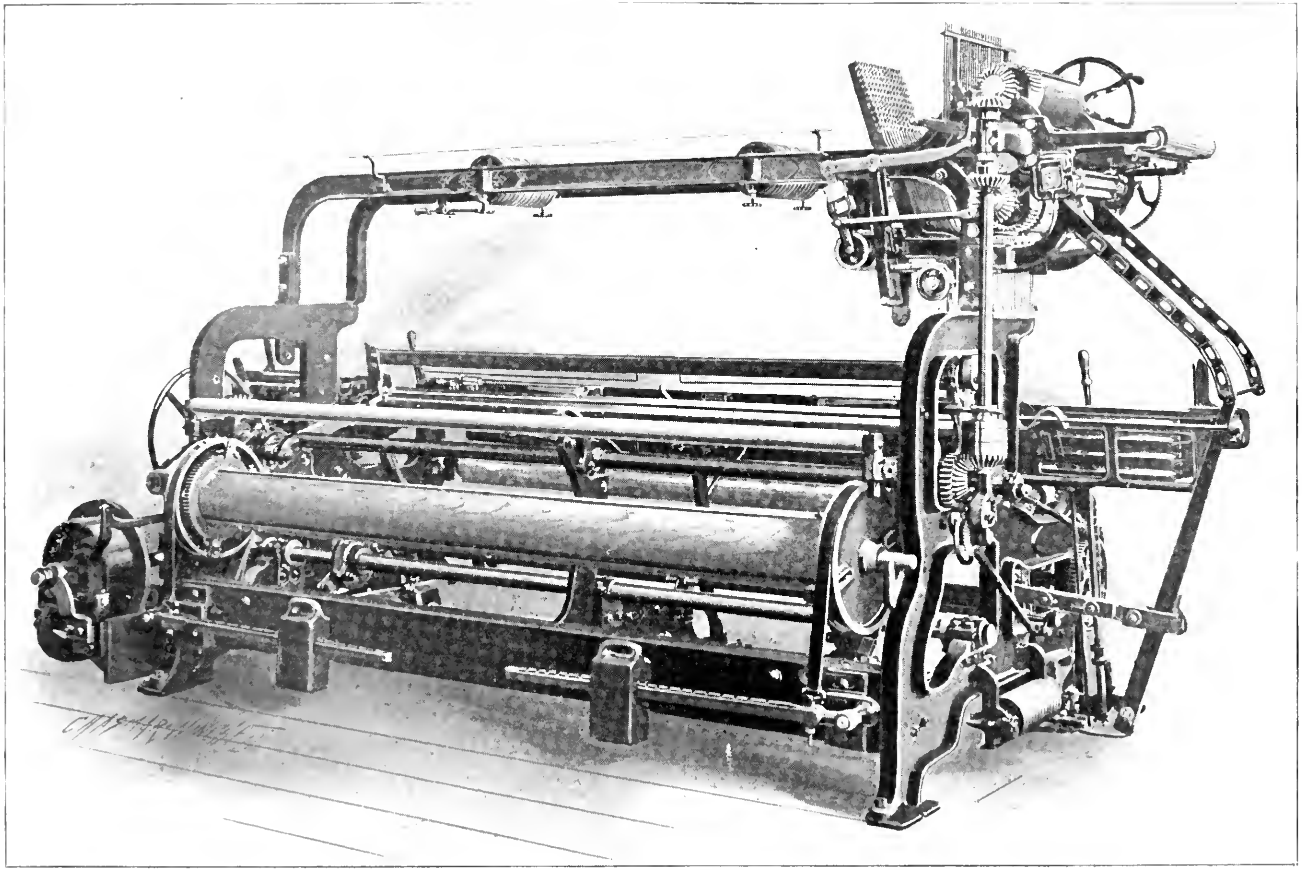


Fig. 129.

Fig. 128 is an enlarged diagram of a fabric woven on the simplest rib weave that can be constructed. It is made by raising 1 warp thread for 2 consecutive picks, and lowering the same warp thread under the next 2 picks; the second thread being exactly the reverse of the first.

By a careful study of Fig. 128 and Weave 129, a clear idea of the designing of these weaves will be obtained. The warp thread No. 1 is raised when the pick A is inserted, and the same position of warp threads is obtained in the case of the second pick, B. When C and D are woven, the warp thread No. 1 passes under them, the warp thread No. 2 passes under A and B and over C and D, which is the reverse of the intersections on thread No. 1.

It will be seen that this weave is nothing more than the



CASSIMERE LOOM WITH 92-INCH REED SPACE

Crompton & Knowles Loom Works

plain weave, with an additional pick made in the direction of the filling. This causes the warp to cover the filling. This effect is called a rib, and is made by the warp. These weaves are called warp-rib weaves, because the rib is formed by the warp, but the rib line runs across the piece or width of the fabric. In the filling-effect weaves, the rib lines run in the direction of the warp, but are formed by the filling. The threads 3 and 4 are the duplicates of 1 and 2. This weave repeats on 2 harnesses and 4 picks, Fig. 128 being the design for the enlarged section of the fabric.

The warp-rib weaves do not have the extended use which the filling ribs do. These are also an enlargement on the plain weave basis, but instead of being in the direction of the filling, the rib is

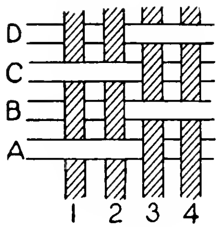


Fig. 130.

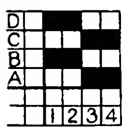


Fig. 131.

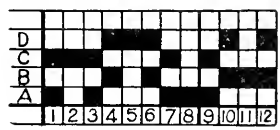


Fig. 132.

in the direction of the warp. Fig. 130 and Weave 131 illustrate the simplest filling-rib weaves that can be constructed. Fig. 130 is the enlarged section of the fabric, and Fig. 131 is the design for Fig. 130. The pick A is over the two threads 1 and 2 and under the two threads 3 and 4; the second pick, B, is the reverse of A, and the third and fourth picks, C and D, are the duplicates of A and B. The weave repeats on 4 warp threads and 2 picks. In the fabrics woven on this principle, the face rib is formed by the filling, and it covers the warp almost entirely. On account of this characteristic, these weaves are used largely in the manufacture of woolen and cotton union fabrics, that is, a cotton warp with woolen filling; but because of the slippery character of the cotton warp, and the filling crossing each bunch or set of threads in the same manner, it is found that in the fabric the filling will slip or pull on the warp and form open spaces. This defect can be remedied to some extent by using such a weave as is shown by Fig. 132. In this weave it will be noticed that a warp thread is lowered on every rib or cord; this additional intersection holds the filling and keeps it from slipping on the warp.

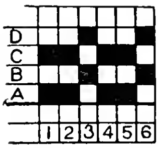


Fig. 133.

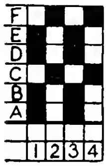


Fig. 134.

From the plain rib weaves the fancy and irregular rib weaves are made. These consist of the combination of two or more rib weaves of various widths in one design. Fig. 133 shows the design for a weave of this class, which repeats on 3 threads and 2 picks. Fig. 134 is the same idea designed for a warp rib.

EXERCISES FOR PRACTICE.

1. Make designs for warp-rib weaves to repeat on 2 harnesses and 6 picks, for 2 harnesses and 8 picks; also for 2 harnesses and 10 picks.

2. Make designs for filling-rib weaves to repeat on 6 threads and 2 picks; also 8 threads and 2 picks; also 10 threads and 2 picks.

3. Make designs for irregular rib weaves of this character, consisting of the combining of those weaves where the filling crosses 2 threads and 3 threads, 3 threads and 1 thread, 4 threads and 2 threads, and 4 threads and 1 thread.

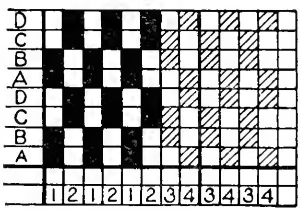


Fig. 135.

4. Make designs where the warp thread crosses the same number of picks as the warp threads in the above examples.

5. Make a diagram of each weave and a cut section of the first and second picks of each design.

WARP EFFECT, FIGURED RIB WEAVES.

The first step in making figured rib weaves is to break the rib line or to change it after a certain number of warp ends. The method of designing these weaves is shown in Fig. 135, where the rib line on the first 6 warp ends is the same, then by raising the intersection 1 pick, the rib line is broken from a straight line across the fabric. On this break it also covers 6 ends, so that the weave repeats on 4 picks and warp ends. This weave can be varied considerably by using a different number of warp ends in the change of the rib line, such as using 12 ends for the first direction of rib line, and then a smaller number for the second direction.

Fig. 136 is the combination of the 4 up and 2 down rib weave, using 6 ends for each change of the rib line; this makes a broad and a narrow rib line, and is a very good fancy effect. It repeats on 12 ends and 6 picks. By using various rib weaves and changing the arrangement of the number of threads used for several widths, a great variety can be produced.

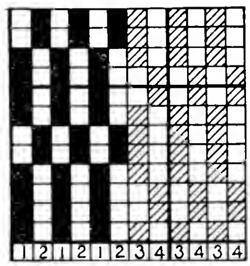


Fig. 136.

FILLING-EFFECT, FIGURED RIB WEAVES.

These weaves are designed on the same principle as the warp-effect rib weaves, except that the rib line runs in the direction of the warp instead of the filling. Fig. 137 shows the narrow and wide rib weaves combined, the rib line running for 6 picks, then changing on the next 6. This will produce an alternating wide and narrow rib effect.

The filling effects, as in the warp effects, can be varied by using various widths of rib weaves and different numbers of picks for the various widths.

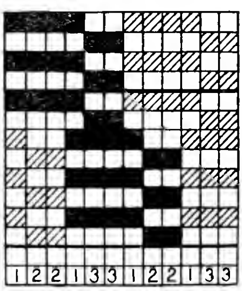


Fig. 137.

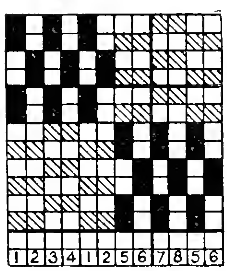


Fig. 138.

The next class of figured rib weaves combines the warp and filling effects in one weave. This is usually done in the shape of block effects, using the warp or filling effect for the ground, and the opposite of what is used for the groundwork of the pattern for the figure. Fig. 138 is the combination of the 2 up and 2 down, using the filling effect for 6 ends and 6 picks, and the warp effect for 6 ends and 6 picks; this repeats on 12 ends and 12 picks.

8	F	F	W	F
8	F	F	F	W
8	F	W	F	F
8	W	F	F	F
	8	8	8	8

Fig. 139.

Fig. 139 is an idea for a weave of this character, each square representing 8 ends and 8 picks. Where W is marked, use warp-face and in those marked F filling-face rib weave.

EXERCISES FOR PRACTICE.

1. Make this weave (Fig. 139), which will require 32 ends and 32 picks; also make two other designs of this same class.

2. Make designs for three of the figured warp-effect rib and three of the figured filling-effect, marking number of ends used for each weave. Eight designs in all.

OBLIQUE RIB WEAVES.

These weaves are a combination of the warp and filling effect rib weaves, and are used principally in the manufacture of what are called bird's-eye effects. They produce a square pattern in the cloth, which fact will be readily observed from a careful study of the weaves.

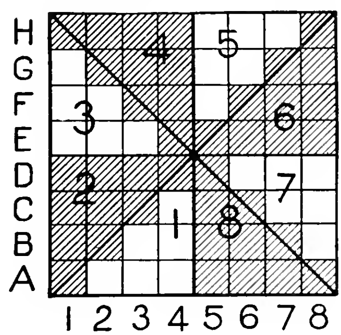


Fig. 140.

To design these weaves first mark off on the design paper the repeat of the weave; that is, if it must be woven on 8 harnesses, mark a square containing 8 ends and 8 picks; subdivide this square into eight parts, as shown in Fig. 140; number each triangle in rotation 1, 2, 3, 4, 5, 6, 7, 8. To design an oblique rib weave, mark in each uneven numbered square the warp-effect rib weave (see Fig. 141), and in each even numbered square the filling-effect rib weave, which produces the completed oblique rib weave (Fig. 142). This procedure can be reversed; that is, the filling-effect rib can be designed in the uneven numbered triangles, and the warp-effect rib in the even numbered triangles, which will produce the finished weave (Fig. 143).

All weaves of this class are designed either commencing rib effects alternating with filling or the reverse.

These weaves are also combined with plain rib weaves for producing checks, usually using the oblique rib weave as the groundwork of the check, and the plain rib weave as the over-plaid or check. A weave of this class is shown in Fig. 144, where the groundwork of check is the 8-harness oblique rib

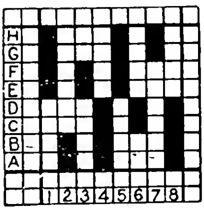


Fig. 141.

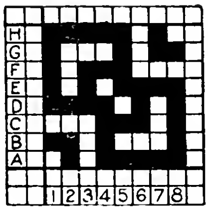


Fig. 142.

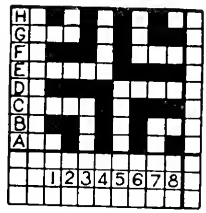


Fig. 143.

weave designed by commencing with the filling-effect rib in first triangle; the 4-harness rib filling effect for the warp over-checking, and warp effect for filling over-checking.

These combination weaves are simple, the only difficulty being experienced where the warp and filling effects of overchecking join. At this point care should be taken that the weaves come together, preserving as nearly as possible the effect of both. These weaves are principally used in the manufacture of piece dyed worsteds.

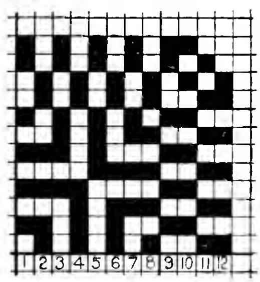


Fig. 144.

EXERCISES FOR PRACTICE.

1. Make designs for 6, 8, 10, 12, 14, 16 harness weaves of this class, using warp-effect rib in first triangle; also make 6, 8, 10, 12, 14, 16 harness weaves, using-filling effect rib in first triangle.

2. Design two weaves of this class, combining the 10 and 12 harness oblique weave with warp and filling effect rib weave.

BASKET WEAVES.

The common weaves of this class are simply an enlargement of the plain or cotton weaves, in that the intersections are 1 end up and 1 end down, and 1 pick up and 1 pick down. To enlarge on this requires that the number of ends and picks on the same intersection must be made larger. The plain weave consists of 1 end and 1 pick each way, and to enlarge on this arrangement the number of ends and picks must be increased. It

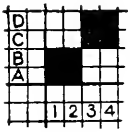


Fig. 145.

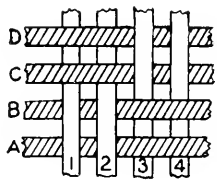


Fig. 146.

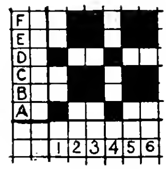


Fig. 147.

is obvious that the next change would be 2 ends and 2 picks each way. This produces the simplest basket weave that can be constructed, shown in Fig. 145, of which Fig. 146 is an enlarged section of a fabric woven on this weave. This basket is the 2 and 2.

Fancy basket weaves are constructed from the plain or common basket weaves. These are solely the combination of two or more weaves of the common basket, or a basket and the plain combined.

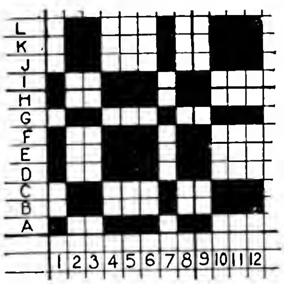


Fig. 148.

Fig. 147 is an illustration of these weaves. There is combined the plain and the two basket to form a weave which repeats on 3 ends and 3 picks. Fig. 148 shows the combination of a more complicated weave of this class. It is the 1, 2 and 3 combined, and consists of three changes. It repeats on 12 ends and 12 picks. In designing these weaves always commence at the left-hand corner and run the weave across the paper to the upper right-hand square. Two repeats of the original weaves are necessary before a complete repeat of the weave is secured. After designing these on paper, fill in the rest of the weave, always counting the changes the same both warp and filling way.

EXERCISES FOR PRACTICE.

1. Make the designs for example 1, 3 and 3; example 2, 4 and 4; example 3, 5 and 5.

2. Combine the following in fancy basket weaves: example 4, 2–4; example 5, 1–4–2; example 6, 2–3–1–2–1; example 7, 1–1–2–2–3; example 8, 2–3–4.

CORKSCREW AND DOUBLE-TWILL WEAVES.

These weaves are chiefly used in the manufacture of worsted suitings and trouserings, and in some branches of silk manufacture. They are similar to oblique warp-effect rib weaves, in that they require a fine or close set, since the warp forms to a great extent the surface of both face and back of the cloth, the filling being merely embedded between alternate warp threads.

We shall now describe the construction of a few of these weaves, a close study of which will readily demonstrate the endless variety of new designs to be made in this manner.

With reference to the theory of constructing this class of weave, the true corkscrew is made from the regular twill weaves on an uneven number of harnesses, by using the regular 45-degree twill for a chain, and drawing the threads through the harnesses in the same order as the intersections would occur in any given sateen weave on that number of harnesses.

In order to provide for the equal overlapping at the juncture of the corkscrew twill, the warp section of the 45-degree twill must use one point in excess of the filling section or sinkers, thus:

$$\frac{3}{\quad 2} = 5 \text{ threads}; \quad \frac{4}{\quad 3} = 7 \text{ threads}; \quad \frac{5}{\quad 4} = 9 \text{ threads}$$

If the overlapping of floats at the juncture of the two twills is more than one point, the effect of this style of weave will be lost. This explains the reason why this method of drafting is impracticable on weaves of an even number of harnesses, as an even number cannot be divided into two unequal parts, one of which will exceed the other by one point only. The fewest number of harnesses to make a corkscrew weave is the 5-harness $\frac{3}{\quad 2}$ 45-degree twill; the 13-harness being the largest corkscrew weave in practical use.

Fig. 149 is the 5-harness 45-degree twill.

Operation: Divide the number of harnesses into two parts, one of which will exceed the other by one point or unit; thus, 3

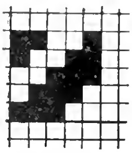


Fig. 149.

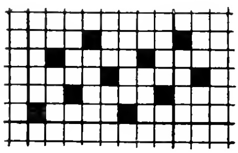


Fig. 150.

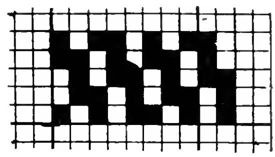


Fig. 151.

and 2 equal 5. The drawing-in draft to be made on the same principle as a sateen weave, always commencing with the first thread on first or front harness, using one of the numbers to count with as a move number, thus: first thread on first harness, second thread on fourth; that is, first and move 3, — this move will place the third thread on the second harness; second and move 3,— this move will place the fourth thread on the fifth harness; fifth and move 3,— this move will place the fifth thread on the third harness; third and move 3,— this move places the sixth thread on the first harness and determines one repeat of the weave.

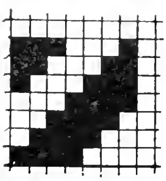


Fig. 152.

This draft shows a straight draw for 5 harnesses, consider-

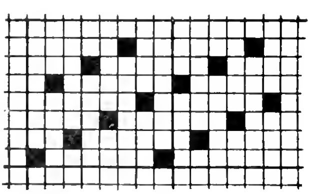


Fig. 153.

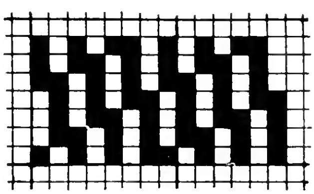


Fig. 154.

ing every other warp thread only, viz.: every uneven warp thread, 1, 3, 5, 7, 9, etc., etc., calling in turn respectively for the first, second, third, fourth and fifth harnesses; the even warp number 2 commences on the fourth harness; considering again every other warp thread only; viz., every even warp thread, numbers 2, 4, 6 and so on, calling in turn respectively for harnesses numbers 4, 5, 1, 2, 3. The draw or draft completed will read 1, 4, 2, 5, 3, 1, 4, 2, 5, 3. A study of Figs. 150 and 151 will explain. Explanation in detail:

1st thread on No. 1 harness, count off 3 places
2d thread on No. 4 harness, count off 3 places
3d thread on No. 2 harness, count off 3 places
4th thread on No. 5 harness, count off 3 places
5th thread on No. 3 harness, count off 3 places
6th thread on No. 1 harness, count off 3 places
7th thread on No. 4 harness, count off 3 places
8th thread on No. 2 harness, count off 3 places
9th thread on No. 5 harness, count off 3 places
10th thread on No. 3 harness, count off 3 places

Fig. 151 shows the corkscrew weave carried to its full extent. It will be noticed that in the first half of the draft, the first or odd thread commences the draw, whereas in the second part of the draft it is the sixth thread or even number that commences the draw. The draft must be extended to double the original weave to make one full repeat.

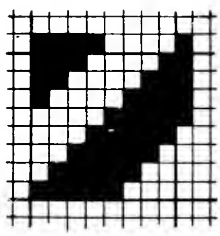


Fig. 155.

Fig. 152 is a 7-harness weave. Seven divided into two parts, one of which will exceed the other by one point only, 4 and 3 equal 7. $\frac{4}{\quad 3}$ 45-degree twill.

Fig. 153 represents the harness draft, and Fig. 154 is the extended design or corkscrew twill; 4 is the move number.

Fig. 155 is a 9-harness weave. Nine divided into two parts, one of which will exceed the other by one point only, 5 and 4 equal 9. $\frac{5}{\quad 4}$ 45-degree twill, with 5 for the move number. Fig. 166, harness draft. Fig. 157, extended design.

Uneven balanced weaves will always produce more perfect corkscrew weaves than the even-sided twills, since it is only possible with the uneven-sided twills to balance the cut-off of the double twill. The direction of the twill will be reversed by using the lesser number.

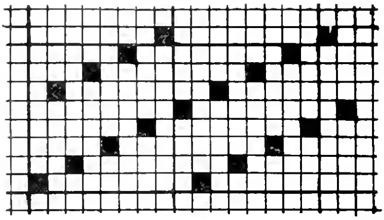


Fig. 156.

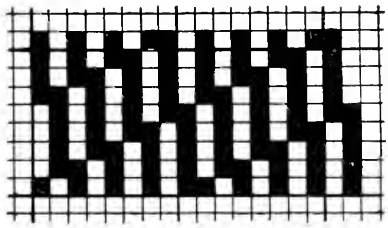


Fig. 157.

Corkscrew weaves on an even number of harnesses. No matter what even-harness 45-degree twill is used for the foundation for an even-harness corkscrew weave, the junction of the two twills will be faulty. There is not the equal cut-off as produced with weaves having an uneven number of harnesses for repeat; but sometimes a corkscrew weave on an even number of harnesses is required, especially with fancy effects, in which corkscrew weaves are used in combination with other weaves. For instance, a case may occur in which a corkscrew weave for an even repeat of harnesses is required to connect with a 6-harness twill. Fig. 158 is the $\frac{3}{}\frac{}{3}$ 45-degree twill.

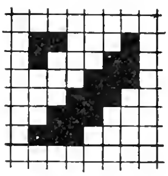


Fig. 158.

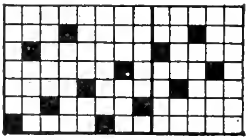


Fig. 159.

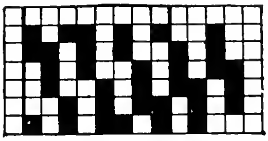


Fig. 160.

Fig. 159, drawing-in draft. Fig. 160, extended design.

It will be noticed that with this weave there is not the perfect junction when the two sections meet, as there is in the 5-harness weave, and this is always the case with an even-sided 45-degree twill.

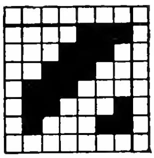


Fig. 161.

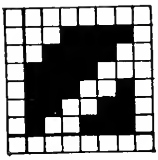


Fig. 162.

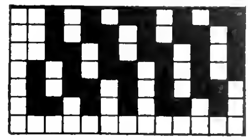


Fig. 163.

There is no true corkscrew weave on an even number of threads less than 12; and this weave is composed of two 6-harness twills, viz.: $\frac{3}{3}$ (Fig. 161) and $\frac{4}{2}$ (Fig. 162) twills. To obtain the even cut-off of the two twills, commence with the first thread of the $\frac{3}{3}$ twill and the fourth thread of the $\frac{4}{2}$ twill,

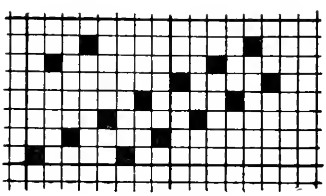


Fig. 164.

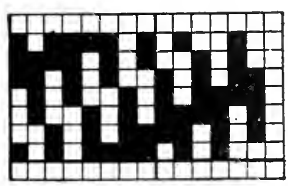


Fig. 165.

then take the threads alternately from each twill; thus, 1, 4, 2, 5, 3, 5, 4, 1, 5, 2, 6, 3 (Fig. 163); this weave repeats on 12 threads and 6 picks, having a balanced cut-off between the double twills, however, showing two slightly different sizes of twill effects,—that is, a 4-float alternating with a 3-float.

Again, such corkscrew weaves do not permit of a reduction of harnesses, which is a serious defect. The above example cannot be reduced to less than 12, whereas the uneven-number corkscrew weave can be reduced to the number of the original 45-degree twill.

When corkscrew weaves are made from weaves exceeding 9 threads and picks, the interlacing of warp and filling is very loose, so that the fabric is not merchantable, as the warp will slip on the filling. To remedy this without changing the face of the fabric, the warp floats upon the back must be reduced by adding one or more points of interlacing.

Take an 11-harness 45-degree $\frac{6}{\quad 5}$ twill. To change this twill so that it will bind firmly, the five sinkers which go to the back must be made to interlace $\frac{1}{2 \quad 2}$; this changes the 45-degree twill to interlace $\frac{6 \qquad 1}{\quad 2 \qquad 2}$ = 11 harness.

Figs. 164 and 165 illustrate the 7-harness weave constructed the wrong way. Compare these Figs., 164 and 165 with 153 and 154.

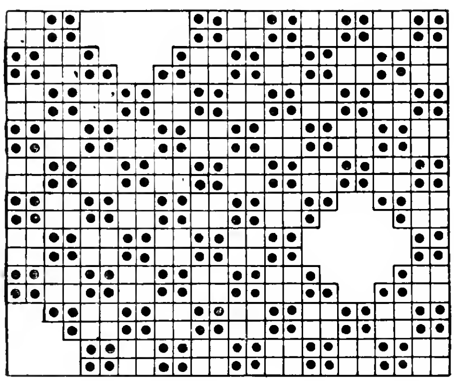


Fig. 27.

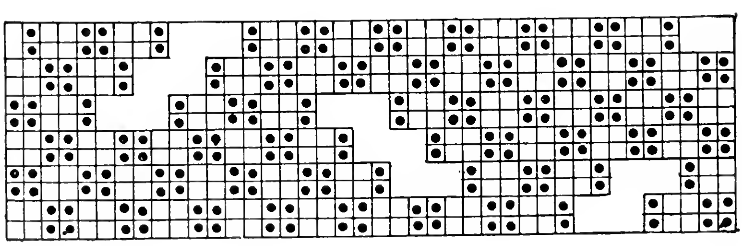
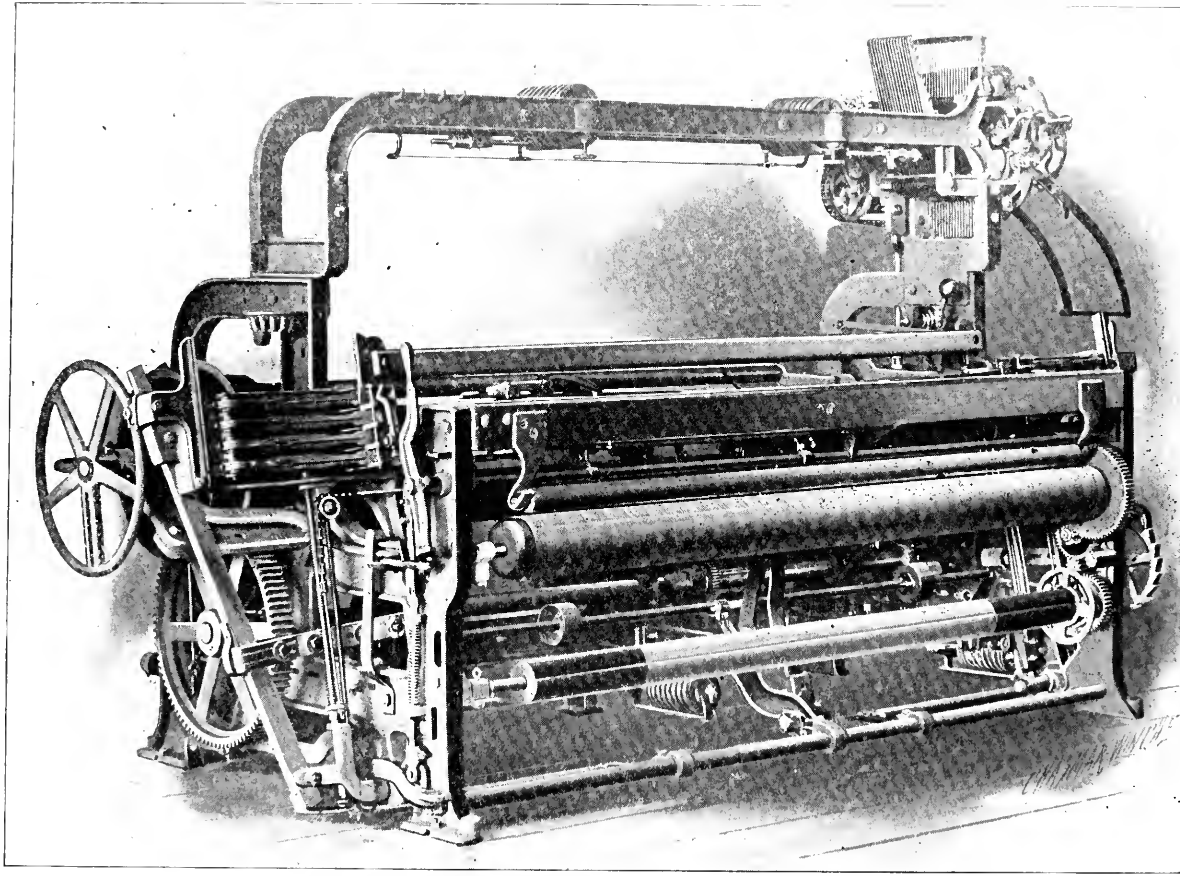


Fig. 28.



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TEXTILE DESIGN.

PART III.

CLOTHS BACKED WITH FILLING.

This branch of weaving has not had a very extensive use in the cotton trade, but in the woolen and worsted industries it has a very wide application.

The term, single cloth, is generally applied to a fabric that is interwoven with one set of threads for the warp and one set of picks for the filling. This may be a cloth in which the weave will allow the warp and filling to be equally divided between the face and under surface of the fabric, or such cloths as sateens and doeskins where the warp or filling predominates on the face.

A fabric which has an extra layer of threads woven on the under surface or back of the cloth, and which is distinct from the face, is called a backed cloth. These extra threads may be in the direction of the warp, or they may be in the direction of the filling.

Backed fabrics of this description are not what is understood as double cloths. There is as much difference between a backed cloth and a true double cloth as there is between a single cloth and a cloth backed with either warp or filling.

To retain the fine surface and appearance of a light-weight pattern on the face of a fabric, and at the same time to increase the weight or bulk of the fabric, a lining or back must be interwoven on the under surface of the cloth. This back can be interwoven either in the direction of the filling or warp.

Double cloths are composed of two distinct sets of threads, both in the warp and filling. They are two separate cloths, interwoven at various intervals to form one compact fabric.

Sometimes one fabric is superior to the other in quality; in such cases the fine fabric is called the face and the inferior fabric is called the back; or it may be that the two cloths are of the same quality and material, but of different colors, one cloth forming the outer garment, while the other cloth forms the lining. The face of one cloth may be of a very fine surface and of one color; the lining of such a cloth can be composed of a fancy weave, and the pattern and coloring of several bright and radical colors.

There are three methods of backing a fabric:

First, by having one warp, with two fillings; one filling for face and the other for back.

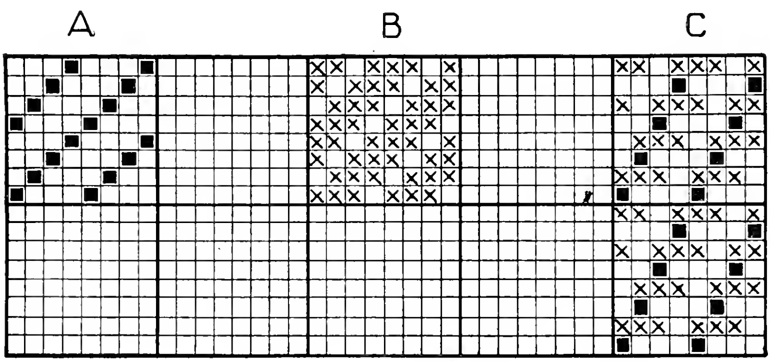
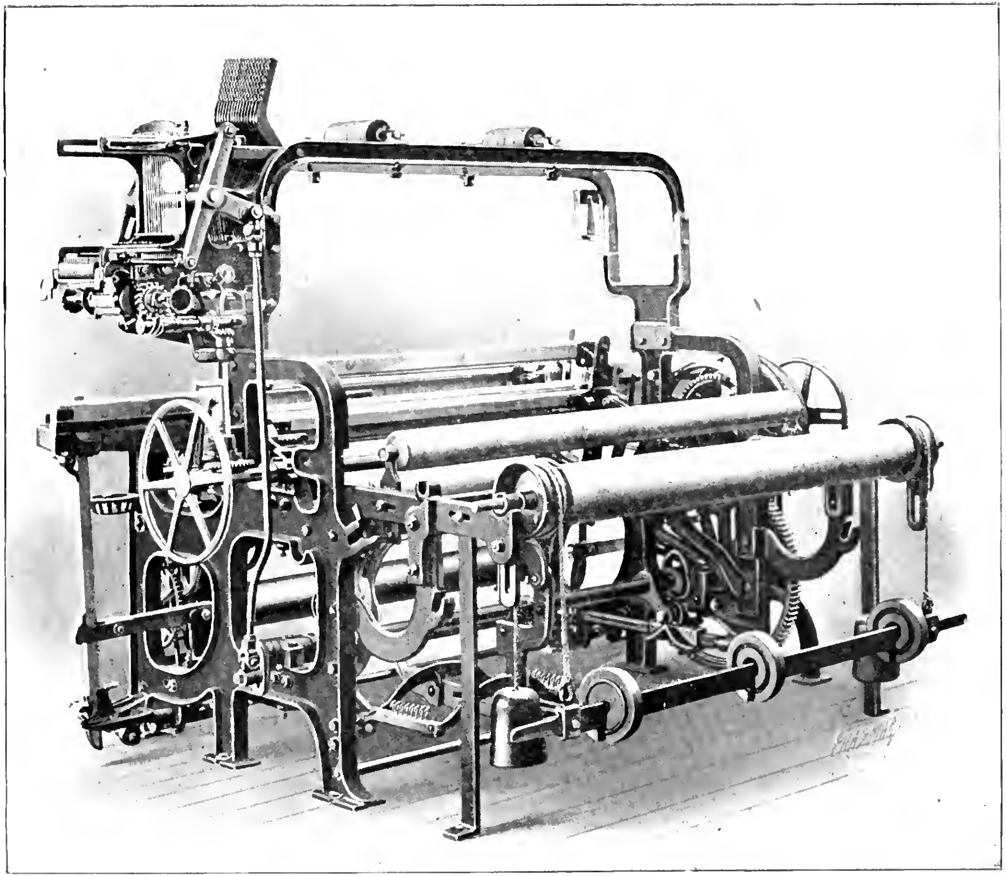


Fig. 166.

Second, by having one filling and two sets of warp threads; one set for the face, the other set for back.

Third, by having two distinct sets of warp and filling, interwoven so as to make two different fabrics, bound together at certain intervals.

Those backed with filling are usually low or medium grades of cloth. This system is probably the best for such fabrics, as it allows the warp threads to be set close together, and also allows the manufacturer to use heavier yarn in the filling at the back of the cloth. But this system of backing does not allow the back to assimilate with the face, as all the yarn at the back is in the direction of the filling. Cloths backed in the direction of the warp can be made to correspond with the face of the fabric, especially in stripe effects. Some of the finest of worsted cloths backed on this system are as neatly colored on the back as on the face of the fabric.



DOBBY SILK LOOM FOR TAFFETAS AND OTHER BROAD SILKS

Crompton & Knowles Loom Works

Fabrics backed with two sets of filling threads and one set of warp threads may be divided into two classes: first, those with one pick of face and one pick of back; second, with two picks of face and one pick of back.

In designing a fabric on any one of these systems it is very essential that the point or position where the face warp interweaves with a backing pick, or *vice versa*, should be very carefully placed.

Fig. 166. A is the face of the cloth, B is the back, C represents the two cloths combined. Take note of every detail. A is a filling flush, 4-harness twill, while the back is a warp twill on 4 harness. Study where these two weaves can be joined together, so that the point of intersection or binding will not show on the face.

When binding a flush weave, the point of intersection should always be at the place where the thread has just been down in one pick and will be down at the next pick (see Fig. 166, C). It will be noticed that the face filling floats over three warp threads, and in the center of these at the backing pick is where the two weaves are amalgamated. This, the point of intersection, is covered by the filling on each side of the back pick, so that when the cloth is completed the warp is entirely covered, and the two surfaces presented, which may be of two indifferent colors, show only the filling. In this make of cloth the backing filling must not be much heavier than the face yarn. Otherwise the face yarn cannot cover the intersecting or binding points of the backing pick.

In order to have an even face on cloths backed with filling it is necessary to have the same number of picks on the face as on the back; that is, if in a given sample of single cloth there are 30 picks per inch, the backed cloth would require 60 picks per inch, as, for instance, a cloth composed of the 4-harness cassimere twill for face weave, and the 4-harness crow weave for back.

Fig. 167 shows a most satisfactory binding for coarse and medium set goods. It will be noticed that the backing pick floats under three warp threads and interweaves at the fourth thread. Notice also the point of intersection or tie. The first pick of face, 3d and 4th thread down. The first pick of back, 4th thread down or stitch. The 2d pick of face, 4th and 5th threads down.

Thus, the first backing pick in Fig. 167, C, takes down the fourth thread, which has been depressed by the first face pick and

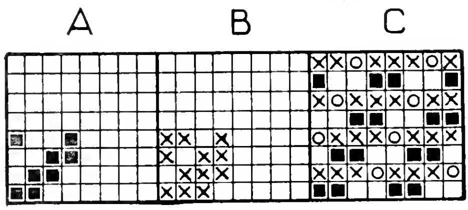


Fig. 167.

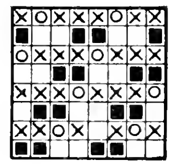


Fig. 168.

also followed by being depressed at the second face pick. Thus the flushing on each side of the back pick by the first and second face picks conceals the stitching point or binding.

Fig. 168 represents a cloth composed of the same two weaves as those at Fig. 167, but the point which unites the back to the

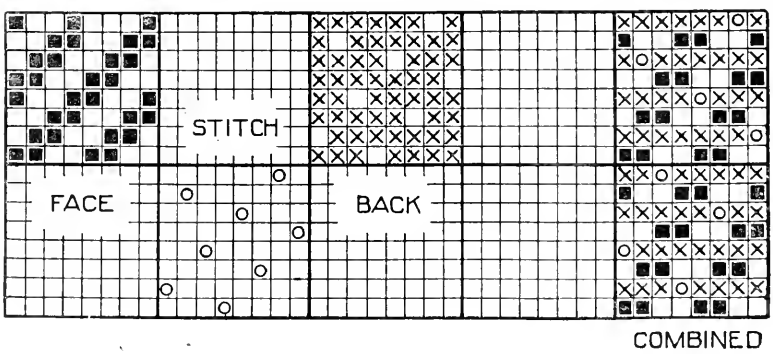


Fig. 169.

face is not in a position where it can be covered on both sides by a filling flush.

Fig. 169 is the very best way in which a filling back can be woven to a cassimere twill weave. The backing is an 8-harness sateen weave. It will be observed again here that the points of intersection on the face are depressed previous to, and after the intersection of, the backing pick. The 8-harness sateen back produces a soft and full texture.

Backed cloths in the proportion of two picks of face and one pick of back. There is one important fact with this system; that is, that the backing pick cannot be bound as satisfactorily as in the one-and-one system. Fig. 170 shows that only every alternate thread is interwoven with the back. To have a thoroughly even balanced cloth, every thread should have the same amount of binding, otherwise the thread that has the greater number of interlacings must necessarily "take up" the quickest in weaving; therefore, in making an uneven fabric, to have each thread take up equally, the warp should be dressed on two beams.

There are cloths woven on this principle which have only one beam, but the fabric i not satisfactory, especially when the backing filling is much heavier than the face filling. After a certain length of cloth has been woven, the threads with which the backing has been interlaced most frequently will work tight and cause streaky places to appear in the cloth.

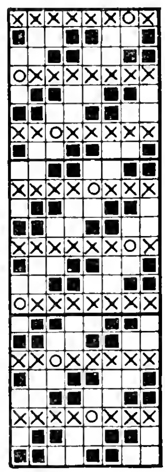


Fig. 170.

It must be thoroughly understood that whenever the structure of the design will admit of the arrangement of backing ties, these should always be preceded and followed by flushes of face filling. This is the secret of good binding.

In making figured designs, the same principles will apply. Fig. 171 is a checker-board pattern, the weave of which cuts at every eight threads and pick. Therefore, as the design stands, two face picks then one of back, it would be impossible to arrange it in such a way as to have the filling flush on each side of the binding point if the first and sixth picks were not coupled together.

Fig. 172 shows the wrong way, and Fig. 173 illustrates the correct method to arrange such weaves.

Fig. 174 represents a figure warp-surface weave. It is a design which illustrates the irregular system of binding; this figure is bound at two points on the filling pick and only one on the warp thread.

There is one other class of goods that has had a considerable sale, and the designing principles of which are very similar to those just referred to; cotton warp, worsted or woolen face, woolen back. The weave is generally a filling flush, as represented in Fig. 175. The chief object in this class of work is to hide the cotton warp, so that the face represents a perfect and smooth worsted or woolen surface. As the weave is made of long filling flushes, it is not a very difficult matter to find a suitable place to join the back and face to the cotton warp.

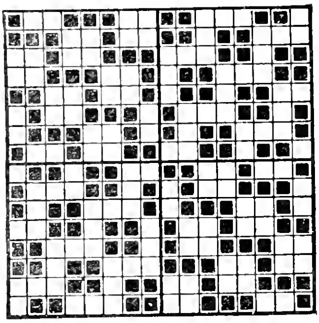


Fig. 171.

Fig. 176 represents a class of goods which is made in direct opposition to the previous example. The cloth is made from worsted warp.

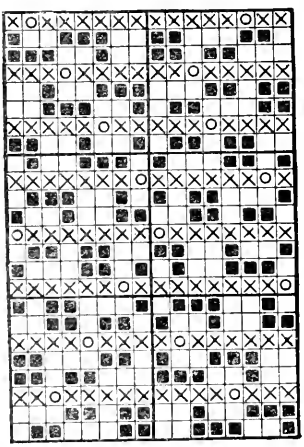


Fig. 172.

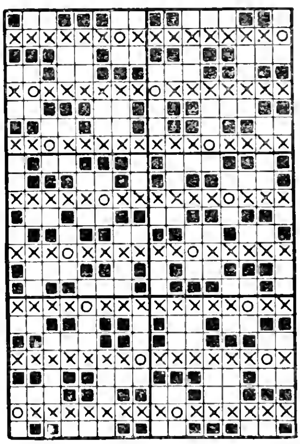


Fig. 173.

Cotton filling and woolen back. These designs are more difficult to bind than the preceding examples, as there are no filling flushes. The binding is done with the warp threads, on the reverse principle to the filling flush. When binding with a warp thread, the thread previous to the binding and the thread after the binding must be elevated, so that the point of interlacing is between two warp flushes. This character of fabric must have the warp threads set compactly in the loom.

CLOTHS BACKED WITH WARP.

This type of fabric can be backed by two methods: by the one-and-one principle and also by the two-and-one system. The example Fig. 177 illustrates a cloth backed with filling and requiring only five harnesses to weave the design, but the cloth when backed with warp requires an extra set of harnesses, and generally requires twice the number of harnesses as there are threads in the face weave. For instance, with the four-harness cassimere twill and the eight-harness sateen for the back, twelve harnesses are required to complete the full draft. Four harnesses for the face and eight for back equals twelve. The arrangement upon paper for the design is exactly the reverse of the fabric backed with filling.

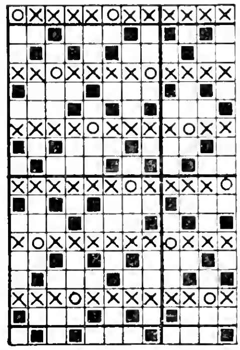


Fig. 175.

Fig. 177 represents a cloth backed with filling, while Fig. 178 illustrates a fabric backed with warp. On careful examination it

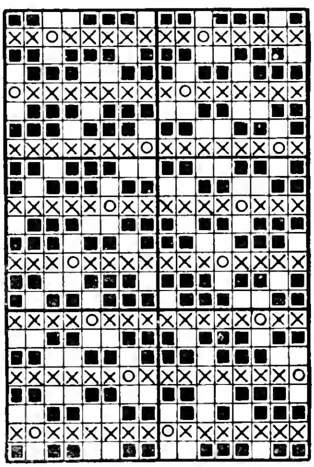


Fig. 174.

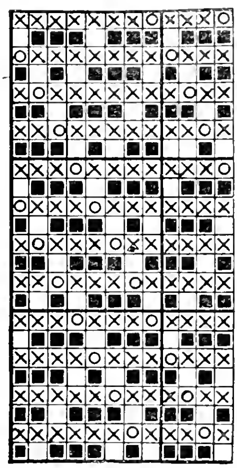


Fig. 176.

will be found that the risers and sinkers on each design are nearly the same; therefore the explanations that have been given for the one fabric will hold good for the other fabric. There is, however, one advantage to be gained by using an extra warp; on each side of the fabric an entirely different design can be made, and as it takes extra harnesses to weave a warp back, the designer can utilize them to vary the figure. There is not much diversity applied to the under surface. This is usually of a sateen character, but the face weaves have every variety of design. The point of tie is as important in this type of cloth as in the previous one; the binding should fall in such positions as have face warp threads elevated on both sides, exactly as flushes of face-filling are necessary to effect the successful binding when backing with filling. Flushes of face warp are as essential to cover the ties when backing with warp as are filling flushes when backing with filling. The order of laying out this class of fabric is on the one-and-one principle. To arrange the threads on the two-and-one system, would necessitate the use of a heavier yarn for the back, and even then would produce a rather open texture on the under-surface. The yarns used for warp backs are, as a rule, about the same size of thickness as those used for the face fabric; the yarn is set close in the reed, and the warp contains a large number of threads per inch in proportion to their counts or sizes.

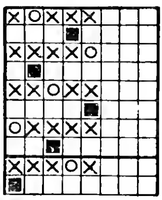


Fig. 177.

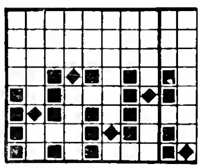


Fig. 178.

EXERCISES FOR PRACTICE.

1. Back plans 1 and 2 with weft 3 picks face to 2 picks back; plans 3, 4 and 5, 2 picks face to 2 picks back.

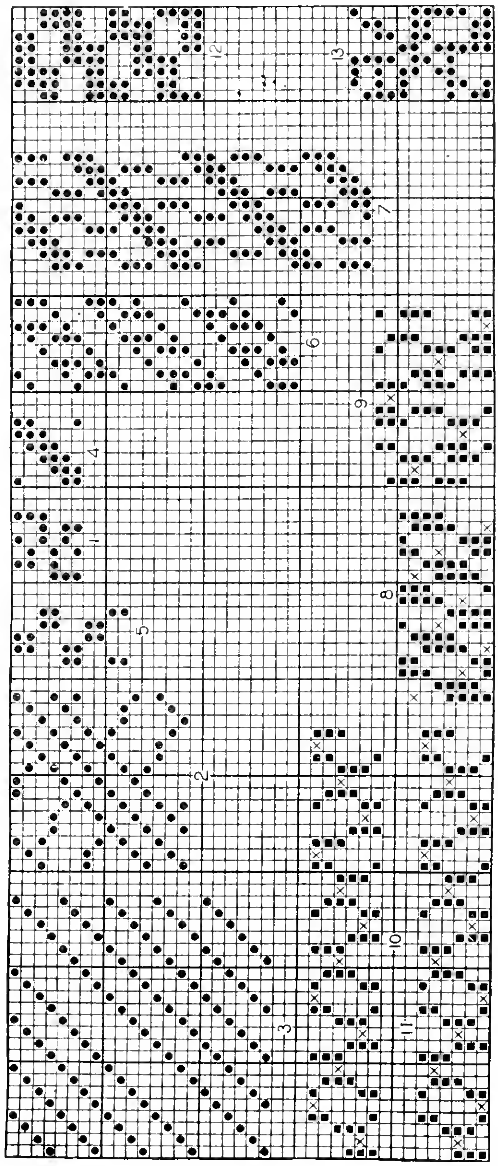
2. Back plans 6 and 7 with weft, 3 picks face to 1 pick back.

3. Point out any defect in plans 8 and 9 and give connected plans.

4. Plans 10 and 11 show two methods of backing the same weave with warp 2 and 1. Which do you consider the better of the two and why?

5. Back plan 12 with warp, 2 ends face to 1 end back so that there may be one pick only in each shed.

6. Would the face weave in plan 13 be affected in any way by the stitching of the backing weft?



Give the reason for your answer and make a plan of this weave stitched correctly.

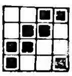
EXERCISES FOR PRACTICE.

1. Back with warp 1 face to 1 back, plans 1–6, stitching firmly.

2. Back with weft 1 face to 1 back, plans 7–12, stitching once in the repeat.

3. Back with warp 1 face and 1 back, plans 13–18, stitching so that the back will be like the face.

4. Back with weft 1 face to 1 back, plans 19–24, stitching so that the back will be like the face.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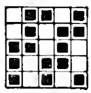
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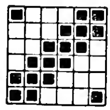
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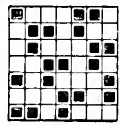
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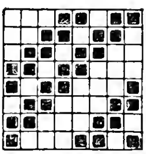
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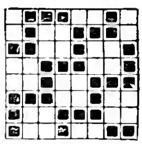
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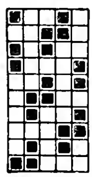
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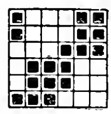
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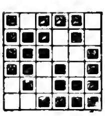
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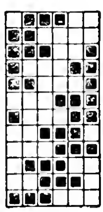
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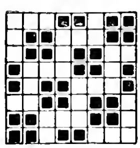
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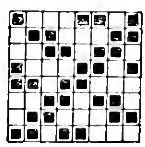
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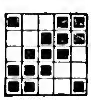
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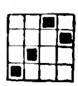
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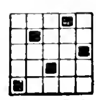
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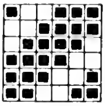
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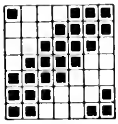
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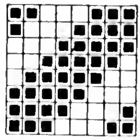
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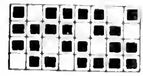
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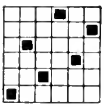
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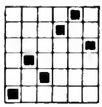
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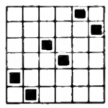
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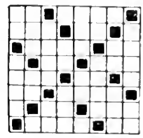
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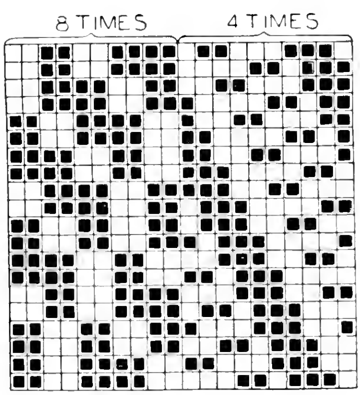
5. Back plan A with warp, 2 ends face to 1 end back, and give peg plan to weave it with draft B.

6. Back plans C D and E with warp, 3 ends face to 2 ends back.

7. Back plan F with warp, 2 ends face to 1 end back, so that there may be one pick only in each shed.

8. Give draft and peg plan to weave design G with a warp back, 1 end of face to 1 end of back.



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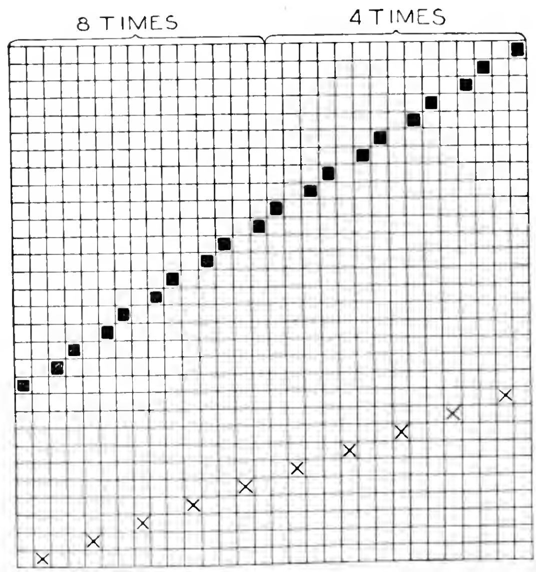

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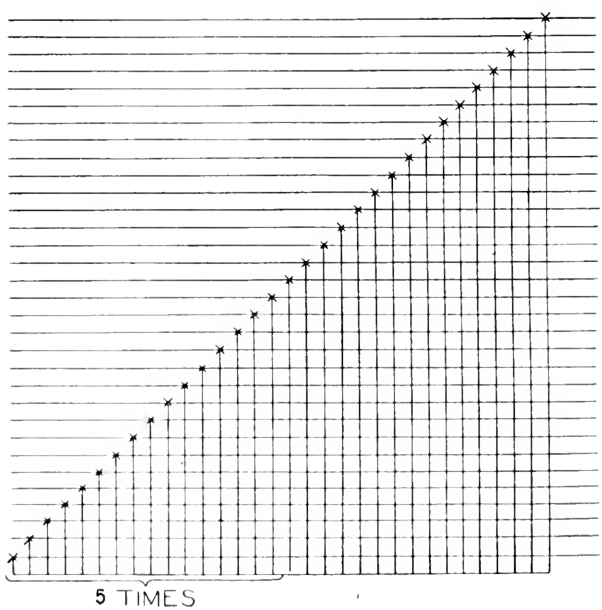

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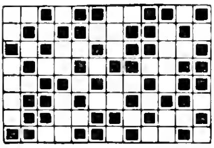

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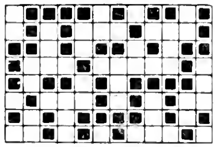

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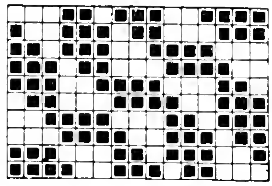

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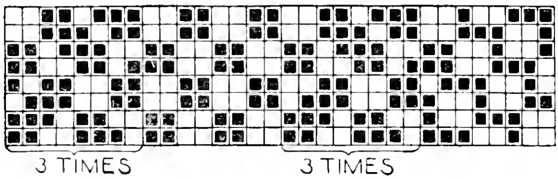

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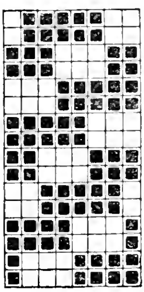

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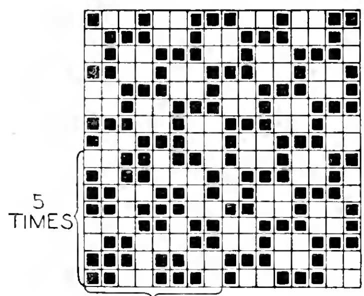


H

9. Back plan H with warp end and end and give peg plan to weave your design with draft J.

EXERCISES FOR PRACTICE.

1. Back plans 1–6 with warp 2 face to 1 back, stitching each backing end once in a repeat of the face weave.

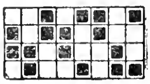
2. Back plans 7–12 with warp 2 face to 1 back, stitching twice in a repeat.

3. Back plans 13–18 with weft 2 face to 1 back, stitching twice in a repeat.

4. Back plans 19–24 with warp end and end.

5. Back plans 25–30 with warp end and end, stitching so that the back will be like the face.

6. Back plans 31–33 with weft, 1 face to 1 back.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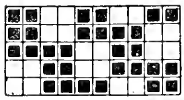
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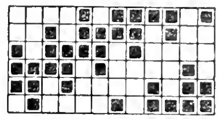
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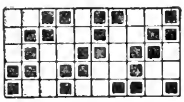
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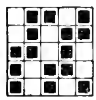
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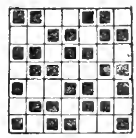
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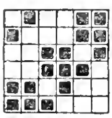
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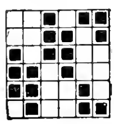
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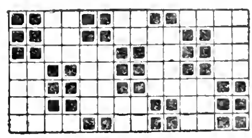
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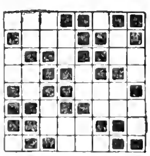
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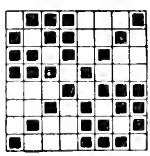
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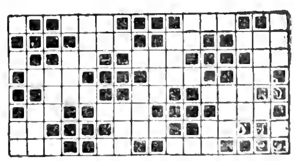
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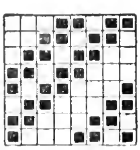
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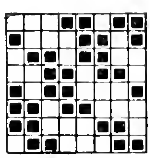
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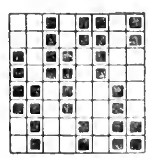
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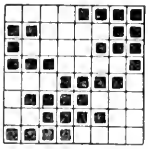

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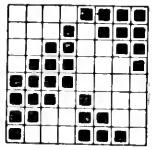

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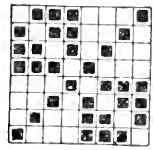

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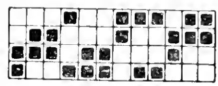

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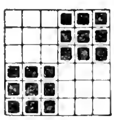

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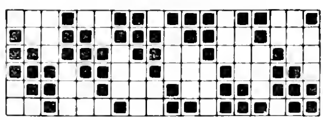

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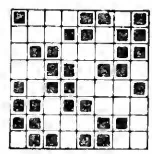

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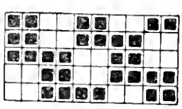

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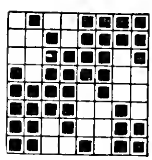

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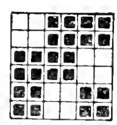

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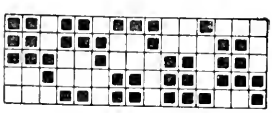

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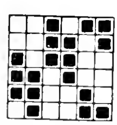

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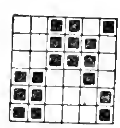

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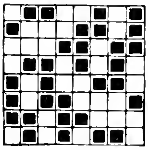
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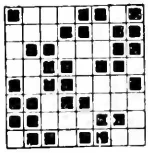
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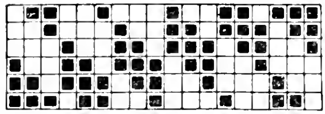
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EXERCISES FOR PRACTICE.

PAGE 125.

1. Put a warp back on plans 1–36, binding with a firm stitch. 1 end face to 1 end back.

2. As No. 1, but 2 face to 1 back.

3. Put a weft back on plans 1–36, binding with a loose stitch. 1 pick face to 1 pick back.

4. As No. 3, but 2 picks face to 1 pick back.

EXERCISES FOR PRACTICE.

PAGE 126.

1. Back plans 1–5 with warp, end and end, and with weft 2 picks face to 1 pick back.

2. Back plans 6 and 7 with warp end and end, stitching firmly, and give draft and peg plan for your answer.

3. Back plans 8 and 9 with warp end and end, stitching loosely, and give draft and peg plan for your answer.

EXERCISES FOR PRACTICE.

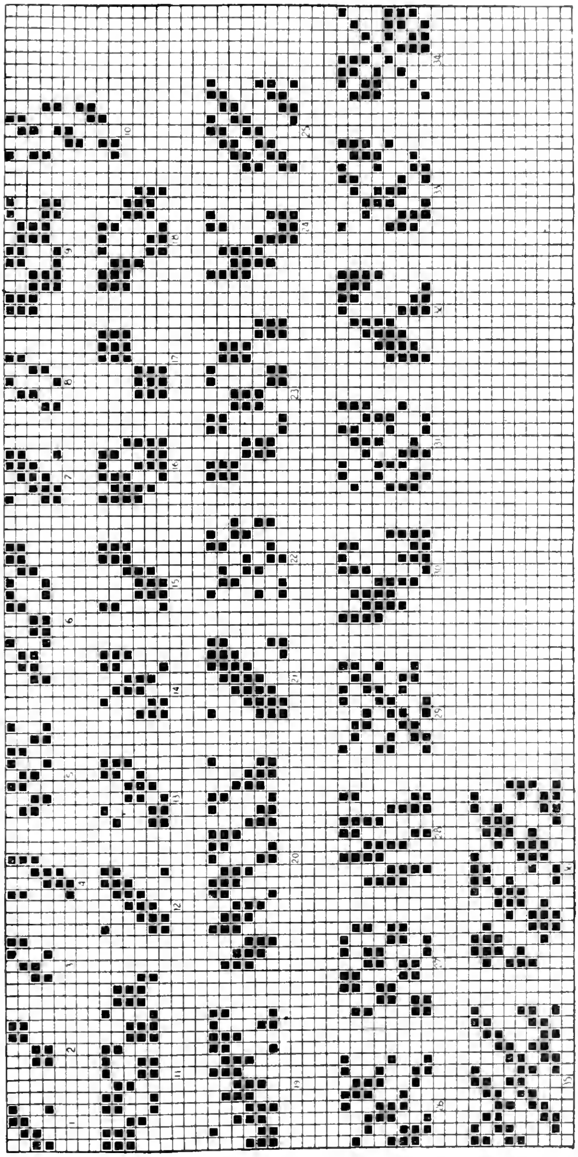
PAGE 127.

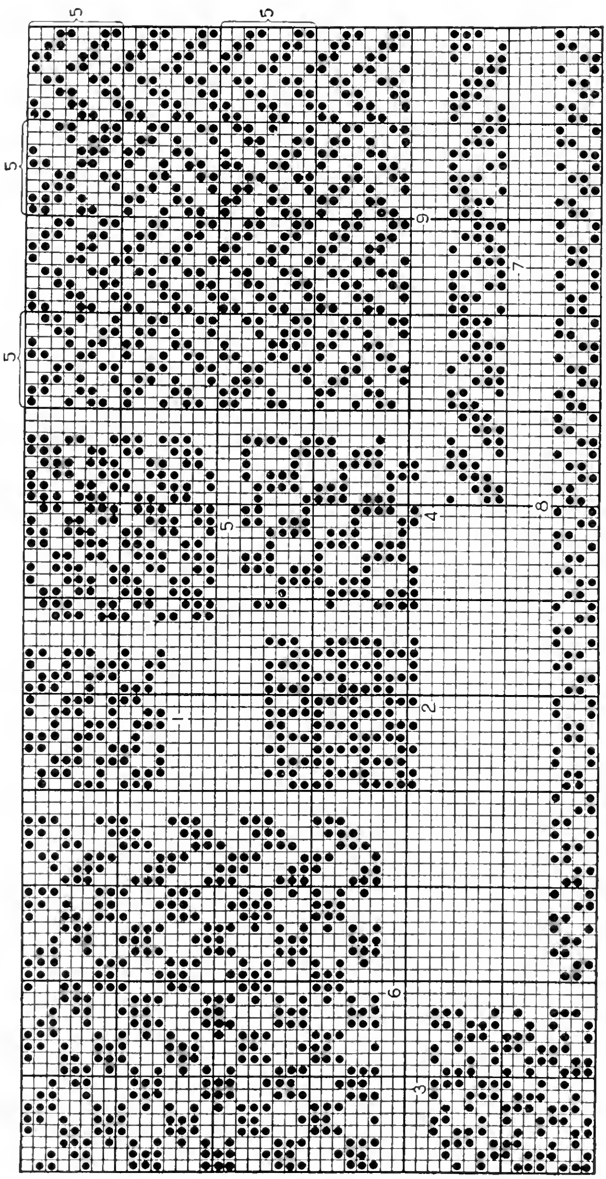
1. Complete design 1, of which 8 picks are given, and back with weft 2 face to 1 back.

2. Back plan 2 with warp, 2 face to 1 back, and give draft and peg plan.

3. Back plan 3 with warp, 2 face to 1 back.

4. Give draft and peg plan to weave design 4 with a warp back. 1 end of face to 1 end of back.





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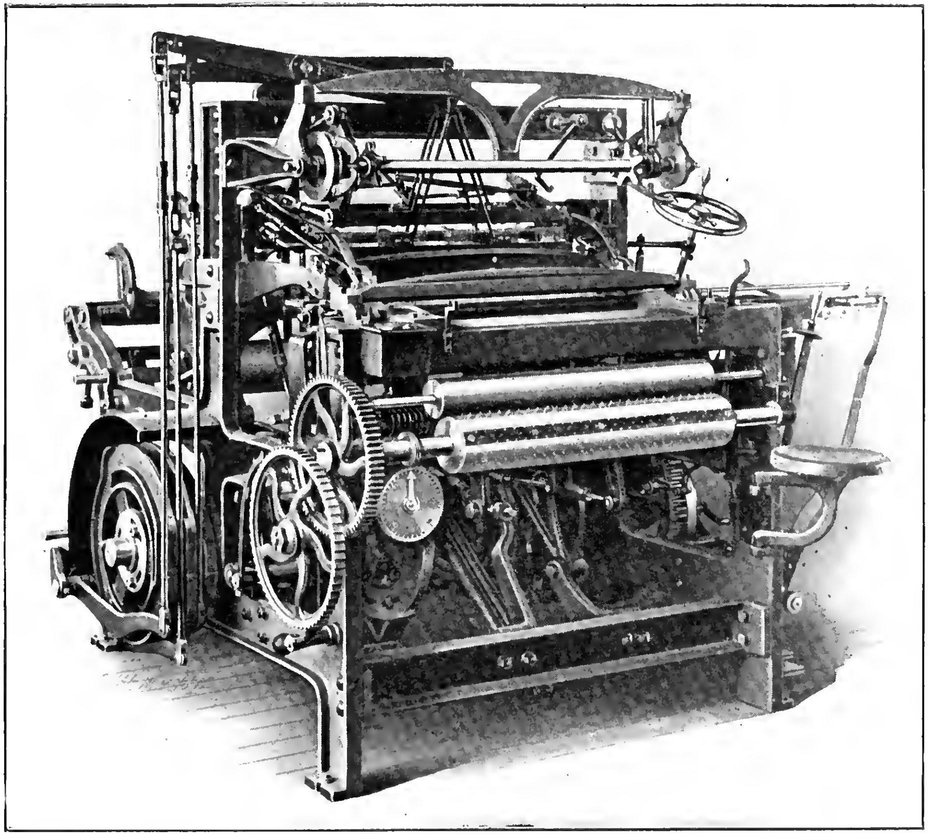
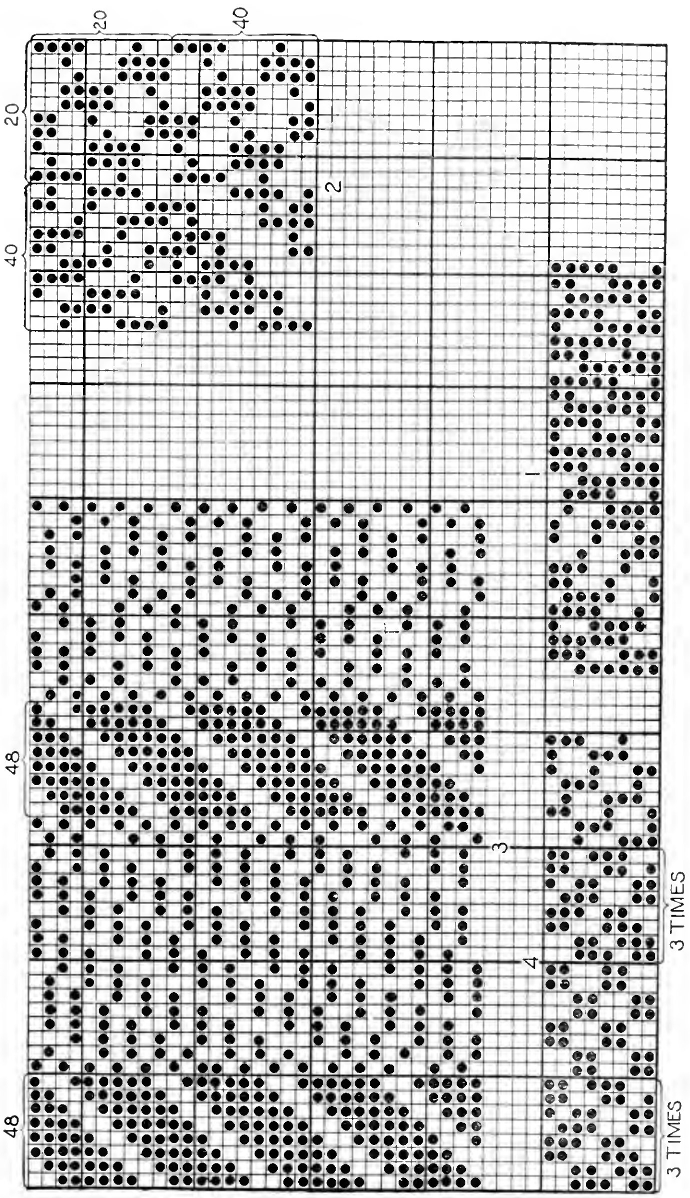


KNOWLES AXMINSTER CARPET LOOM

Crompton & Knowles Loom Works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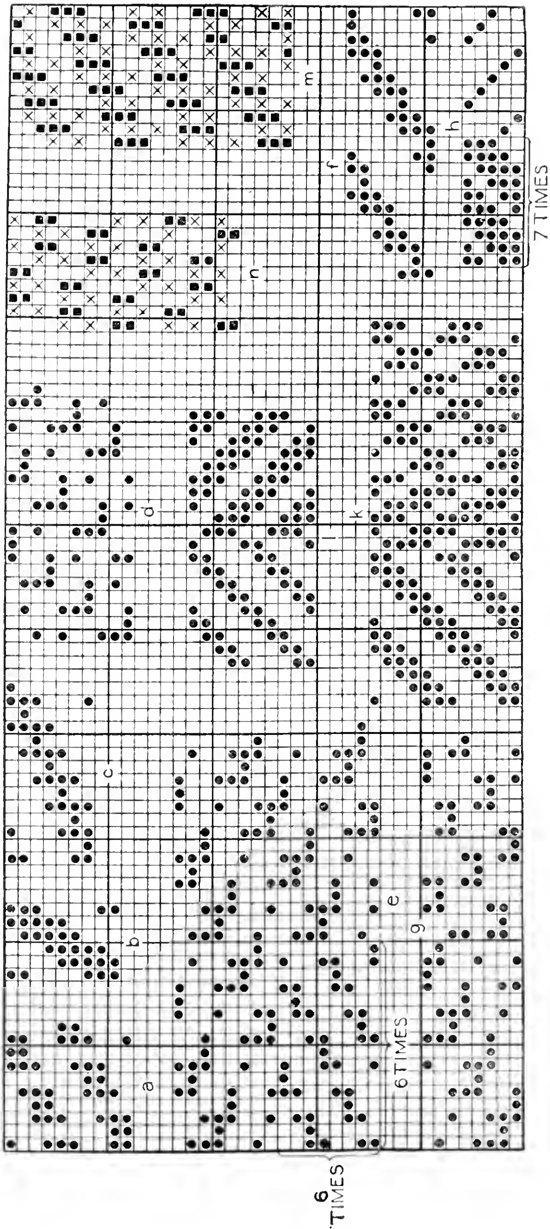

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EXERCISES FOR PRACTICE.

PAGE 128.

1. Make a design for a single cloth to weave on one beam and appear like plans a, b, c and d, in the same set.

2. Make a design with single weave to imitate the warp-backed design, e.

3. Make designs with single weaves to imitate designs f and g, then back your designs with weft 2 picks face to 1 pick back, so as to hide the backing weft as much as possible.

4. Back designs h and k with warp, 2 face to 1 back, then make single cloth designs to imitate them, giving suitable setting and counts of yarn for each.

5. Back design 1 with warp, 2 face to 1 back, then make a single cloth design to imitate your backed design and to weave on 30 shafts or less.

6. Make designs for backed cloths to give the nearest effect to plans m and n.

DOUBLE CLOTH.

The next step is to make two separate and distinct fabrics employing two warps and two fillings. Cloths of this kind may be made with either both sides alike, or totally different: that is, each of the separate cloths may be of the same pattern and made from the same yarns and the same quantity of yarn in each, or one cloth may be much finer than the other, and of totally different pattern.

Double cloths are merely two separate and distinct single fabrics woven on the same loom at the same time, but during the weaving process, so bound together as to appear like one fabric. The two fabrics may be identical in appearance and make-up, or one may be a coarse fabric and the other a fine one with the weaves and color arrangement differing radically without interfering with each other. Designs for such fabrics are made on design paper just the same as for single cloths, but the threads and picks on the design paper are divided into two sets, one for face threads and picks, and the other for back threads and picks. A good practice to adopt for distinguishing one set from the other is to shade the threads and picks to be used for the back cloth, in their proper arrangement, with a light wash of color or by fine lines. Different proportions of face and back may be used, as one thread of face to one of back, two threads of face to one of back, two threads of face to two threads of back, three threads of face to one of back, or any other arrangement which may suit any particular design. Whatever the system adopted, it is customary to start the design with one thread of face. In the case of two of face and one of back arrangement, the order would be one face, one back and one face, repeated to the full extent of the design.

Suppose, for instance, that it is required to make a double cloth, each fabric to be a simple four-harness cassimere twill, as shown in Fig. 179. The warp threads would follow in the harnesses alternately, one of face and one of back, and the filling threads would appear in the same manner. Seeing that alternate

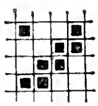


Fig. 179.

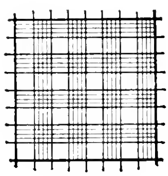


Fig. 180.

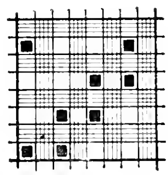


Fig. 181.

threads on this paper represent two different cloths, the student should run a faint wash of color, or shade with fine lines, over one of the sets of threads, so that when putting the design on paper there will be little liability to confusion (see Fig. 180). Now proceed to put the face weave upon one of the systems of threads, as shown by squares in Fig. 181; then put the back weave on the other system of threads, as shown in Fig. 182 by the oblique crosses, remembering all the time that the shading put upon one set of threads possesses no significance but to guide him. If divested of the shaded lines and color, the weave will now have the appearance of a simple eight-harness twill, as shown in Fig. 183, and if woven as given here would produce a simple twill and not a double cloth. Then something more must be done. When the face filling is being put in, all the back warp must be left down for the shuttle to pass over, and when the back filling is put in, the face warp threads must be lifted for the shuttle to pass under. This is quite easy of accomplishment. Simply add to Fig. 182 the marks which will raise the face warp when the back pick is going in, as shown in Fig. 184 by the circular marks.

One thing must be made perfectly clear at this point: the crosses or marks cannot be subject to any variation; they must be put on the back pick and upon every face thread. There will be some apparent interference with this when binding or stitching the two cloths together, but in the meantime the rule must be held to be absolute. Now suppose the matter is carried a step further, and the twill is to be used for the face cloth only and the back be made plain, as in Fig. 185. This arrangement of design is quite simple and easy. Each weave is put on paper upon its own threads only, and then the marks are inserted to cause each filling to interweave with its own warp only.

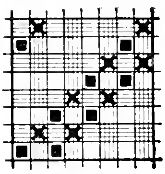


Fig. 182.

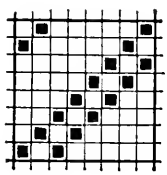


Fig. 183.

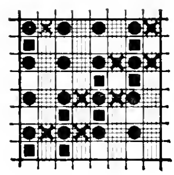


Fig. 184.

Attention must be directed to the probabilities in dealing with such a design as this. Here the threads of the two cloths are alternate, but their weaves are different. It requires little ingenuity to point out, and but little knowledge on the part of the student to understand, that if one cloth be woven twill and the other plain, and the yarns of the two are the same, one cloth must be much finer than the other. So that if any fabric is woven to this design and each cloth is intended to be equal in structure, as regards the relationship of yarn to weave, then that of the twilled cloth must be thicker in proportion than the plain cloth, and that proportion will be governed by the order of intersection. It is not often that this is done. Generally, in cloths of this kind, the two are of the same weave and quality, and consequently there is little trouble on that account. They may, of course, be of any pattern, such as that in Fig. 186, which consists of two six-harness twills, or they may be of fancy weaves.

Generally speaking, this kind of double cloth is made when it is desired to have both sides of the fabric of the same texture, but perhaps of different colors. They are seldom made use of except in simple patterns, such as twills of the simplest kinds. Fancy designs, so far as the interweaving is concerned, are seldom used, the variety of patterns desired being generally produced in colors, which may be in stripes, checks or over-plaids.

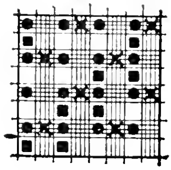


Fig. 185.

Attention must now be directed to double cloths in which fancy designs and weaves are required, the backing, as in most double-filling fabrics, being for the purpose of giving bulk and weight to the fabric. The conditions of arrangement are somewhat similar to those of cloth backed with filling, but there are two warps, and of course both have to be taken into account. Take, for example,. the pattern given in Fig. 187, which consists of the four-harness cassimere twill for face and the two-harness plain cotton weave for back; there are two threads of face to one thread of back. the face weave being shown in Fig. 188 and the back weave in Fig. 189. As will be noticed, the same practice is followed out as in the one-and-one system. The face weave is first put upon its own series of threads, and then the back weave is dealt with in like manner; when both weaves are completed the rising marks are put on the back pick and upon the face threads, to cause a separation of the two cloths.

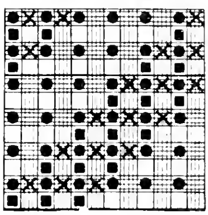


Fig. 186.

Now, to carry this out to a greater length, make a six-harness twill face and a plain back, as shown in Fig. 190, with face weave in Fig. 191. In this case, if the pattern is only carried out once, there would be but three threads of backing, and as a plain cloth is not complete upon three threads, the whole must be carried out to double the length, so that twelve threads of face and six of back must be employed. In such a case as Fig. 192, there would be no necessity for a repeat of the weave; as the face pattern in Fig. 193 occupies eight threads, four threads would be required for back, and consequently the whole would be complete on twelve threads.

It will be well to keep the practical application and the arrangement side by side. For instance, the question of drafting will come forward, because in many cases the face pattern will be a very elaborate one and the back may be perfectly plain, or a simple twill, and consequently does not require many harnesses to

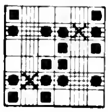


Fig. 187.

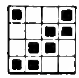


Fig. 188.


Fig. 189.

weave it. In the design, Fig. 187, there would be no reduction, because the face weave occupying four threads and the back weave two threads, there would of necessity be six harnesses required, but the matter of arranging the harnesses must be considered; that is, the arrangement of the draft must have particular attention, not only so as to know how the threads will be drawn through the harnesses, but also to determine the actual positions of the face threads and the back threads. Draw the face threads on the four front harnesses and the back on the two back harnesses, as in the draw in Fig. 194 and chain in Fig. 195; then reduce Fig. 190 to the smallest possible number of harnesses, as in the draw in Fig. 196 and chain in Fig. 197; next reduce Fig. 192 to its lowest number of harnesses, as in the draw at Fig. 198 and chain in Fig. 199.

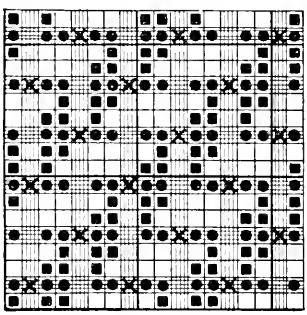


Fig. 190.

Binding. So far, the designs give two entirely separate fabrics, and to complete the double fabric it is necessary to bind the two together. To accomplish this binding, which is also termed stitching, tacking, etc., either one of two systems may be adopted. The two cloths may be bound together by lifting a back thread over a face pick at certain intervals, or by sinking a face thread under a back pick at certain intervals, one system being

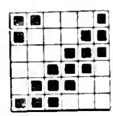


Fig. 191.

exactly the reverse of the other. Several considerations must be taken into account at this time, however, for if these binding points are selected indiscriminately a faulty piece of cloth is sure to result.

To bind correctly by lifting a back thread over a face pick, it should be lifted between two risers of face and either between two risers or next to a riser of back on the back thread. It is usually possible to lift between two back risers, but when a plain weave is used for the back, it is lifted next to a riser as the thread is not lifted over two consecutive picks. If, when binding in this manner, the back thread is lifted over a face pick at a point where

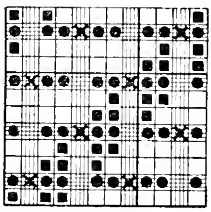


Fig. 192.

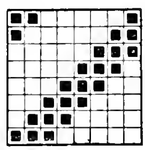


Fig. 193.

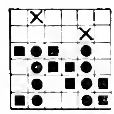


Fig. 194.

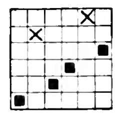


Fig. 195.

a sinker of face weave would come on either or both sides, the thread lifted would float over the face filling which is on the surface at this point and consequently the back warp thread would be brought to the face at this point, and if, as is often the case, the two cloths were of different color, the result would be a plainly discernible imperfection.

By lifting the back warp thread between two face threads which are lifted, the two face threads come into close contact and cover the back thread completely. It is necessary to lift the back thread between two risers or next to a riser, because, if the back thread were weaving on the under surface of the back cloth and carried directly through to the face of the cloth, it would carry the face pick through to the back in such a manner as to make it show on the back, causing a similar imperfection on the back to that which was caused on the face. The second system of binding being just the reverse of the first, the point selected for the binding should be just the reverse in every particular for similar reasons to those just given for the first system.

The binding points in a design are generally arranged in some definite order, such as a twill or sateen, so as to distribute them evenly throughout the cloth, but this order must suit the other requirements named. Taking now the design in Fig. 184, which requires only the binding to complete it: suppose it is to be bound by the first system, the binding points to be distributed

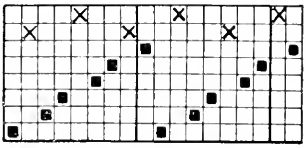


Fig. 196.

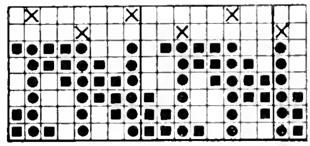


Fig. 197.

in the order of a $\frac{1}{3}$ four-harness twill. By the rule, the first point must come where a face pick crosses a back thread between two risers of face and between two risers or next to a riser of back. The only point on the first face pick answering these requirements is where the first face pick crosses the first back thread, as indicated by the diamond-shaped mark in Fig. 200. Letting this mark indicate a riser, it shows the back thread lifted over a face pick, thus binding together the two cloths. Following out the binding points in the order as decided upon, the next point will come where

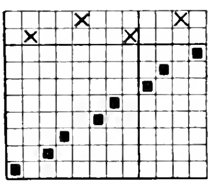


Fig. 198.

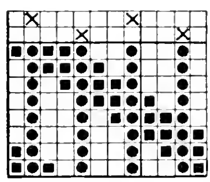


Fig. 199.

the second pick crosses the second back thread, this point coming in consecutive order, and answering all the requirements. By indicating all the binding points in their order as the first have been indicated, the design will appear as in Fig. 200; and if a fabric were woven with this design, it would be a double cloth with cassimere twill face and back, and bound together by interweaving the face-filling with the back warp in the order of the $\frac{1}{3}$ twill. This binding would be very close and firm, and in most cases it is desirable that the binding should be distributed at greater intervals, as further examples will show. Fig. 201 is a cut section of the first two picks of Fig. 184, and Fig. 202 is a cut section of the first two picks of Fig. 200, showing the binding, and Fig. 203 is a diagram of the complete weave.

For a further illustration of binding, suppose a cloth is desired with the same face and back weaves as were used in the previous example; but this fabric is to be bound by the second system, with the binding points arranged in the order of an eight-harness sateen. As the binding is to be done with the face threads, and eight threads are required for the face, with the design arranged in the proportion of one thread of face to one of back, there would necessarily be eight threads required for back, giving sixteen threads and picks required for a full repeat of the design.

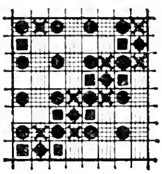


Fig. 200.

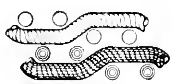


Fig. 201.

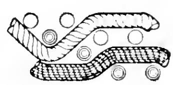


Fig. 202.

Rule.—To find the dimensions of a ply or multiple fabric, find the least common multiple of the number of threads required for each of the single weaves to be employed, including the binding motive, and multiply by the number of threads in one repeat of the ply dressing; i. e., if the cloth is arranged one of face and one of back and one of face, multiply by three, etc. A double cloth arranged in the proportion of one thread of face to one of back is called a one-and-one double cloth, or a double cloth arranged on the one-and-one system: and a double cloth arranged in the proportion of two threads of face to one of back is called a two-and-one double cloth, or a double cloth arranged on the two-and-one system.

Having found sixteen threads by sixteen picks to be the dimensions of the design given, shade off the design paper and place upon it the face and back weaves and the face lifters on the back picks, each of the two weaves being carried out twice in each direction, as in Fig. 204. To select the first binding point, the requirements are to sink a face thread under a back pick between two sinkers on the back pick and between two sinkers or next to a sinker on the face thread. On the first back pick two such points may be found, the first on the fourth face thread and the second on the eighth face thread, both of which are equally good. Taking the point where the first back pick crosses the face thread as the first binding point, the face thread is found to be lifted by the system of lifting all of the face threads on the back picks; in this case the thread must not be lifted, but must be

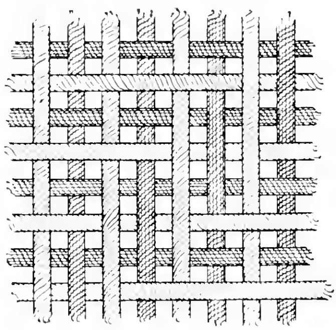


Fig. 203.

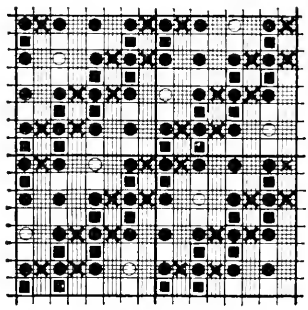


Fig. 204.

sunk under the back pick to effect the binding. This being the case, the mark indicating a lifter must be removed, and the space left vacant showing the thread to be sunk, but for convenience in showing the binding arrangement, the point is indicated by a circle, as in the design.

Now as an eight-harness sateen is to be used for a binding motive, and as either five or three may be used as move number to produce an eight-harness sateen, it must be decided which number will give the proper arrangement to suit the other requirements. Using three as a move number, and counting off from the first point already selected, the next binding point would come where the fourth back pick crosses the fifth face thread, and as this point is surrounded by risers of both face and back weaves, it is obviously incorrect for this system of binding. Then using five instead of three as a move number, the next point would come where the sixth back pick crosses the fifth face thread, and as this point is a good one in all respects five may be accepted as a move number for the sateen, as it will distribute the binding points in correct positions all over the design, as shown by circles in Fig. 204. Fig. 185 should be bound with the same motive as Fig. 184; Fig. 186 may be bound in a similar manner to Fig. 184, using instead of the one up and three down binding motive, the one up and five down, commencing at a similar point; Fig. 187 could not be suitably bound without a further extension, as there are only two back threads; Fig. 190 could be bound with the same motive as Fig. 186; and Fig. 192 with the same motive as Fig. 184. Any changes made in the design by inserting or removing risers for binding purposes will, of course, necessitate a corresponding change in the drawing-in draft and chain.

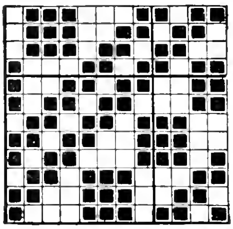


Fig. 205.

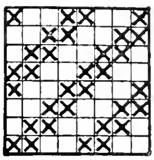


Fig. 206.

It will be noticed that the last three examples are arranged in the proportion of two threads of face to one of back. With designs arranged in this manner, the first system of binding is always preferable because the addition of binding points would be likely to so complicate the face weave as to necessitate the use of more harnesses.

With the design arranged one of face and one of back, there would be no choice of binding systems, except in a case where the face weave were a fancy one with a plain or simple twill back. Then the binding should be done by the second system, as it would not increase the number of harnesses required, because the face weave would probably occupy a greater number of harnesses than the back. Suppose for example the face weave is an eight-harness fancy twill and is to be backed by a four-harness twill, the binding motive to be an eight-harness sateen. If the binding were done by the first system, it would require eight back threads to repeat the binding, and as the back weave would repeat on four, it would prevent any reduction of the number of harnesses for the back weave. If the binding were done by the second system, as the face is composed of eight face threads, the binding would not increase; the number of harnesses would then be reduced to four.

As a further illustration of weaves and binding, suppose that Fig. 205 is to form the face fabric, and that there must be a back cloth woven upon it, and also suppose that the cassimere twill in Fig. 206 is the back weave, and that there are two threads and picks of face to one each of back. What would be the relations of the two weaves to each other? The face pattern occupies twelve threads and the back weave occupies only four threads, consequently, there being two of face to one of back, when the face pattern is complete there would be six threads, or one repeat and a half of the back weave, so that to make the whole complete the face must be repeated and the back continued until there are twenty-four of the face and twelve of the back, as shown in Fig. 207. When this is done, it must be evident that the relations of the two weaves must be different in the first half and the second half respectively.

Now suppose that in the design given in Fig. 207, a binding point were found as indicated on the second face pick and first back thread; the corresponding point in one repetition would not bear the same relation to the face and back respectively, as is shown on the seventh back thread and second face pick, by the hollow diamond. The correct arrangement is shown fully carried out in the design, but not in the chain and draft. It will be seen that at the point of binding when the back filling is over one of the threads of its own cloth, and the next pick of the face following immediately upon it is passing under the same thread, there is a great probability of one showing through to the surface of the other.

In binding two cloths together, there must be some attention paid to the distribution of the bindings, exactly as there is when backing with warp or filling only, and this may materially affect the number of harnesses employed. If the binding is to be done by the second system, then in all probability there would be no necessity to increase the number of harnesses employed, because at the point of binding any one of the harnesses carrying the warp thread selected for binding could be left down at the desired point for the back filling to pass over, and the distribution could be arranged according to the character of the design; if, however, the first system is used, then for the purpose of obtaining the desired distribution there must be more backing harnesses employed.

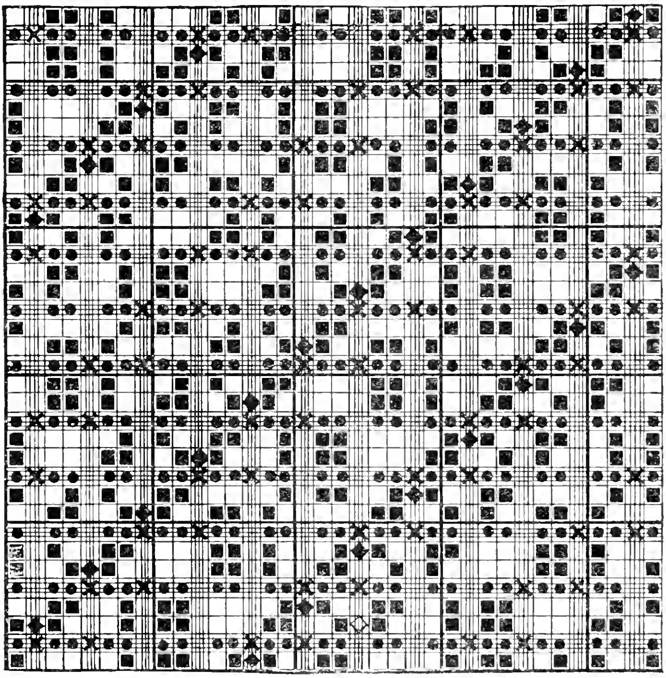


Fig. 207.

Look for example in Fig. 207, the draft of which is given in Fig 208 and the chain in Fig. 209; there are four back harnesses only. There could be no proper distribution of a reasonable character if the binding were done on the back warp threads, therefore there must be an extension. Take for example Fig. 210, which is the same face design with a plain back, with the draft in Fig. 211 and the chain in Fig. 212; here it would be absolutely impossible to bind the two cloths together in anything like a reasonable manner with the face filling passing under a backing warp, because there are only two backing harnesses used, and therefore it could only be on alternate threads. The practical

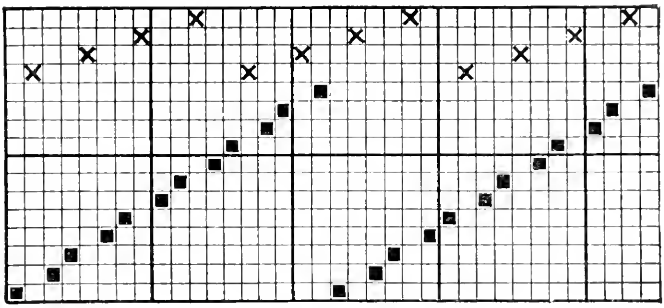


Fig. 208.

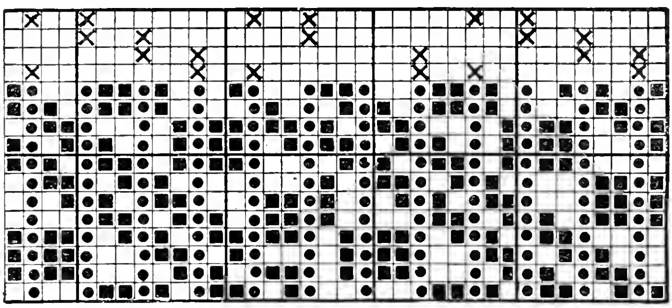


Fig. 209.

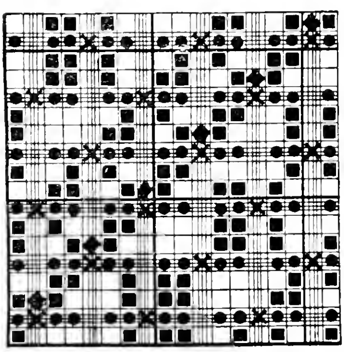


Fig. 210.

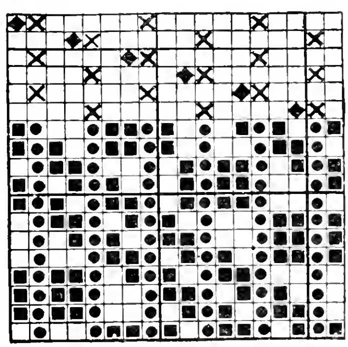


Fig. 211.

course in this case would be to increase the number of backing harnesses, so that the distribution could take place in accordance with the requirements of the pattern.

To bind this design a $\frac{1}{5}$ motive should be used, starting on the first back thread and second face pick. The complete chain, including the binding, is shown in Fig. 211 and the draw in Fig. 212.

TO LAY OUT A DOUBLE-CLOTH DESIGN.

First: Obtain complete dimensions and mark off.

Second: Shade the back threads and picks with light blue.

Third: Place the face weaves on the face threads and picks with black.

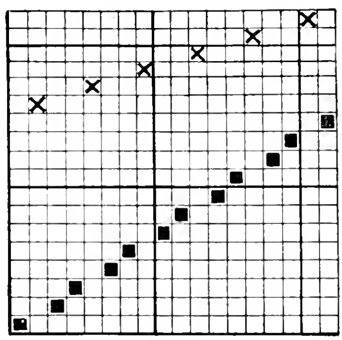


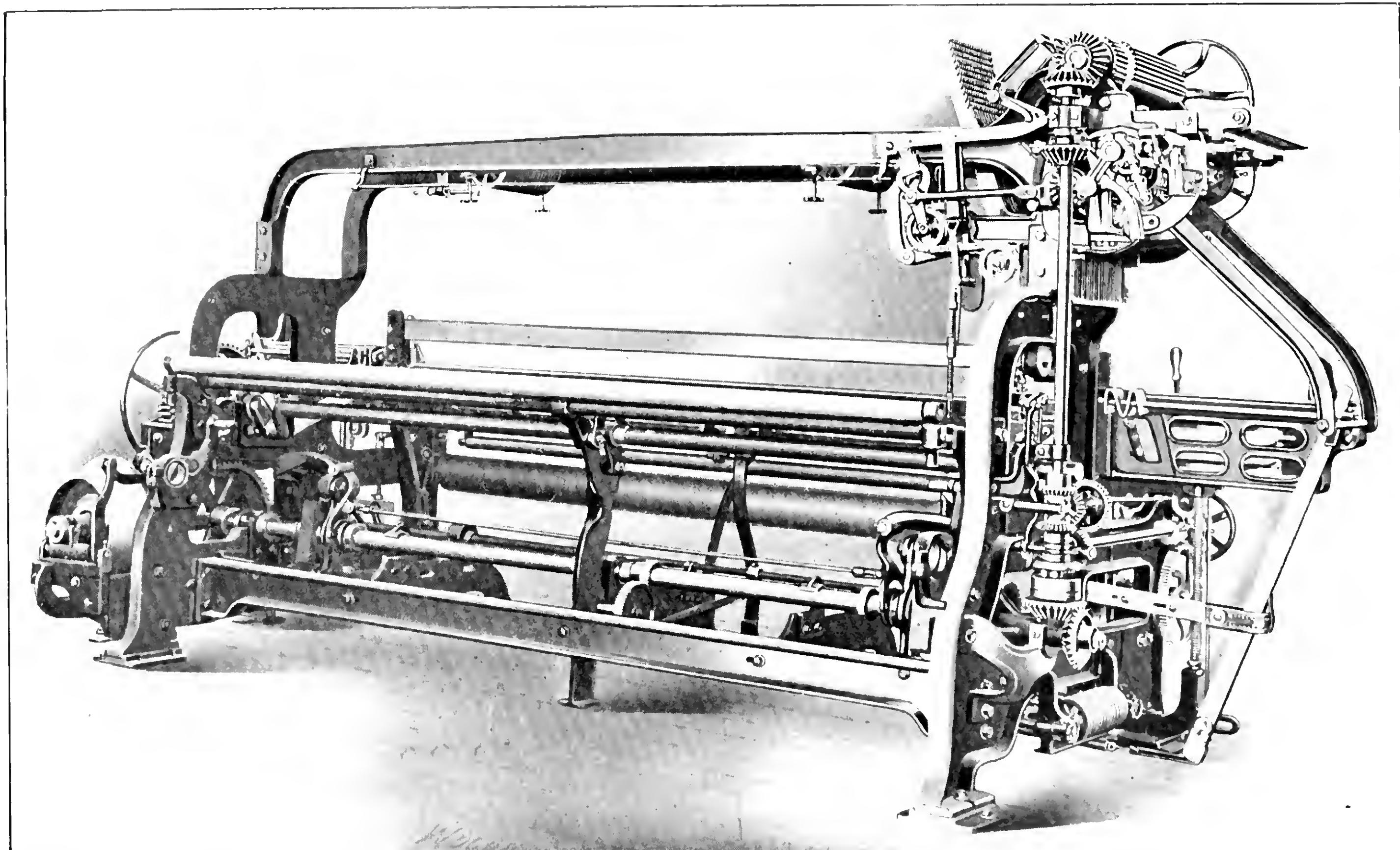
Fig. 212.

Fourth: Place the back weaves on the back threads and picks with red.

Fifth: Raise all the face threads on the back picks with green.

Sixth: Stitch by lifting a back thread between two risers of face and next to a riser of back, indicating with yellow; or

Seventh: Stitch by sinking a face thread between two sinkers of back, indicating with a circle.



REAR HARNESS-END VIEW OF HEAVY WORSTED LOOM
Crompton-Thayer Loom Co.

EXERCISES FOR PRACTICE.

PLATE A.

1. Stitch plans 1–5 for double cloths, using both warp and weft for this purpose.

2. Complete plans 6–9 for double cloths, using both backing warp and weft for stitching.

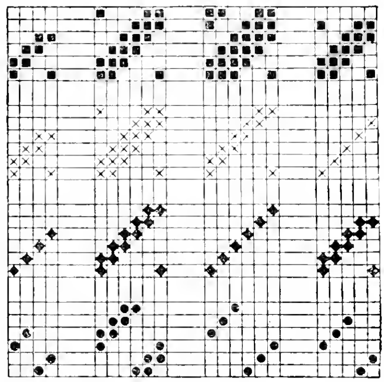
3. Make 4 plans for double cloths from the following particulars:

Plan of Face Weave

Plan of Back Weave.

Plan of Back Warp stitch.

Plan of Back Weft stitch.



4. Make plans for double cloths with 1 end and pick of face to 1 end and pick of back, using both backing warp and weft for stitching: with plan 10 for face and plan 11 for back: plan 12 for face and plan 12 for back; plan 13 for face and plan 14 for back.

PLATE B.

5. Complete plans 1–4 for double cloths, using both backing warp and weft for stitching.

6. Complete plans 5–8 for double cloths, using the backing warp for stitching.

7. Make plans for double cloths 2 face to 1 back in warp and weft, with plain backs, and weaves 9, 10 and 11 for face.

8. Make plans for double cloths 2 face to 1 back warp and weft, with twill backs, and weaves 12, 13 and 14 for face.

9. Point out any defect in plan 15, and give corrected plan.

10. Analyze plans 16 and 17, and give face and back weaves, stitching and separating plans.

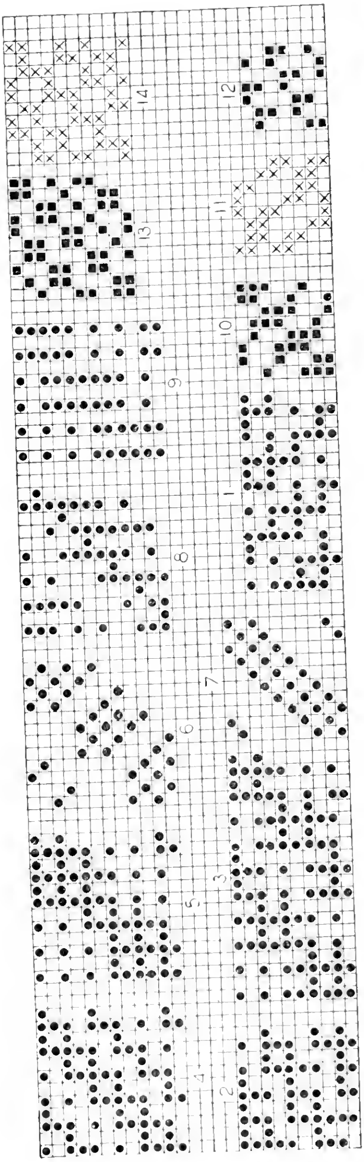


PLATE A.

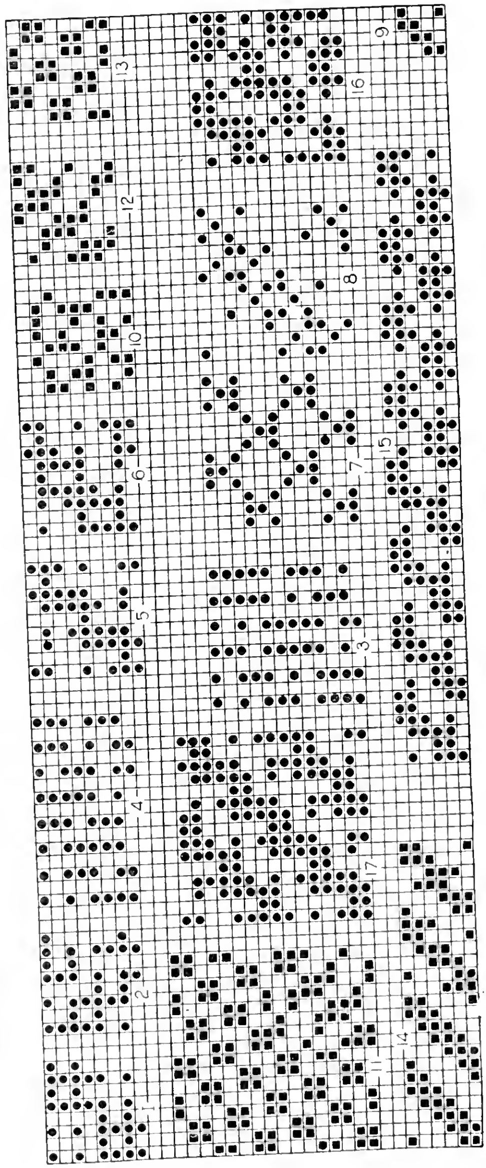
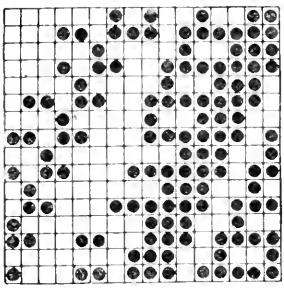


PLATE B.

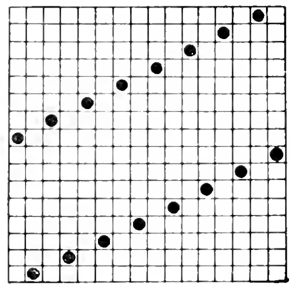
EXERCISES FOR PRACTICE.

1. Plan A is a peg plan for draft B; work out the design that would be produced, analyze it and describe its construction.

2. Give designs for double cloths, 1 and 1 warp and weft with (1) plan C for face and back, (2) plan D for face and back, also give peg plans to weave them with draft B.

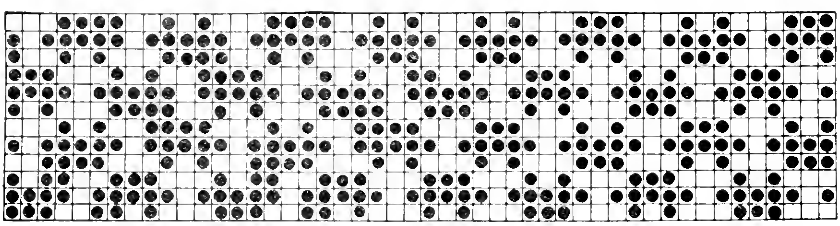


A



B

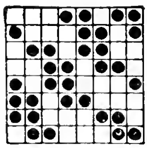
3. Make draft and peg plan to weave design E, backing healds to be in front, and give two peg plans for original designs to be woven in the same draft.

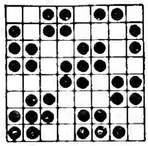


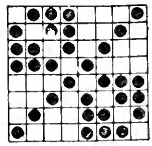
E

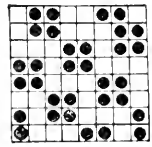
4. Put a plain back on plans F, G, H, 2 ends and picks of face to 1 end and pick of back; give peg plans to weave all in same draft.

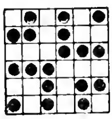
5. Make plans for double cloths with weaves K, L, M for face and same for back, 1 end and pick of face to 1 end and pick of back, and make a diagram showing section between 2d and 3d picks of plan M.

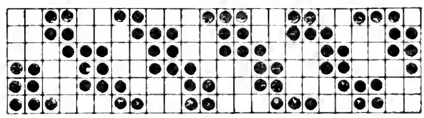

C

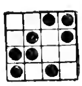

D

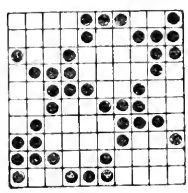

K


L


F

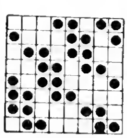

G

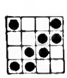

M

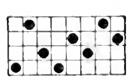

H

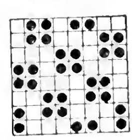
EXERCISES FOR PRACTICE.

1. Make plans for double cloths with plans A, B, C for face and D for back in each case; 1 end face to 1 end back, and 2 picks face to 1 pick back.


A

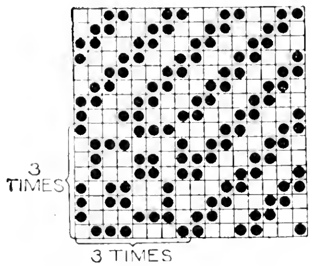

B


C


D

2. Make a double cloth with design E for face and a wadded satin back.

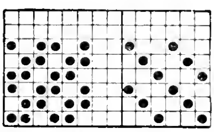
3. Give design, draft and peg plan for a double cloth, 2 face to 1 back, with original check plan for face, and a back which will hide the backing weft as much as possible.



E

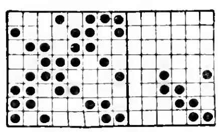
4. Make designs for double cloths A to G with the following weaves: 1 thread face to 1 thread back, warp and weft, using extra warp for stitching.

G



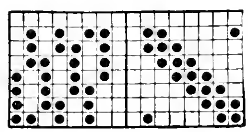
Face Back

H



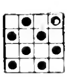
Face Back

I



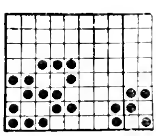
Face Back

F



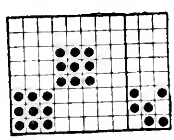
Face and Back

J



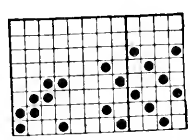
Face Back

K



Face Back

L

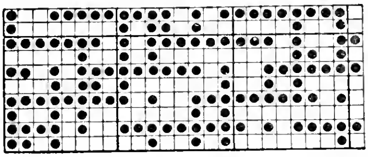


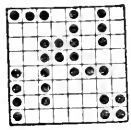
Face Back

5. Rearrange the double cloth designs F and G with 2 ends and picks of face to 1 end and pick of back, the stitching warp to have the same number of ends as the backing warp.

6. Analyze plan H, showing on point paper the face and back weaves, stitching plan, etc.

7. Point out any defect in the plans K and L for double cloths, and give the correct plan in each case.


M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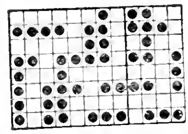
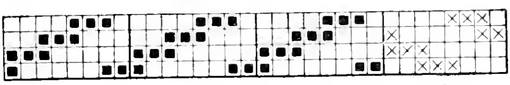
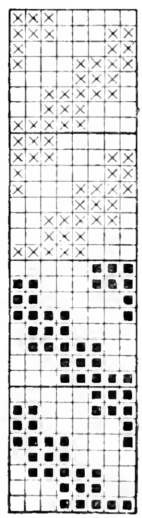

O

8. Make a 2 and 2 twill double cloth stitching by means of an extra stitching pick.

EXERCISES FOR PRACTICE.

1. Supply 2 single weaves for each of the accompanying designs, 1, 2, 3 and 4 to weave with the same set and in place of the portions in crosses (×).


2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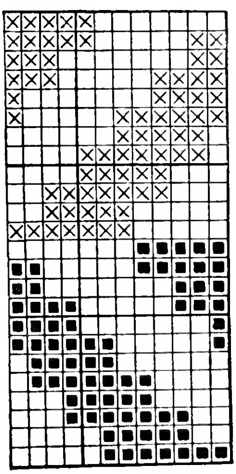
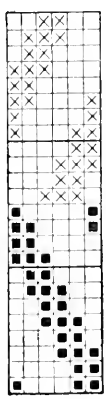
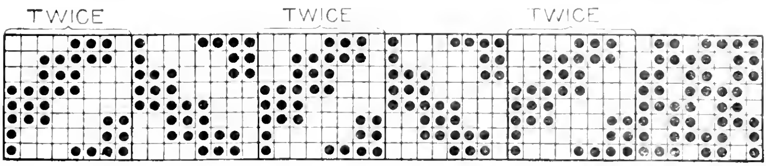

4


1

2. Give color figure produced from design 5, with the following warping and wefting:

Warp No. 1 Color — . 1 1 . 1 1 }
Warp No. 2 Ground — $\underbrace{2\ 1\ 3}_{8\ \text{times}}$, 2 2 2 } — 72

Weft No. 1 Color — 1 1 }
Weft No. 2 Ground — 3 2 1 } = 8

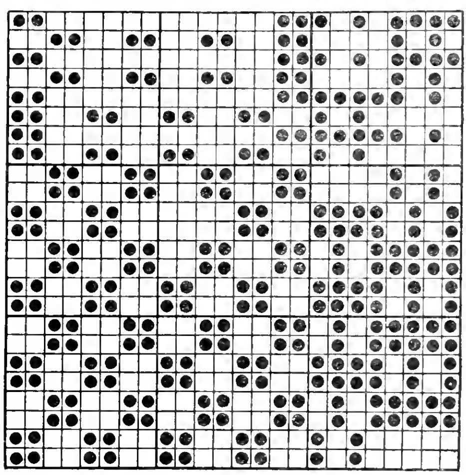


5

3. With a similar design, make an original color figure.

4. Color design 6, thus showing the effect produced in a cloth woven as follows:

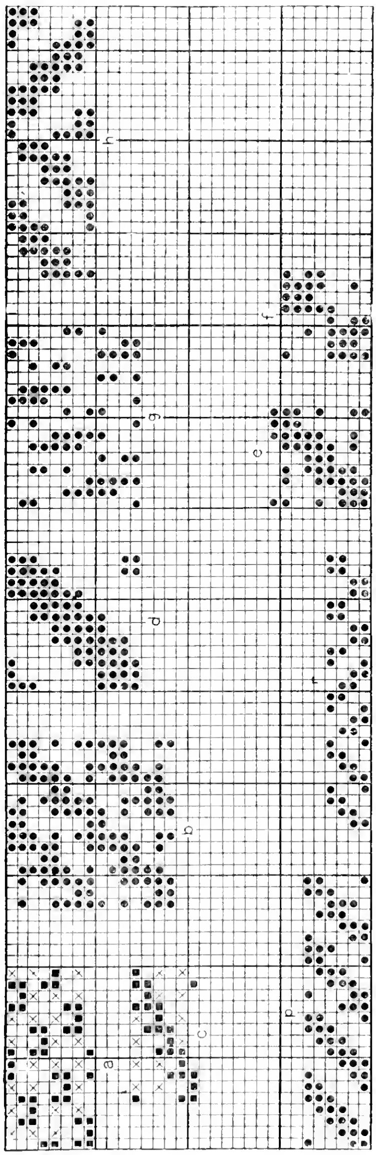
Warp and Weft { No. 1 Ground $\frac{2}{36}$s White — 17 1 1 1 }
{ No. 2 Color $\frac{1}{16}$s Light Blue — 1 1 1 1 } = 24



6

EXERCISES FOR PRACTICE.

1. Make plans to imitate plans a, b, c, in a weft-backed cloth.



2. Make plans to imitate plans d, e, f, g, in a single cloth.

3. Give backed or double cloths of which plans h, k, l, m, n, are imitations.

4. Back plans p and r with warp 1 and 1, and make single cloth weaves to imitate them in the same settings.

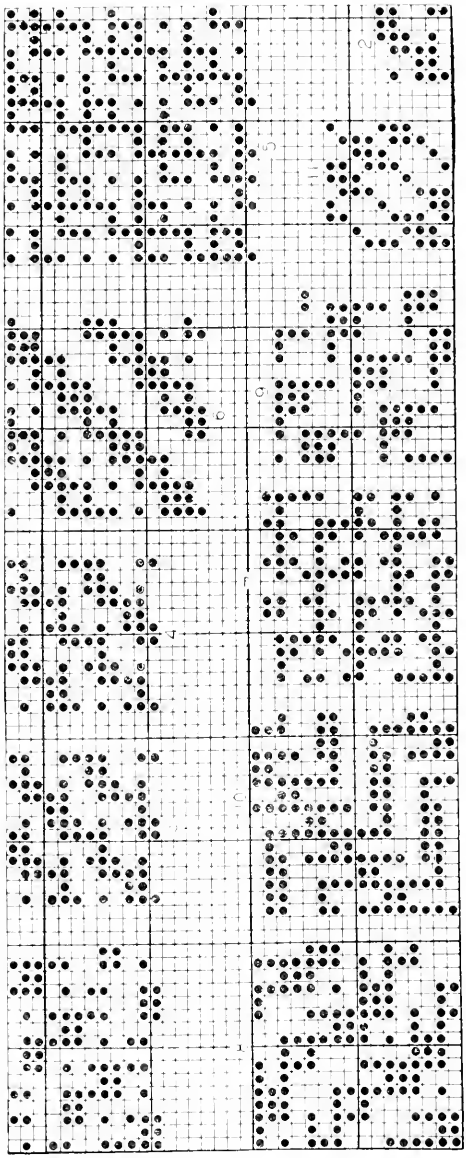
5. Point out any defects in the designs 1 to 7 for double cloths, and correct.

6. Make plans for a double reversible 6 and 6 twill and 8 and 8 twill, stitched as lightly as possible.

7. Analyze the accompanying plans 8 and 9 for double cloths, giving face and back weaves and stitching plans.

8. Describe the construction of design 10 and analyze it, giving separate plans of each component part.

9. In analyzing a double cloth the face weave is found to be plan 11, and the back weave plain; make peg plan to weave the cloth with a draft separating the back and face healds.



163

THREE-PLY OR TRIPLE CLOTHS.

Having treated with double cloths, the next fabric to be considered is three-ply or triple cloth. Triple cloths are fabrics having three distinct sets of warp and filling, constructed in a similar manner to double cloths. There are three different fabries, called the face, middle and back, bound together at certain intervals so as to form one complete fabric. The binding is done by the principles as employed in binding double cloths, and, in fact, any of the principles used in the construction of double cloths apply equally well to the construction of all multiple fabries. There is ordinarily an equal proportion of face, middle and back employed, i. e., one thread of face, one thread of middle and one thread of back, with the filling in the same order.

Yarns differing greatly in size may not be used for the different fabrics of a three-ply cloth unless the weaves employed are such as will permit of a variation in the diameter of the yarn. For instance, if a plain weave is being used for one fabric, and it is desired to increase the fabric in weight and yet retain the same number of threads per inch, coarser yarn could be used, but the weave would have to be changed to one with longer floats and fewer intersections, so as to accommodate the increased diameter of the yarn. Of course the same number of threads per inch must be retained so as to correspond with the other two fabrics.

The opposite will hold true about changing the weaves, as any radical difference in the weaves used would result in a difference in texture, i. e., making it either closer or more open, accord ing as to whether the change would be made from a long float weave to one with shorter floats, and a greater number of intersections. For this reason either a finer or a coarser yarn would be required to make up for such a difference, unless the number of threads per inch could be changed.

In these triple cloths the weaves generally used are the plain weave, simple twills and basket weaves combined in various ways. Different effects in such cloths are usually produced by the coloring, which may vary extensively in different cloths, and sometimes differs entirely on the two surfaces of the same fabric.

The face and back fabrics are often of a very similar quality, with an inferior class of material for the middle fabric. In fine-surface lighter weight goods of high quality the middle cloth would probably be of fine worsted warp with a medium woolen filling, but with the cheaper class of goods, where a good surface is also required with a somewhat greater weight, a cotton or cheap woolen middle warp would be employed, with a coarse and cheap woolen filling.

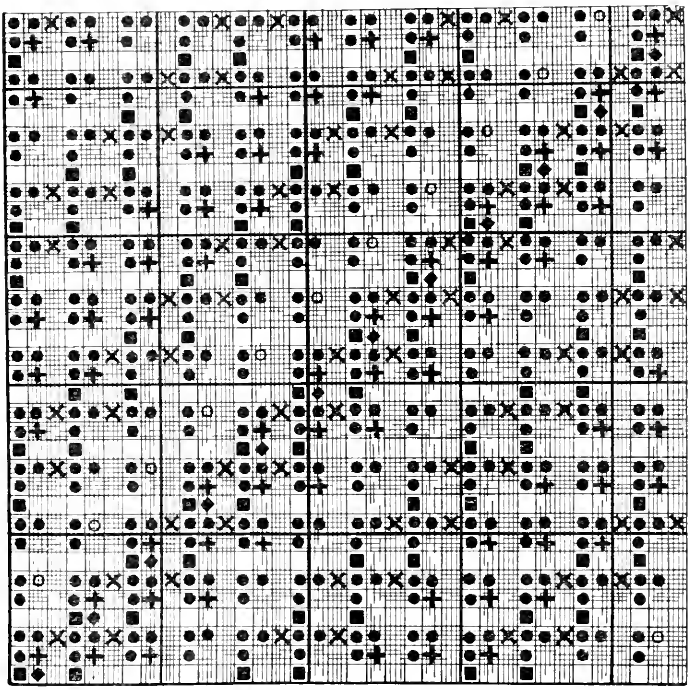


Fig. 213.

Now suppose it is desired to make a three-ply cloth with face and back of an equal quality, with a coarser middle cloth. For the face and back the cassimere twill weave $\frac{2}{\quad 2}$ may be used, and for the middle cloth the $\frac{3}{\quad 3}$ six-harness twill may be employed so as to permit the use of coarser yarn. It may also be the twelve-harness twill $\frac{1}{\quad 11}$. Knowing the weaves to be employed, together with the binding motive, the dimensions of the complete design may now be ascertained.

The least common multiple of 4, the face and back weaves, 6, the middle weave, and 12, the binding motive, is 12, and as it is a three-ply cloth, multiplying by 3 will give 36 threads and picks, the dimensions of the complete design. Having found the dimensions required, the design paper may be shaded to indicate the different sets of threads and picks, as was done with double cloths; but, as in this case there are three different sets of threads, two different kinds of shading must be used, one for middle and one for back, the face being left unshaded. For the middle a light wash of yellow may be used, and for the back a light wash of blue; or the middle may be shaded with broken fine lines, and the back with unbroken fine lines, as shown in Fig. 213. By the use of either of these methods confusion is avoided.

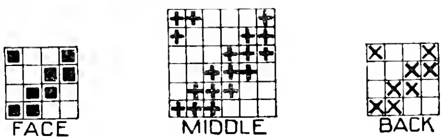


Fig. 214.

Next place the different weaves on the shaded paper, indicating the face weave with full squares, the middle weave with straight crosses and the back weave with oblique crosses, as shown in Fig. 214. This being done, the weaves for the different fabrics are all indicated, but nothing has been done to separate the three fabrics, i. e., to prevent the filling intended for one cloth interweaving with the other warps. When the face filling is being interwoven, the middle and back warps must be left down, and as these warps have not been raised on the face pick, no change is necessary on that pick. When the middle pick is being interwoven, the face warp must all be lifted and the back warp must all be left down, so on this pick the face warp is lifted, as shown by the round marks in Fig. 213. When the back pick is being inserted, both the face and middle warps must be lifted out of the way of the back filling, and this is done as indicated by the round marks on the back pick in Fig. 213. Now all the weaves are indicated, and the lifters which separate the three cloths are also indicated, the binding only being necessary to complete the design, because the design without the binding would produce three distinctly separate cloths not joined together at any point.

The best results in binding three-ply cloths are obtained by using a combination of the two methods employed for double cloths in such a manner as to bring all the binding on the middle threads. This is accomplished by lifting a middle thread over a face pick at a suitable point, thus binding the face and middle cloths together, and by binding the middle and back together, by sinking a middle thread under a back pick at a suitable point. The rules given for selecting binding points hold good with three-ply, the same as with double cloths. Occasionally a three-ply fabric is bound directly through from face to back, or *vice versa*, but unless this is made necessary by some particular reason, it should not be done. Now to bind the design above: first bind

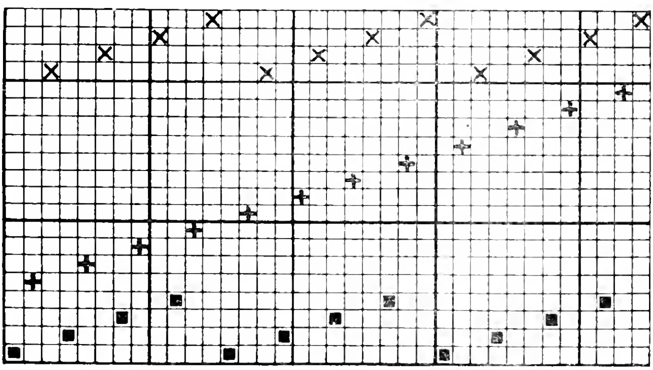


Fig. 215.

the face and middle together by lifting a middle thread over a face pick. Referring to the design, it will be seen that on the first face pick there is but one point which answers the requirements necessary to produce a perfect binding. This point is where the first face pick crosses the first middle thread, and it will be noticed that the face thread on each side of this point is lifted, and also the middle thread is lifted over the middle pick preceding and the middle pick following this point, thus making it a perfect binding point in every way. This may be taken as the first point, and as the face and middle weaves are regular twills, the binding motive also being a regular twill, the consecutive binding points will come at positions governed by the same conditions,

i. e., at the point where the second face pick crosses the third middle thread, etc. These points are indicated by the diamond-shaped marks in Fig. 213, making the binding of the face and middle complete. To complete the design, it is only necessary to bind the middle and back fabrics together by sinking a middle thread under a back pick. As all the middle threads have been lifted over the back picks by the circular marks in the same design, it is necessary to remove one of these marks wherever the binding makes it necessary, or such point may be indicated with a circle, this circle to indicate a sinker. This binding point must come where the back filling crosses the middle warp, with a sinker of back on each side and a sinker of middle both on the preceding middle pick and on the middle pick following.

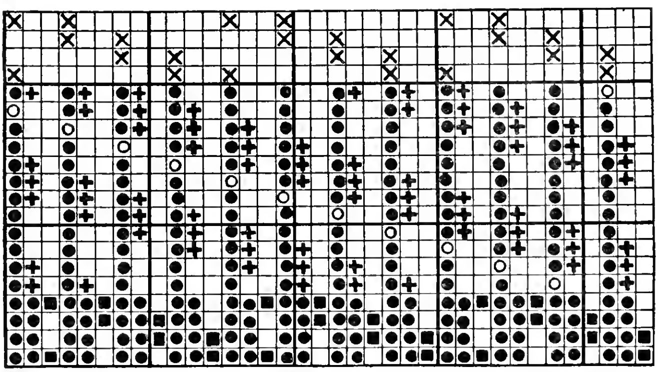


Fig. 216.

Referring to the design, it will be seen that there is but one point answering this description on the first back pick, and that is where it crosses the last middle thread. This point has a sinker of back on each side of it, and a sinker of middle preceding and following it, answering fully the required conditions. Taking this point as the first, indicate it with a circle, as shown, and following out the binding points in consecutive order the next comes where the second back pick crosses the first middle thread, etc., continuing until all the points are indicated by these circles. The design is now fully completed, the three different weaves being indicated, also the face lifters on the middle picks, and the face and middle lifters on the back picks, the three fabrics thus being bound together.

The drawing-in draft for the above design is given at Fig. 215, with the chain-draft at Fig. 216, and a cut section of the first three picks at Fig. 217. Fig. 218 is a design composed of the same three foundation weaves as before, and is like Fig. 213 in every way but the binding. In this case the binding is done by lifting a middle thread over a face pick to bind the middle and face together, and by lifting a back thread over a middle pick. The binding motive is a twelve-harness twill $\frac{1}{11}$ and the binding is indicated in the design by the diamond-shaped marks, Fig. 218. The threads are numbered underneath the design in the order of the drawing-in draft, and as this design would require twenty-eight harnesses as compared with twenty for the previous example, it shows clearly the advantage of doing all the

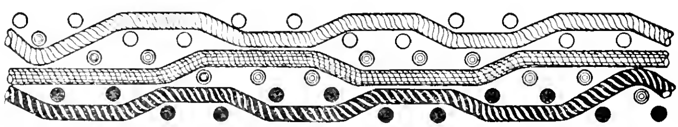


Fig. 217.

binding with the middle warp as in Fig. 213. The difference of eight harnesses is often the difference between a design which may be practicably woven and one which may not, and in this case may be truly said to be so.

In many mills cloths are woven which have two fillings interwoven with three warps, the middle warp being employed only for the purpose of binding the face and back fabric together. This warp, which is called the stitching or binding warp, would, in the finer class of goods, probably be made of fine worsted, and in the cheaper class of goods be made of cotton.

The advantage of using this middle warp is that a double-face cloth using such a warp is usually of a much softer and fuller texture than a double cloth in which the two fabrics are bound directly together, and there is less danger of the colors of one cloth showing through the face of the other. The superior texture of a cloth made with a binding warp is due to the shrinkage of the wool in the face and back fabrics during the fulling process, which affects the worsted very little, or the cotton not at all, thus causing the worsted or cotton warp to kink enough to allow the face and back fabrics to separate slightly, and in this way cause the extra softness, where in the ordinary double cloth the two fabrics would be firmly felted together.

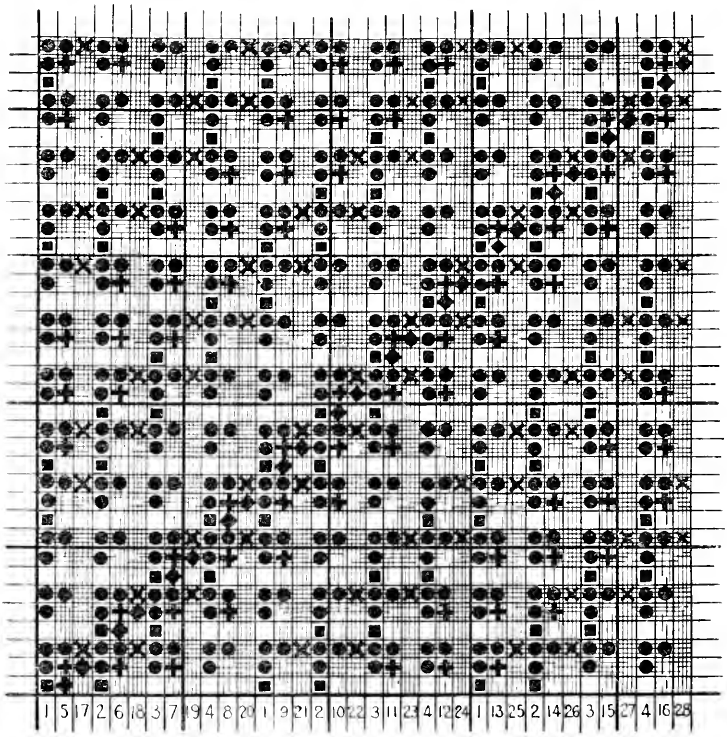
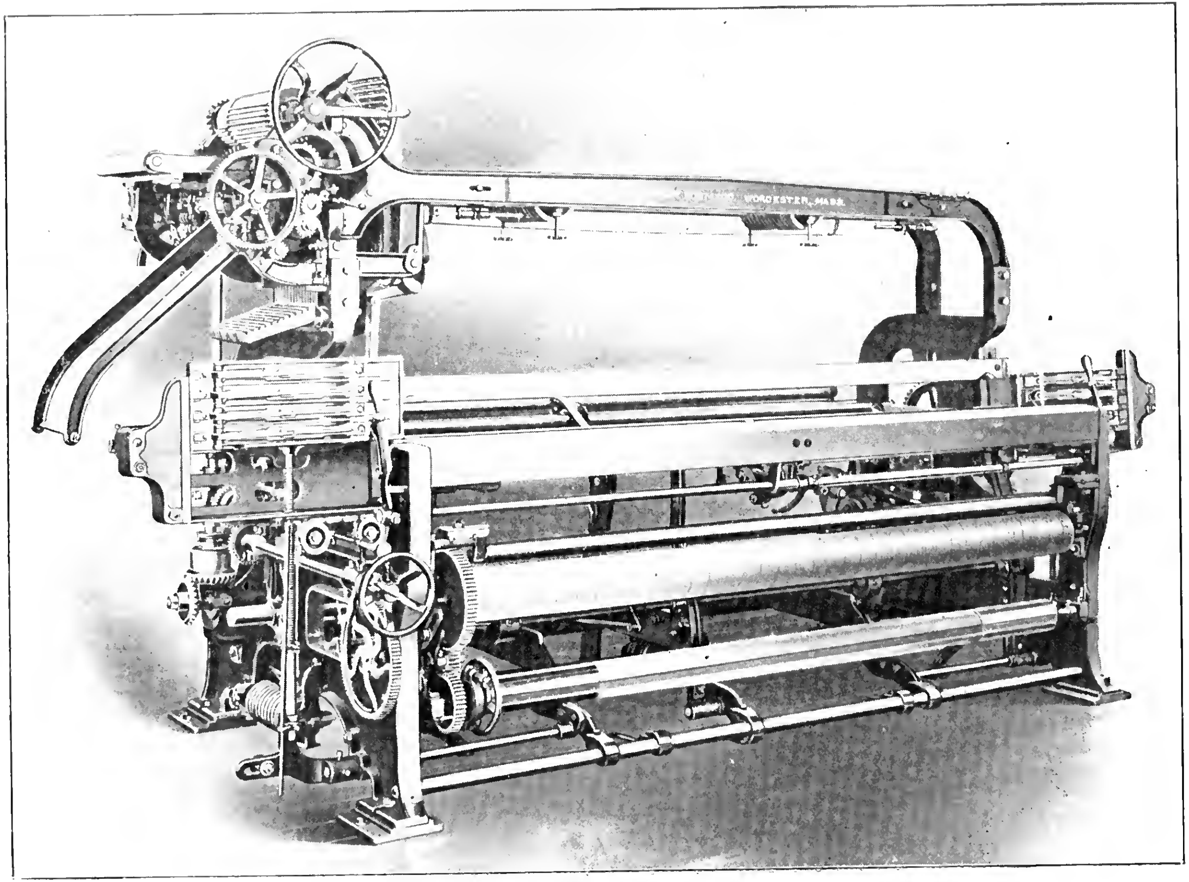


Fig. 218.

A design for this kind of fabric is given at Fig. 219, where the face and back weaves are both the four-harness cassimere twill $\frac{2}{2}$ bound together by first lifting the middle thread over a face pick, and then sinking it under a back pick at such points as meet the proper requirements, at other points it merely floating between the face and back fabrics.

The binding motive is an eight-harness sateen, as indicated by the diamond-shaped marks where the binding threads are lifted



HEAVY WORSTED LOOM WITH 82-INCH REED SPACE
Crompton-Thayer Loom Co.

over the face picks, and by the circles where they are sunk under the back picks.

Other multiple cloths may be made in the same manner as those already described, in varying proportions, as two warps with two or three fillings; three warps with two, three or four fillings; four warps with three, four or five fillings, etc. For fabrics used for clothing anything over three-ply is rarely made, but as a matter of experiment, fabrics have been woven up to eight-ply.

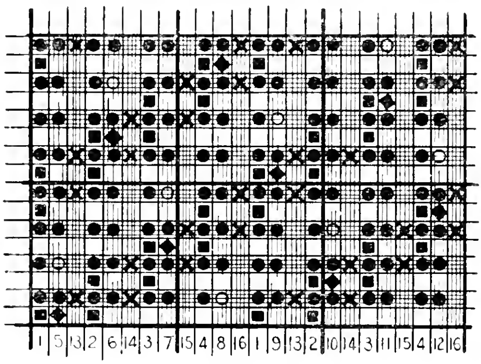


Fig. 219.

TO LAY OUT A TRIPLE CLOTH DESIGN.

First: Obtain complete dimensions and mark off.

Second: Shade the middle threads and picks with light wash of yellow.

Third: Shade the back threads and picks with light blue.

Fourth: Place the face weave on the face threads and picks with black.

Fifth: Place the middle weave on the middle threads and picks with blue.

Sixth: Place the back weave on the back threads and picks with red.

Seventh: Raise all the face threads on the middle picks, and all the face threads on the back picks, with green.

Eighth: Stitch by lifting a middle or back thread between two risers of face or middle, and next to a riser of middle or back, indicating with yellow; or

Ninth: Stitch by sinking a face or middle thread between two sinkers of middle or back, indicating with a circle.

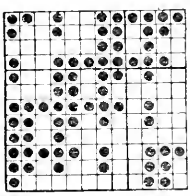
Tenth: In some triple cloths where an extra heavy middle cloth is used to gain weight, the back thread should be lifted right through to the face to prevent any possibility of the stitching showing, as would be likely if the middle warp were used for that purpose.

EXERCISES FOR PRACTICE.

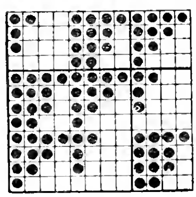
1. Make a design for a three-fold cloth with a 2 and 2 twill for face and hopsack back.

2. Make a design for a cloth with 4 warps and 3 wefts, with a prunelle twill for face and back.

3. Analyze the design A, giving diagram of a section of the cloth weft way.



A

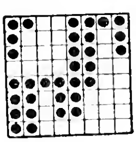


B

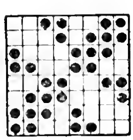
4. Describe the construction of the designs B and C, and mark the ends in the plan which you would put on the same beam.

5. Make a design for a double 3 and 3 twill, same face as back, with a third warp in the middle, having half the number of threads of the face warp.

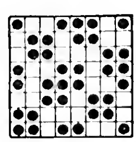
6. Make plans for 3-fold cloths with designs D and E for face and back, and with a plain cloth in the middle.



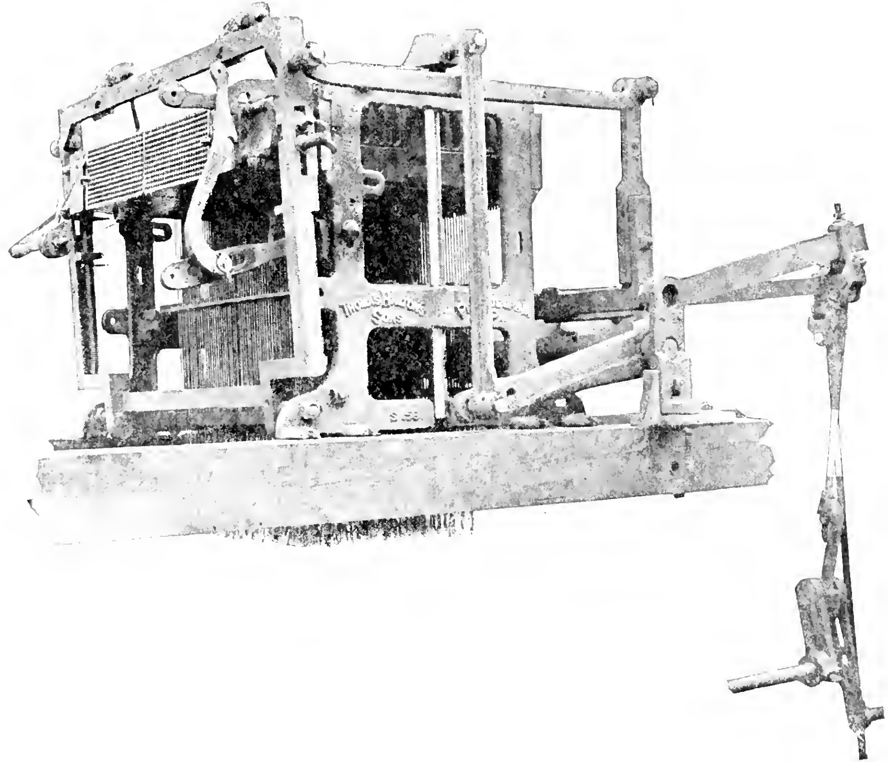
C



D



E



THE INDEPENDENT BATON CYLINDER MOTION WITH 624 SINGLE LIFT MACHINE
Thomas Halton's Sons

TEXTILE DESIGN

PART IV

DOUBLE PLAIN

"Double plain," as the name implies, means a double fabric composed of two warps and two fillings, the face warp and filling weaving plain, and the back warp and filling weaving plain. This class of weaves is chiefly used to produce fancy effects by combining or interchanging the single cloths. If one color of yarn is used for both face and back cloths, two fabrics of the same color and construction will be produced; while if the odd-numbered threads and picks are one color and the even-numbered threads and picks are a second color, two separate cloths of different colors will result. Assuming that the first color is black and the second color is red, the fabric will have a black face with a red back or lining.

It will not be difficult to understand that if the face and back cloths are interchanged; *i. e.*, if the black face yarn is woven on the back, and the red back yarn is woven on the face, at predetermined intervals, a variety of stripes and figures may be formed. It is on this principle that the characteristic double plain patterns are made.

Construction. Designs of this class differ from the usual double and triple cloth designs chiefly in the manner of binding the cloths. Where a twill, hopsack, or some other weave with floats of two or more threads, is used for the face cloth, it is a very simple matter to produce perfect binding by lowering a face thread under a back pick, or by raising a back thread over a face pick. These methods are impracticable in constructing double plain designs, because the plain weave, one up, one down, does not contain floats of two threads, consequently the plan of binding would be plainly visible on the face of the fabric. This would be especially true when different colors of yarns were used for the face and back cloths. However, the manner of stitching the cloth is of secondary consideration, for when the face and back fabrics are interchanged, they are, of course, bound together.

The first step in laying out a design is to shade the back threads and picks, then placing the face and back weaves on their respective threads, and raising the face threads on the back picks. This is plainly shown in Fig. 219, which gives the successive steps in laying

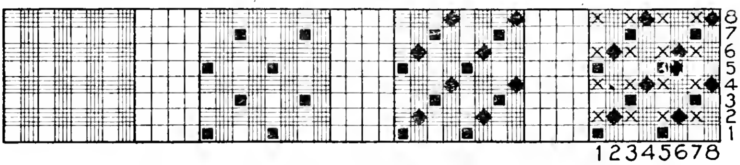


Fig. 219.

out a simple double plain design. If this design were woven with one shuttle, two separate cloths bound only at the selvedges would be woven. If two shuttles were used, two cloths, independent of each other in every way, would be produced.

The diagram, Fig. 220, shows the threads interlaced in regular plain order and gives the relative positions of the face and back cloths. It also emphasizes the statement made above to the effect that a double plain design does not permit of perfect binding by the methods used on the usual ply fabrics. By careful attention to Fig. 221 it will be seen that the face and back cloths may readily be woven in solid colors without interfering with each other in any way. This figure shows a cut section of the first four picks, and represents two plain cloths one over the other.

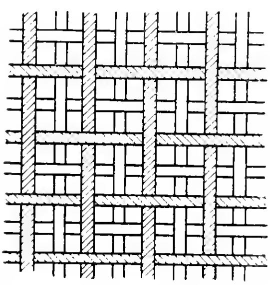


Fig. 220

The foregoing explains the principle of double plain construction, but, excepting in the manufacture of seamless bags and pockets, it is not used to any extent. It is used here to illustrate the possibilities of double plain designs and the impossibility of obtaining good results by attempting to bind them by ordinary stitching. With these points clearly understood, those that follow will present few difficulties.

The simplest pattern that may be produced is the "Hairline" or very fine stripe effect in solid colors, the effect being produced by the face and back cloths interchanging. To explain how this is done, it will be best to select a pattern and illustrate the successive steps necessary for its production. For example, assume that a pattern must be made with alternate stripes of black and red on the face, the black stripe to be six threads wide and the red stripe to occupy two threads. When the cloth is turned over, the color effect will be reversed, showing six threads of red and two threads of black.

Referring to Fig. 222, it will be noted that 16 x 8 squares have been marked off, and the first twelve threads shaded in the usual way to produce double plain cloth. These threads give the black stripe on

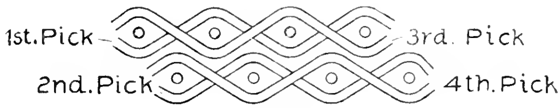


Fig 221.

the face of the cloth and the red stripe on the back. So far no change has been made from the method pursued in Fig. 219, but it is evident that something must be done to reverse this order and make the red stripe appear on the face. This is accomplished as follows:

Those picks and threads that were shaded for the back cloth are now used for face, and *vice versa*. The warp being dressed one black, one red, the opposite color will be raised to the face. The even numbered threads and picks are now the face threads and face picks, and therefore a solid red stripe is formed at this section of the design.

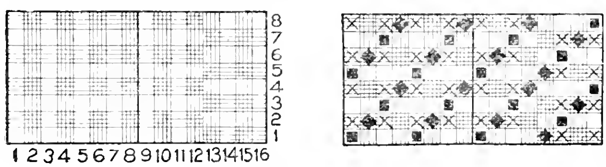


Fig. 222.

The complete design also is shown in Fig. 222. After the threads are shaded, the design is completed by putting the plain weave on both face and back ends and picks, and raising the face warp on the back picks in the usual manner.

The cut section in Fig. 223 shows the first four picks. It will be noted that the odd picks, which are black, interlace only with the odd-numbered threads, while the even-numbered picks, which are red, interlace only with the same color of warp. The cloths are bound together at the point where the interchanging takes place, which in this design is at threads 11, 12, 13, and 14. If the design were carried out one more repeat, it would, of course, be bound at threads 1, 2, 15, and 16, as the black face cloth returns to its normal position.

For a further example of double plain stripe patterns, refer to Fig. 224. The warp for this design is dressed one black, one red; and the filling pattern also is one black, one red. When woven, the face

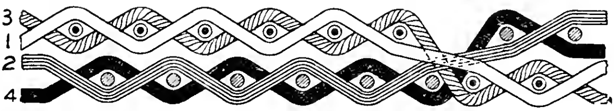


Fig. 223.

pattern of the cloth will be six black, two red, two black, two red. Of course, the under surface of the cloth will be the reverse, or six red, two black, two red, two black. The chief object of this design is to show how the face cloth is returned to the face of the fabric after weaving on the back.

Examples of stripe patterns formed on this principle could be multiplied, but the principle is the same in all. The important points to be remembered are to shade the threads and picks as in the case of double cloth, interchanging the cloths by bringing two back or two face threads together.

Check patterns are made by extending the principles used in the production of stripe effects. This is illustrated by the shaded design paper shown at Fig. 225. It will be noted that not only do two face and two back threads come together, as at BB and FF, but two face

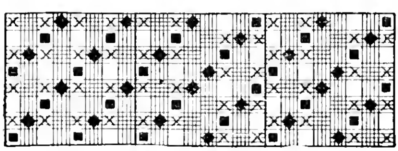


Fig. 224.

and two back picks adjoin as at *bb* and *ff*, reversing the cloths at these points which, of course, are the binding points of the fabric. To better explain the construction of check patterns it will be best to work out from the beginning a design of this class.

The first step is to select a suitable pattern, which in this case is a black and white checkerboard effect to repeat on twenty-four threads and twenty-four picks. The warp will be dressed one black, and one white, and the filling will be woven one black, one white. After determining the area the design is to occupy the ends must be shaded and the face weave placed on the face threads and picks. This is shown at Fig. 226. The plain weave must now be placed on the back threads and picks, and risers be filled in to lift the face warp over the back picks. The complete design is shown at Fig. 227, and if woven the effect would be alternate squares of black and white, each square occupying six threads and six picks.

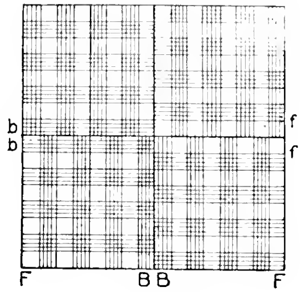


Fig. 225.

Spot effects or floral designs may be produced upon the same principle by allowing the back cloth to weave on the face to form the required spot or floral effect.

SPOT WEAVES

This class of weaves is used to a large extent in manufacturing cotton and worsted fabrics, as the nature of spot weaves makes them

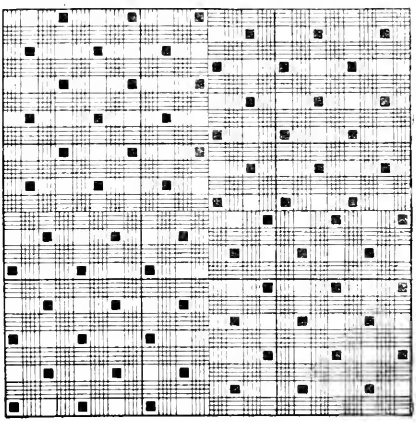


Fig. 226.

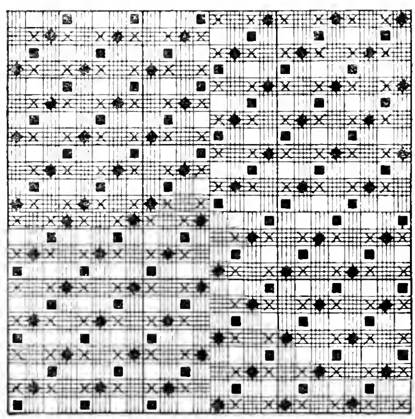


Fig. 227.

especially adapted to the production of large varieties of neat effects.

It will be readily understood that it is necessary to have some of the yarn float on the face of the cloth where it is desired to form a spot;

also that the manner in which the yarn is allowed to float determines the shape and appearance of the figure.

Spot effects may be produced in three ways; *first*, by forming the spot of the same yarn that forms the body or ground work of the cloth; *second*, by employing an extra warp which does not in any way affect the ground weave, but is brought to the face at regular intervals to form the figure; *third*, by the use of an extra filling which, like the extra warp, floats on the back of the cloth when not weaving on the face to make the pattern. The first method limits the pattern to the colors used in the ground, while the second and third methods permit the use of different material of any color desired.

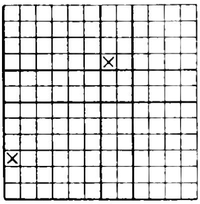


Fig. 228.

It is unnecessary to take up the first method very fully as it is similar to many of the simple weaves already explained, and also because it is taken up on a larger scale under the heading "Jacquard Designing." It will be sufficient to state that spots formed by the yarn that composes the body of the cloth are produced by introducing, at the point where a spot is desired, a second method of interlacing

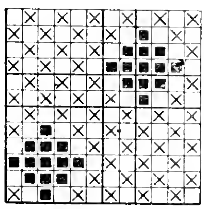


Fig. 229.

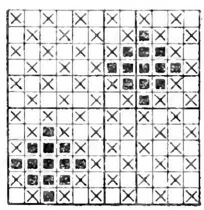


Fig. 230.

the threads. For instance assume that a diamond spot is required on a plain ground (that is, the ground to be woven with a plain weave), the spots to be arranged in plain order, and the full design to repeat on twelve threads and twelve picks.

The first step is to mark off the extent of the design or the area it is to occupy, and as the spots are to be arranged in plain order, to divide it into four equal parts, each containing six threads and six picks. This is shown at Fig. 228. As the spots must have the same relative position it will be helpful to mark one of the small squares that the spots may be filled in with relation to these squares. This also is shown at Fig. 228.

The next step is to fill in the spots and place the ground weave around them as shown at Fig. 229. Careful attention must be given to the arrangement of the figures and the manner of filling in the ground weave, otherwise the effect shown at Fig. 230 will be produced.

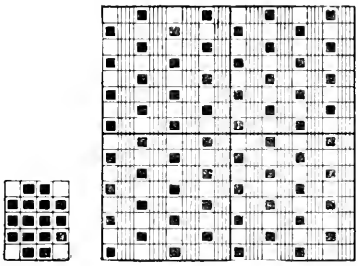


Fig. 231.

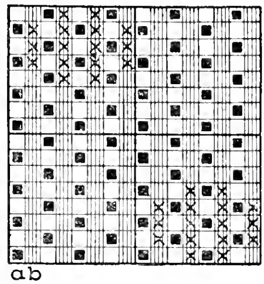


Fig. 232.

A careful study of Fig. 230 in connection with Fig. 229 will emphasize the value of a careful disposition of the spots with regard to facilitating the work of adding the ground weave. Note how the clear cut appearance produced by Fig. 229 is destroyed by the ground weave being run into the figure as at Fig. 230.

The second method of making spot designs, *i. e.*, by the use of extra warp threads to form the figure, presents no difficult features to those who have mastered warp-backed cloth designs for it is similar in every detail. Assume that a design is being laid out for back cloth,

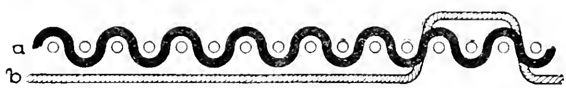


Fig. 233.

but that the backing threads are silk or fine quality cotton or worsted, and instead of being carefully stitched so that they will not show on the face they are floated on the face to form spots. This clearly explains the construction of spot designs by this method.

Attention must be given to the disposition of the spots, as regards the distance they are placed from each other, and the order in which they are arranged, such as plain, sateen, etc. For an example of this method see Figs. 231 and 232. The small figure in Fig. 231 represents the spot which is to be superimposed upon a plain ground. The first operation is to shade the extra threads, or those which represent the extra warp threads, and fill in the plain weave on the ground threads. This is shown at Fig. 231. The figure must now be placed on the shaded threads and the design is complete as shown at Fig. 232. Fig. 233 shows a cut section of the first and second threads interlacing with the filling.

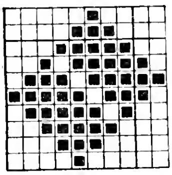


Fig. 234.

This pattern, when woven, will not have the appearance suggested by Fig. 232 as the ground threads will, of course, close over the spaces which represent the extra threads and they will be entirely hidden from view.

It must not be supposed that the ground effect is limited to the plain weave for any of the simple weaves such as twill, sateen, etc., may be used. These figures are not given because of their value as designs but to illustrate the principles on which these effects are laid out.

As a further example of the spot effect produced by extra warp, and one which is of a more practical nature, refer to Figs. 234 and 235.

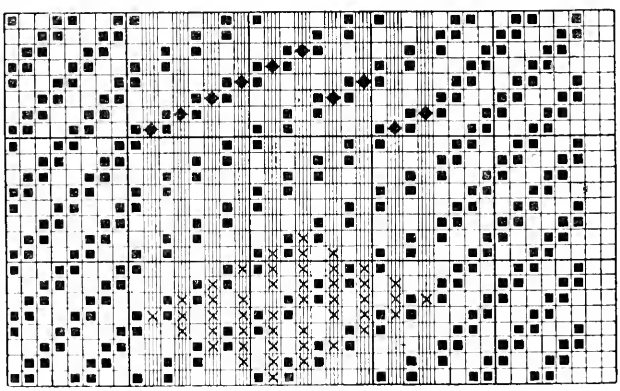


Fig. 235.

Fig. 234 represents a spot which must be produced on a cassimere twill ground, once every twenty-four picks. The ground warp and filling are red and the extra warp is white mercerized cotton. The ground cloth counts forty threads to the inch and there must be one-half inch between the rows of spots.

As in the previous example the extra threads are shaded and the ground weave, which in this case is the cassimere twill, is placed on the ground threads. The next step is to place the figure on the extra threads. Apparently the design is now complete, and in fact it would produce good cloth. However, a designer should seek means to produce the best that is possible and in this case something more may be done to improve the design. The first and last extra threads are interlaced once in twenty-four picks, or in the full repeat of the design. This means that they will float on the back of the cloth for twenty-three consecutive picks if some method is not devised to prevent it. For this reason the extra threads are stitched at convenient places as shown in Fig. 235.

As the ground yarn is red and the spot or extra threads are white, it must be understood that care should be exercised in the selection of binding places or the stitch will spoil the face effect. The rule given

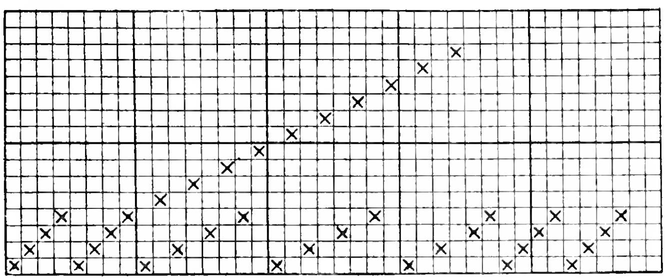


Fig. 236.

for stitching backed fabrics applies equally well here and is as follows: The extra thread must be raised over a pick of the face filling at a point where the threads on each side of it are raised.

The drawing in draft and harness chain for Fig. 235 are given at Figs. 236 and 237. These are made in the manner common to backed and ply-cloths, the ground threads being drawn in on the front harnesses as they are so greatly in excess of the extra threads. This facilitates the operation of weaving the cloth as, there being so many more ground threads, there will be more breakage among them and they may be more readily tied up if drawn in on the front harnesses.

The formation of spot designs by the use of extra filling is the third and last method in our classification. It is exactly the reverse of the second method and the principles involved are very similar to those employed when constructing filling backed fabrics. It is not difficult to understand that the blank squares on the shaded picks in Fig. 238 will make a filling spot of the same character as the small figure at the left of the design. Of course, the crosses represent that the other threads will be raised so that the extra pick, which may be of a radically different color from the ground, will not show on that part of the cloth. If the distance between the figure is so great that the extra filling will float loosely on the back of the cloth, it may be stitched in the same manner that the back filling is fastened to the face cloth in a filling backed design, *i. e.*, by lowering a ground thread under it between the two floats of the ground filling.

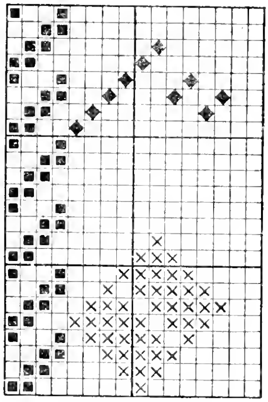


Fig. 237.

To explain the meaning of arranging spots in sateen order Figs. 239 and 240 have been prepared. It should be understood that although this design is of the extra filling class the arrangement of spots secured may be obtained equally well on both the other methods.

The small figure at the left of Fig. 239 represents the spot which it is desired to produce in five harness sateen order on a three harness twill ground, the spots to be placed as close together as practicable. Fig. 239 shows the design laid out with the spot figure arranged on the extra filling picks, and Fig. 240 shows the design complete, with the ground weave filled in on the ground picks. Fig. 241 shows a cut section of the first and second picks interlacing with the warp.

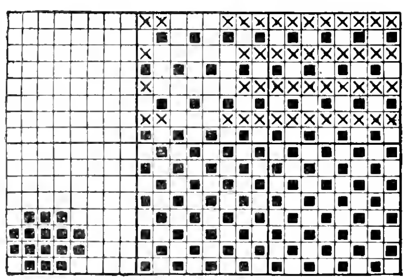


Fig. 238

In all spot designs the ground weave must repeat on the extent of the design, or the arrangement of the figures must be changed to occupy a number of threads and picks which is a multiple of the threads and picks occupied by the weaves. Take for example Fig. 240 which repeats on fifteen threads. If the plain weave were used for the ground in this design, the first and fifteenth threads would be the same,

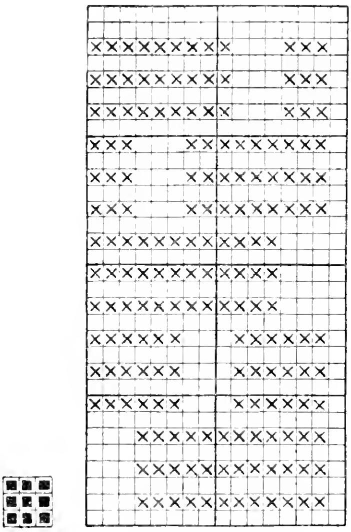


Fig. 239.

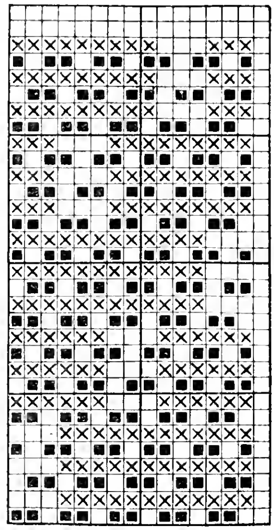


Fig. 240.

and when the design is repeated would come together to form a double thread. This would be a serious defect, and would make the design practically valueless.

PILE OR PLUSH

Fabrics made by this class of weaves differ both in structure and appearance from all others as their surface presents a series of short threads which issue from the body of the cloth. These loops formed by the yarn are termed pile.

Plushes may be divided into two classes, *i. e., warp pile* and *filling pile*. The former is cloth in which the loop is formed by the

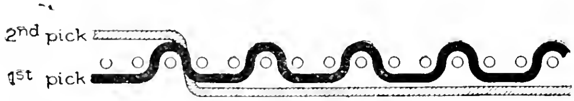


Fig. 241.

warp, while in the latter the loop is formed by the filling These two classes may be subdivided into cut and uncut, or cut and loop pile.

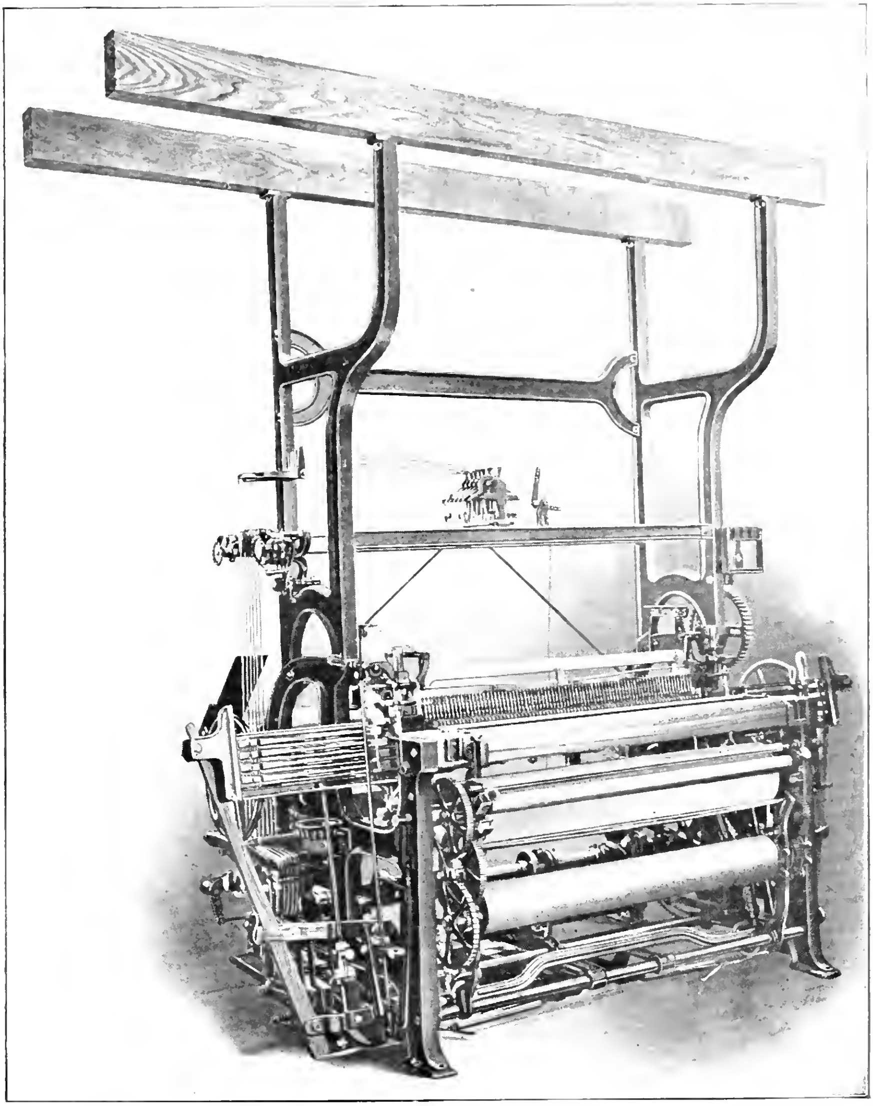
Filling Plush. This is the simplest of all pile fabrics. As suggested by the name, the cloth is formed by a series of filling threads floating on the surface. The operation consists of weaving a ground cloth, plain or otherwise, and weaving a filling floating loosely over the surface and bound into the ground at certain regular intervals. This surface filling is then cut as nearly as possible in the center of the float, and stands up from the body of the cloth, thus forming a cut pile.

The diagram shown at Fig. 242, is a cut section of a common velveteen, the weave being shown at Fig. 243. Two picks are shown in the diagram, one of ground and one of pile. The ground filling, B, in conjunction with the warp forms quite a plain fabric, while the pile filling, A, passes under one warp thread and over five. The letter C shows the pile filling cut at one of the floats. An examination of Fig. 243, will show that the ground weave is plain while the pile picks are bound down once every six threads, there being three picks of pile filling to one pick of ground. The pile picks are marked P, and the ground picks are marked G.

The structure of the cloth must be carefully considered in order to determine the best method of binding the pile into the cloth, and also the best distribution of the pile over the surface of the fabrics. If the pile is not firmly bound it will not permit of its being cut, and if it were cut the yarn would constantly be pulling out in wearing as there would be no power to resist friction.

The firmness of the binding is dependent upon the compactness of the fabric and the manner in which the pile filling is interwoven with the ground, and in the case of Fig. 243, where the pile filling passes around but one warp thread, it makes little difference how the binding point is distributed, because it will have to depend entirely upon the pressure of the ground picks on each side to secure it firmly in the fabric.

In the design shown in Fig. 244, the pile filling interweaves with three warp threads, which, of course, increases the holding power of the ground cloth. The ground picks are marked G and the pile picks are marked P. As in Fig. 243, there are three picks of pile filling to one pick of ground, however, in this design the pile filling floats over nine consecutive threads, making a longer loop. The diagram at Fig. 245 shows a cut section of two picks in this pattern and has been prepared



EMBROIDERY LOOM DESIGNED TO WEAVE A RAISED FIGURE OF ANY DESIRED PATTERN

Crompton & Knowles Loom Works

to show the increased holding power of this method of binding. The pick marked P interweaves with the fifth, sixth and seventh threads. In this instance the ground filling would not have to be beaten up so firmly to produce a good cloth.

It is sometimes found difficult to obtain the requisite weight of texture in plushes made with a plain ground weave, or sometimes for

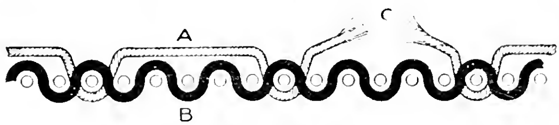


Fig. 242.

other reasons the construction must be changed. At such times the ground may be twill instead of plain and the same plan of distribution followed. However, great care must be exercised in arranging the binding, so as to make it firm.

The diagram at Fig. 245 shows a method of binding into more than one thread upon a plain ground. The same rule will apply to twill grounds, but instead of interweaving with three threads it would be necessary to use four or more as shown in Fig. 246.

In all the examples given there have been three picks of pile to one pick of ground. In order that the impression may not be given

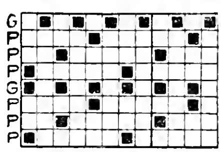


Fig. 243.

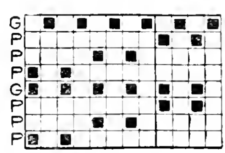


Fig. 244.

that this is the only construction that may be used, Fig. 247 has been prepared with five picks of pile filling to one pick of ground. This of course gives a much denser pile. It will also be noted that in this design every warp thread is used to bind the pile filling, this being necessary where a large number of pile picks are used to give a dense fabric.

Corduroy. In addition to being distributed equally over the face of the cloth, piles are made in stripe or cord form which are termed corduroy when they run in the direction of the warp. The binding differs from that of plushes in that it is confined to a few ends, the object being to present the appearance of ribbed cloth, the rib to stand out very prominently.

Referring to Fig. 248, and comparing it closely with Figs. 243 and 244, it will be readily noted that there is no difference between velvet-

Fig. 245.

eens and corduroys, except in the manner of binding the pile filling; the object in the former being to distribute it as evenly as possible over the entire surface of the cloth, and in the latter to confine it to a

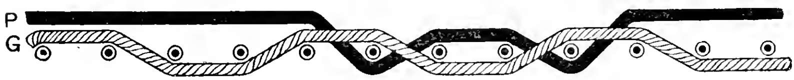


Fig. 246.

few threads that it may run in lines and thus form cords. There are two picks of pile to one of ground and the binding is done by the first, second, sixth and seventh threads.

Another corduroy weave is shown at Fig. 249. In this plan it will be noted that there are eight warp threads, and the four harness cassimere twill is used for the ground. Of these eight threads only two are interwoven with the pile filling, leaving threads one, two, three, four, seven and eight, to form the space between the pile after the filling is cut. The special feature of this pattern is that but one pick of pile is used for one pick of ground. This is due to the fact that the cassimere twill is used for ground, which allows a much larger number of picks to be beaten in than the plain weave would under similar circumstances.

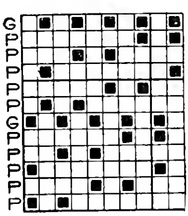


Fig. 247.

Fig. 250 represents still another corduroy weave. The ground weave is a three harness twill, two up, one down, and there are three picks of pile filling to one of ground. The binding is done on the first, second, eighth, and ninth threads.

In all these examples of corduroy weaves, the two loops correspond to two cords in the cloth in each repeat of the pattern. In Fig. 250 the first, third, sixth, ninth, and eleventh picks of pile filling float over seven threads for the first cord, and then over three picks for the second cord, while at picks two, five, etc., the pile filling floats over five threads for each cord. This, in addition to facilitating the binding, gives a rounded cord which is much desired.

There is very little art in making designs for filling plushes and corduroys. The chief objects to be kept in view are, in the former, to produce a firm binding to fasten the pile to the ground and a proper distribution of the binding positions over the surface, while in the latter the binding must be as firm as possible and must be confined to such threads that it will make a prominent cord. However, very frequently figured patterns are made with filling piles by allowing the filling to float on the surface for the space required to form the figure and then binding it into the cloth after the manner of fancy ordinary weaving.

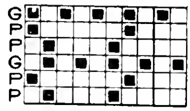


Fig. 248.

Warp Plush. The principles involved in the formation of pile of this description are similar to those in filling pile, yet the treatment and method of constructing the design are different. In the construction of the latter two fillings and one warp are employed, while in the former two warps and one filling are used.

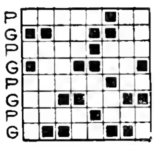


Fig. 249.

The filling pile is woven in the same manner as an ordinary fabric, and when it is to be cut this operation is performed after the cloth leaves the loom. Warp pile is both woven and cut on the loom. Having defined the similarities and differences of these two fabrics, it will be easy to understand how warp pile is made.

Warp pile fabrics are constructed by raising the pile threads and inserting a wire, then lowering the pile threads and interlacing them with the ground weave.

The loops formed by the yarn passing over the wire may be cut to form common velvet, or may be left uncut for Terry cloth. If the velvet effect is desired, the wire over which the warp passes, is equipped at one end with a knife which cuts the pile as it is withdrawn. If Terry is desired, a plain wire is used which, when withdrawn, leaves the loops standing. It will be understood that if velvet is to be produced the loops are cut, while if Terry is desired, the

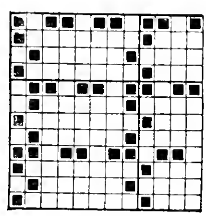


Fig. 250.

loops are left intact. Fig. 251 represents a weave for a Terry fabric.

Fig. 252 shows a velvet weave and that this principle may be thoroughly understood it will be analyzed in conjunction with the cut section shown at Fig. 253. Referring to Fig. 252, it will be noted that there is one pile thread for every two ground threads and a wire for every two ground picks. One-half of the pile warp is lifted over the first wire that is inserted, the other half being lifted over the second wire, and so on. The object of raising one-half of the pile warp at a time is that if all the warp were raised it would cause rows of pile, which would be visible as lines across the cloth. The object of velvet being to produce a perfectly even face, this, of course, would be a defect.

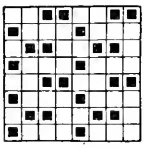


Fig. 251.

As shown in the cut section the pile warp is raised from and returns to the cloth between two ground picks which are in the same shed. It then passes over two picks which are in the same shed (and between which the other half of the pile is raised) and being lowered under the next pick, is again lifted over a wire. This constitutes the principle of weaving warp pile.

When a number of the wires have been woven into the cloth the first one put in is withdrawn (cutting the loops) and inserted again, then the second is withdrawn in the same manner and inserted again. The third follows in like manner and so on, this cycle of movement being continued as long as the loom is operated.

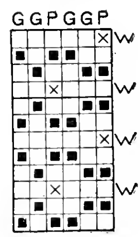


Fig. 252.

In many cases all the pile warp is lifted over one wire as shown in Fig. 254, but as stated above, this to some extent gives the pile the appearance of being in rows which is overcome by raising one-half the pile warp over each wire. The pile must be bound into the ground as firmly as possible. It will be understood that owing to the loops being formed wholly by the pile warp, it takes up much faster than the ground, consequently the pile warp must be woven from a separate beam to which very little tension is applied.

There are other methods of forming pile which are more or less important. One of these is the method of manufacturing Turkish towels, the pile being formed by a cotton warp which is formed into loops on the surface of the cloth. This is done without the assistance of wires by having a special device attached to the reed, which allows the filling to be beaten up to a point some distance from the cloth for several picks and then beating up these picks over the intervening space to the cloth, thus causing the loose pile warp to rise and form a loop. The distance between the binding picks and the cloth, before they are beaten together, determines the length of the loop.

This kind of pile presents a very irregular appearance; the loops

Fig. 253.

do not stand up well, are of various lengths, and intermixed to a great extent. For these reasons this method cannot be used for better grades of goods.

Another form of pile is the one used in the manufacture of Brussels carpets. In this case the pile warp weaves in the ground when not required on the face to form the pattern, the required color being

Fig. 254.

brought to the surface over wires in the order required to form the pattern. If the pile is cut it forms a Wilton carpet, as Wilton bears the same relation to Brussels that velvet bears to Terry cloth.

CHINCHILLA

This cloth derives its name from a small animal native to South America, whose fur it is supposed to imitate. Chinchilla is a very heavy fabric with a long nap on the surface which is rolled into curls in the finishing operation, by the use of what is known as a chinchilla machine. The cloth is used chiefly for heavy cloaks or overcoats being much too heavy for other articles of clothing.

Construction. There are several grades of chinchilla cloth, the construction depending upon the quality desired. The following constructions are in common use: *a,* one warp and one filling; *b,* one warp and two fillings; *c,* two warps and two fillings; *d,* two warps and three fillings; *e,* two warps and four fillings. When more than one warp is used as at *c, d* and *e,* the different threads are designated as face threads and back threads. When four fillings are used as at *e*, the various sets are designated as pile filling, ground filling, stuffing filling and back filling.

The purpose of the pile filling is to form the face of the goods and it gives the long nap necessary for the chinchilla finish. For this reason it is interwoven with the face warp by means of a weave that will give a long filling float on the face of the goods. The pile filling is generally a soft spun thread of fine stock.

The ground filling is to give the fabric the required firmness. It, of course, interlaces with the face warp by means of a much closer weave than is used for the pile filling.

The stuffing filling, sometimes known as the wadding filling, enters the fabric between the face and back warps, not interweaving with either, its purpose being to add weight and bulk to the fabric.

The back filling interlaces with the back warp by means of weaves

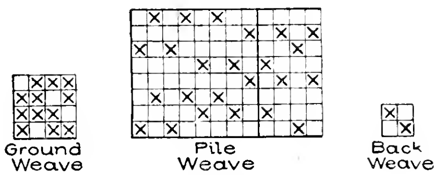


Fig. 255.

which are either even-sided or which present a filling effect on the back.

These facts being understood a chinchilla weave will be constructed, every operation being explained in its turn. As in many other classes of fabrics the principles of double cloth construction are used, being extended or modified as required by the peculiarities of the cloth under consideration. In this instance every step from shading the design paper to binding the cloths together can be easily traced to the double cloth principle, and if looked upon in this light will make the construction of chinchillas very simple indeed.

The three weaves shown at Fig. 255 are to be used in the construction of a chinchilla design. For the purpose of simplifying the explanation they will be termed ground weave, pile weave, and back weave. (Note that the pile weave has long filling floats as explained in the explanation given above.) These weaves are to be used to form a design having two face warp threads to one back warp thread on the one face, one back, one face system. The filling is to be arranged as follows; one pile, one back, and one ground.

Fig. 256 shows the design paper of the area required, with the pile and back picks and the back warp threads shaded. It also shows the pile weave on the face warp threads and pile picks. At Fig. 257 is given the ground weave on the face threads and ground picks.

A little study at this point will reveal a departure from double cloth principles. In double cloth the face weave is placed on the face threads and the face filling is the only yarn that interweaves with this warp (excepting the binding points). In chinchillas the pile filling is an extra set of threads superimposed upon the ground cloth in much the same manner as the extra filling is added to the back of a filling

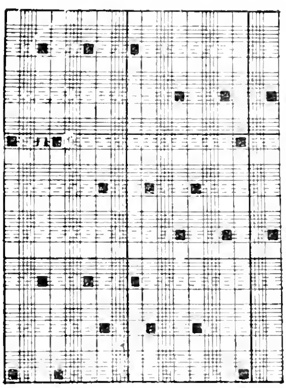


Fig. 256.

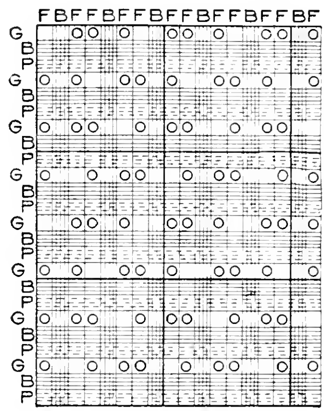


Fig. 257.

backed cloth. For this reason neither the pile nor ground filling is referred to as face filling, for it might cause some confusion, it being much simpler to give them their proper terms. Before proceeding further the relation of the pile and ground picks must be thoroughly understood.

The statement that both weaves are on the same set of warp threads but on different picks explains this fully and Figs. 256 and 257 should be carefully studied until this is firmly fixed in mind.

The design at Fig. 258 shows the back weave placed on the back threads and picks, and Fig. 259 shows Figs. 256, 257 and 258 combined, with the risers added to raise the face warp on the back picks, and the binders to stitch the ground filling to the back warp. The diamond shaped dots represent risers for lifting the face warp over back picks, and the binding places are indicated by the upright crosses. Fig. 260 represents a cut section of the first three picks of Fig. 259 and illustrates very clearly the relative positions of the different sets of threads. It also gives especial prominence to the long filling float of the pile filling. The points marked H show the binding places of the cloth and correspond to the upright crosses on the third pick of Fig. 259.

To explain the use of the stuffing or wadding filling and the method of procedure when the ground filling is omitted another example will be worked out. In this instance a twelve harness double sateen is used for the pile weave, and the back weave is a cassimere

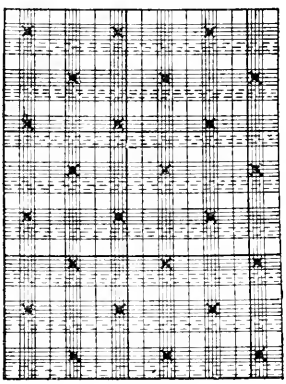


Fig. 258.

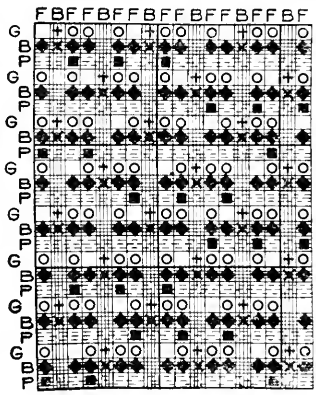


Fig. 259.

twill. The two cloths are to be stitched in twelve harness sateen order. The warp arrangement is one face, one back, and the filling is arranged with one double pick of pile, one stuffing or wadding pick, and one back pick.

It should be stated that in binding chinchilla cloths the same method is pursued as in binding double cloths, that is, by raising a back thread over a ground pick or pile pick, between two risers on the face warp and next to a riser on a back warp. In this particular instance the binding is accomplished by raising a back thread over one of the stuffing picks.

The weaves to be used are shown at Fig. 261, and it should be noted that the pile weave has the long filling floats as in the previous example. The first step is to shade, on the design paper, every even numbered warp thread for back, and to shade the picks for two pile, one stuffing, one back. The pile weave is then placed on the face threads and the back weave is placed on the back threads. Fig. 262 shows the operation up to this point. The letters at the left indicate

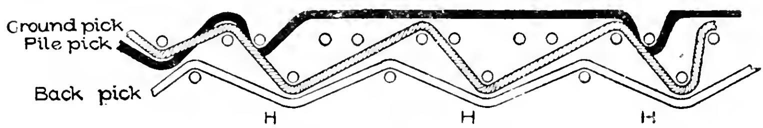


Fig. 260

to which set each pick belongs, P meaning pile; S, stuffing; and B, back.

In completing the design there is one thing that must be done which was not met in the previous example. Reference is made to the stuffing pick which should be put in the cloth when all the face warp is raised and all the back warp is down, as it is not interwoven in any manner with either set of threads. This is accomplished in exactly the same manner as raising all the face warp when a back pick is placed in the back cloth, except that in the latter instance some of the back warp also is raised, while in the former no interlacing is desired, so every thread of the face warp is raised and every thread of the back warp is down.

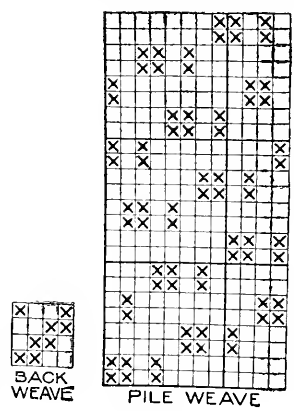


Fig. 261.

The complete design is shown at Fig. 263. The letters at the left of the design are the same as at Fig. 262, being used to designate to which class each pick belongs. The upright crosses, on the first of each pair of stuffing picks, indicate the binding points.

PIQUE

This is a cotton fabric but the principles upon which it is constructed are applicable to Matellasse and other worsted and silk fabrics which require raised patterns. The chief characteristic of this class of cloth is its embossed effect, the pattern being in relief, the stitching forming the outline of the figure.

In all the double cloth fabrics explained heretofore, the necessity of selecting binding points where the stitching would be invisible on the face of the cloth has been impressed very forcibly upon the mind of the student. This is exactly reversed in the present case for the stitching, or at least the effect of the stitching, must be plainly visible upon the face of the fabric to produce the required effect.

The first cloth produced with patterns in relief was probably the old quilts made by stitching two cloths together by hand, the slightly raised parts between the depressions caused by the stitches forming the patterns. The principle is the same to-day, but the two cloths are woven at the same time and stitched as required by interweaving face and back yarns. In many instances the makers of old hand-made quilts spread a layer of cotton batting between the two cloths to increase the weight and bulk of the quilt. The same thing is done to-day by introducing a stuffing or wadding filling, but the object is to produce a more raised pattern.

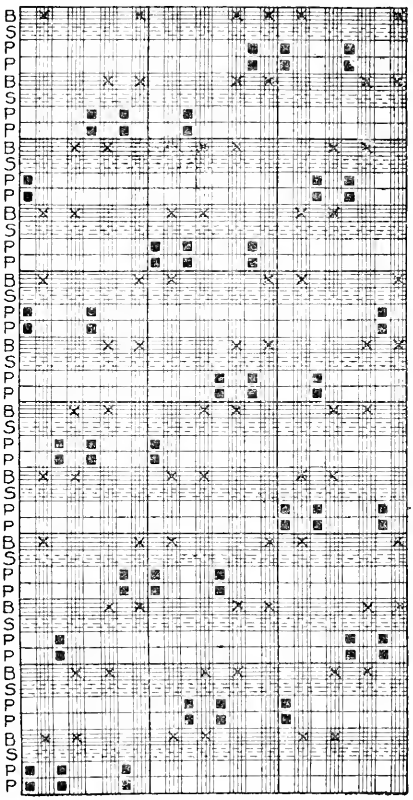


Fig. 262.

Construction. Piqué weaves may be constructed in various ways according to the quality of the cloth, but the common article is woven with face and back warps, and face, back, stuffing, and binder fillings.

The actual operation of making a design is not so formidable as the above would indicate, in fact, most all cloths made with more than one warp and filling are merely variations of double cloth, and if the principles of the latter are thoroughly mastered the former will present few difficulties. The only principle employed in making piqué designs which has not been exploited in the previous articles is the use of a binder pick. The face and back cloths are made in the usual way, and the stuffing filling is employed in the same manner as explained in the lesson on Chinchillas.

The binder pick is interwoven with both warps. It interlaces with the face warp in the same manner as the face picks, but in addition to this, the back warp is raised over it, which has the effect of depressing the face cloth at this point. This depression is further exaggerated by the stuffing pick elevating the ridge or rib line.

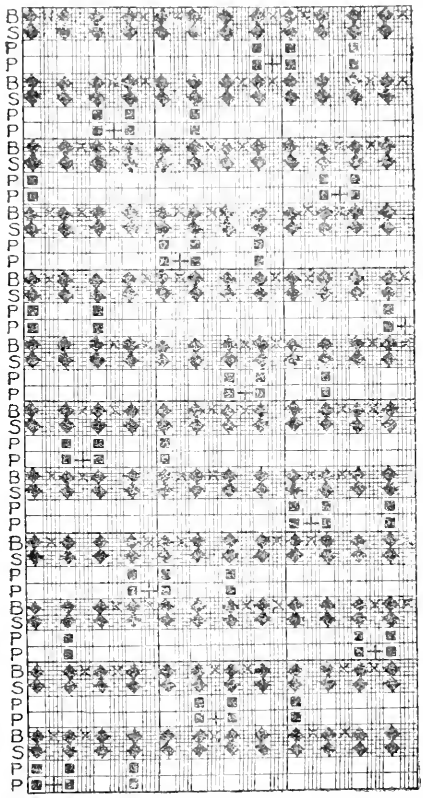


Fig. 263.

The following points should be constantly kept in mind: The face filling always weaves plain with the face warp; the back filling when used, always weaves plain with the back warp; the stuffing filling, when used, enters between the face and back warps; and the binder filling unites the face and back cloths, or the face cloth and back warp according to the construction of the fabric. If a back filling is not used the binder of course unites the back warp with the face cloth.

To illustrate the different classes of piqué three examples will be taken. The first will have face and back warps, face, back, and binder fillings, the warp to be arranged one face, one back, one face, and the filling to be arranged two face, one back, two face, one back, two face, and two binder.

The first step is the one which is common to all cloths containing two or more warps or fillings; *i. e.*, shade that portion of the design paper that indicates the back threads or picks. The next step is to place the plain weave on the face threads and face and binder picks. (The binder picks are always considered face picks when laying out the face weave, the difference being that they are also used as binders.)

Fig. 264 shows the problem worked to this point and gives two

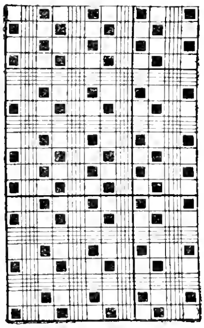


Fig. 264.

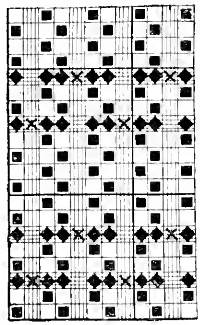


Fig. 265.

repeats each way. The back weave is now put on the back threads and the face warp lifted over the back picks. This is shown at Fig. 265.

Up to this point there has been no deviation from the method of constructing a double plain design excepting that the back cloth is of very loose texture. It is very evident that something must be added or taken away to produce a piqué effect of what is now a double plain design. In this instance something must be added to make the depression or recess which is characteristic of these cloths. The back warp is raised over the two binder picks as indicated by the upright crosses in the complete design at Fig. 266, and as these picks interweave with the face warp in the plain weave order the face cloth is slightly depressed at this point.

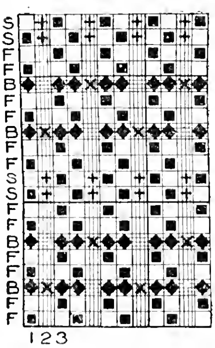


Fig. 266.

The letters at the left of the design show to which class each pick belongs. Those marked F are face picks; B, are back picks; and S, are binder picks. The diagram at Fig. 267 shows a cut section of the first three threads for two repeats of the weave or for the extent of Fig. 266. The end sections of the two binder picks are shown at S. It will be noted that the back thread, 2, passes over these picks while the face threads, 1 and 3, each pass under one of them, which gives the necessary depression.

The second example will be very similar to the one just explained, but in this case the ridges, caused by the portion of the face weave that is not bound, must be more rounded and more prominent. To produce this result the following arrangement will be used: Warp—

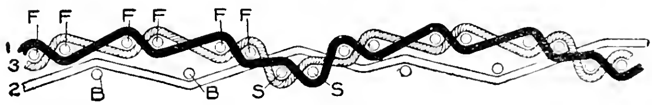


Fig. 267.

one face, one back, one face. Filling—two face, one back, two face, one back, one face, one stuffing or wadding, one face, one back, two face, one back, four face. It will be unnecessary to work out plans showing the various steps in the construction of this design as it is similar to Fig. 266 in every detail excepting the stuffing pick. The complete design is shown at Fig. 268. Note that the only risers on the stuffing pick are to raise the face warp, for this pick lies between the face and back cloths. The system of binding is the same as in the previous example.

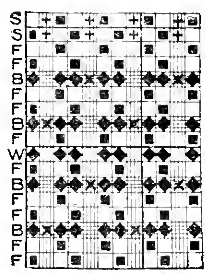


Fig. 268.

It must not be supposed that more than one stuffing pick could not have been put into the design, for one or two more might easily have been included at such places as between the fourth and fifth, and the eleventh and twelfth picks.

The letters at the left of Fig. 268 show to which set each pick belongs, F meaning face, B meaning back, W meaning wadding or stuffing, and S meaning binder.

In manufacturing the cheaper grades of this cloth it is customary to omit the back picks, allowing the back warp to float on the back of the cloth between the binding points. In designs of this class, one or more stuffing picks are generally used. Fig. 269 shows the design paper shaded for a fabric of this construction with the plain weave on the face threads, and face and binder picks. The arrangement is one face, one back, one face, in the warp; and two face, one wadding, two face, one wadding, two face, two binder, in the filling. The shaded picks in this design are the wadding picks. These are marked W. The face picks are marked F, and the binding picks are marked B.

The complete design is shown at Fig. 270. It will be noted that the face warp is raised on the stuffing pick in the usual manner and

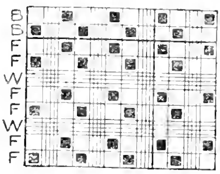


Fig. 269.

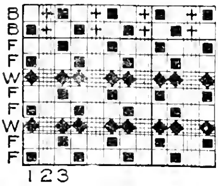


Fig. 270.

that the binding is accomplished by raising the back threads over the binding picks and interweaving the face warp with them in the plain weave order.

When weaving this grade of piqué it is a good policy to have a large amount of tension on the back warp and to use very coarse yarn for the stuffing pick, otherwise the face cloth will not be deflected and the pattern will not be very pronounced. The diagram shown at Fig. 271 represents a cut section of a fabric woven with this design and shows the long float of the back warp.

Figured Pique. The effect of a figured piqué relies chiefly for its value upon the system of binding, all other features being secondary

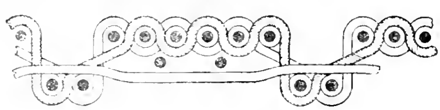


Fig. 271.

to this. In constructing a figured piqué design the principles of double cloth construction are followed very closely, less the use of the stuffing or wadding picks and the method of binding being the only differences. Wadding filling is not indispensible, but as previously explained it makes a more raised pattern.

The first step in making these designs is a departure from the primary operations of other cloths. In this case it is necessary to make a motive which determines the extent of the design. This motive is nothing more than a system of binding. For instance, if one of these designs were bound in twill order or with twelve harness sateen, the twill or sateen would be termed the motive. It should be kept in mind that the motive shows the plan of binding and as the binding forms the outline of the figures, the motive represents the effect.

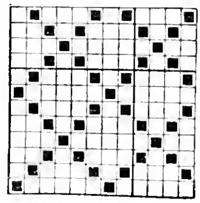


Fig. 272.

For example suppose a cloth is desired with small squares running diagonally across the cloth. The first step is to make a motive that will give this effect. Fig. 272 is the result. Having obtained the motive, it is now necessary to make the design. As each binding point spreads over three picks, the design must cover three times the area covered by the motive or 36 x 36 squares. If stuffing or wadding picks were used in the design the extent in the filling direction would of course

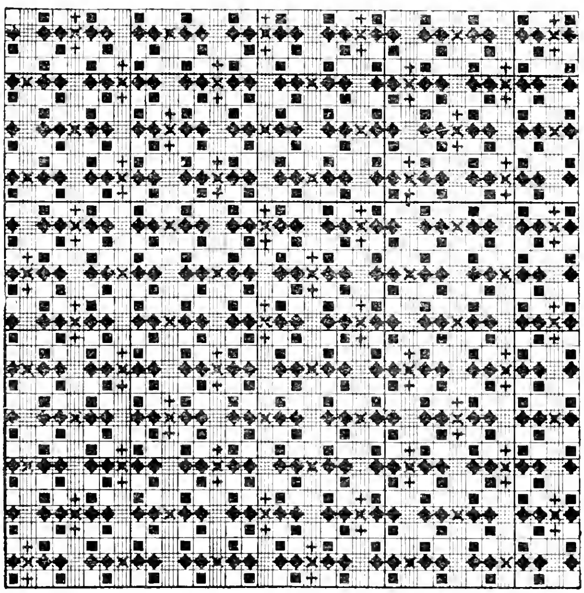


Fig. 273.

be a trifle larger, or to be exact, as much larger as the number of wadding picks. The design paper is shaded in the regular manner for one face, one back, one face, in both warp and filling and the plain weave put on both systems of threads. The risers are now put in to lift the face warp on back picks.

All that has been done so far would be done in the same manner on several other kinds of cloth, but the next step is peculiar to this class of fabrics. Reference is met to the binding from a motive. The rule which applies in this case is as follows: Raise a back warp thread over a face pick on each side of the backing pick and next to a riser on the back warp.

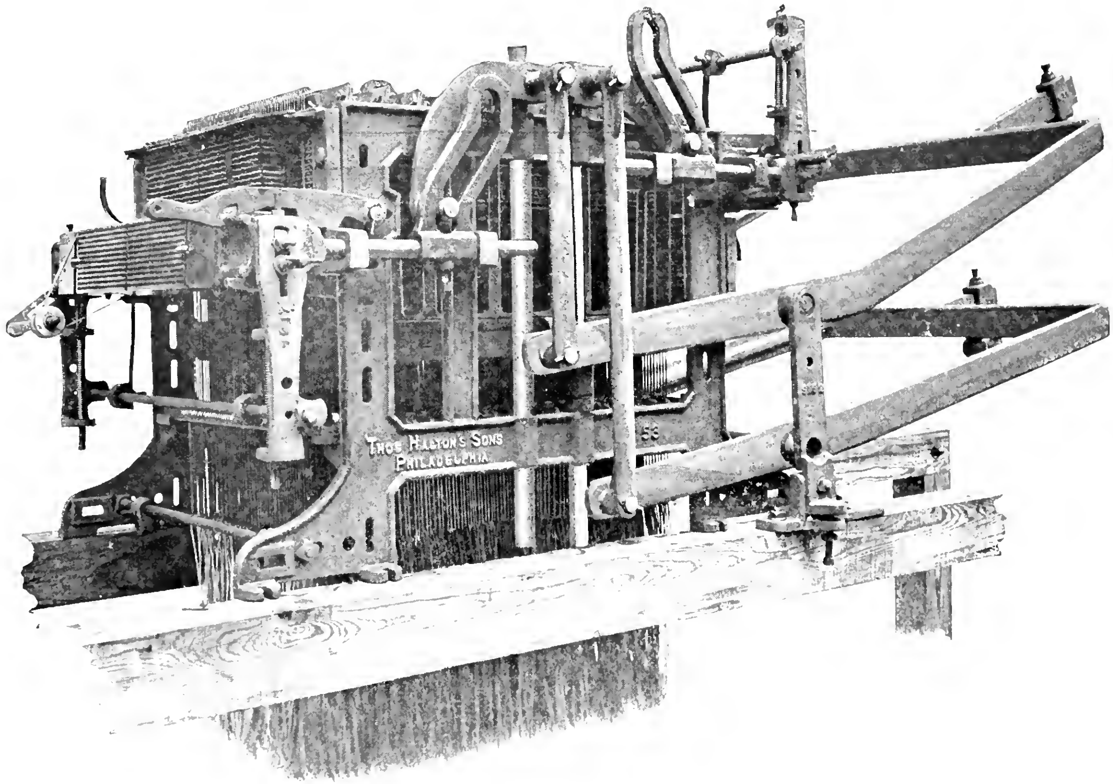
The upright crosses in Fig. 273 show this rule put into effect. In this example a wadding pick is not used but one could be inserted between any of the two face picks, and the same principles would apply as in making plain piqué.

JACQUARD DESIGNING

In all the classes of designing explained up to this point it has been necessary to limit the designs to those that could be woven on the ordinary shedding or harness motion. In almost every instance, they repeat on from two to twenty-four or thirty threads, and when they exceed this number a drawing-in draft can be arranged to weave them on a practical number of harnesses. Jacquard designing includes those designs which are too large to be woven on the ordinary harness motion.

Before attempting to make jacquard designs, it is necessary to form a clear idea of the principles on which the jacquard machine operates. Figure 274 represents a section of a jacquard machine, showing the mechanism for lifting the warp threads. To each of the upright hooks A is attached a neck cord, which takes the place of the harness in an ordinary loom, and from each neck cord are suspended the harness cords through which the warp threads are drawn. A weight is attached to the bottom of the harness cord for the purpose of bringing the harness cord, and thus the neck cord and hook A, to its original position after being lifted.

The position of the hooks (whether raised or lowered) on each pick is determined by the action of the cards upon the needles or wires B. As this is the fundamental principle of jacquard weaving, it should be thoroughly mastered. To make this principle clear, Figs. 275 and 276 have been prepared. Fig. 275 shows a card



DOUBLE LIFT DOUBLE CYLINDER JACQUARD MACHINE

Thomas Halton's Sons

on which one pick of the design is cut, just as one pick of an ordinary design is placed on one bar of the harness chain. This card passes over the cylinder, shown in Fig. 276, in much the same manner as a bar in the ordinary harness chain passes over the chain barrel.

The cylinder has a reciprocating movement, coming in con-

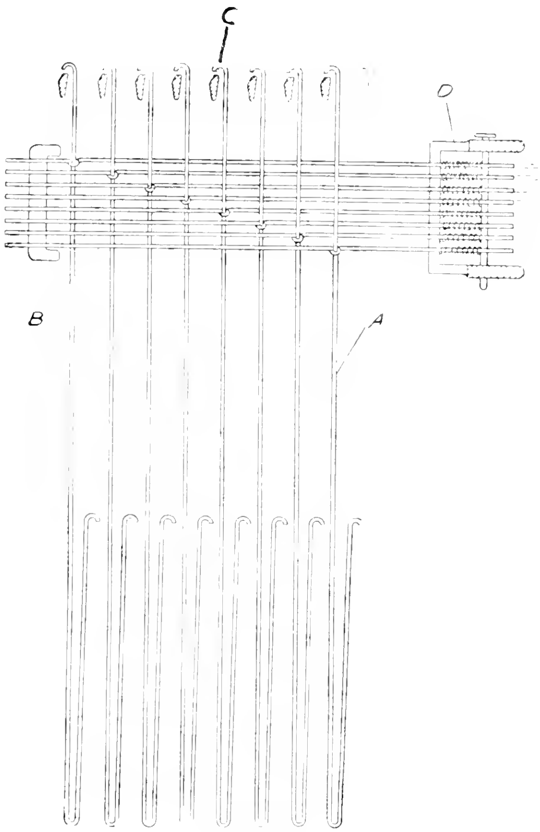


Fig. 274.

tact with the ends of the needles B; the ends of the needles entering the holes in the cylinder. Now, if a blank card is placed on the cylinder, the holes will be covered and all the needles will be pressed back, carrying their upright hooks out of the path of the griffe C, as shown by the dotted line in Fig. 274. The griffe consists of a number of iron bars which have a vertical reciprocating movement and are the direct means of forming the shed.

If a card on which the pattern has been cut, such as the one shown at Fig. 275, is placed on the cylinder, those needles which correspond with the holes in the card, will not be pressed back, and the griffe in its upward movement will lift the upright hooks.

The springs D force the needles and hooks back to their original position after the pressure of the cylinder is removed.

The above are the principles of jacquard machines. A hole in the card always represents a *riser*, as its corresponding hook will be raised and, through the connections, will raise the warp thread. The usual practice in tying up the harnesses is to take

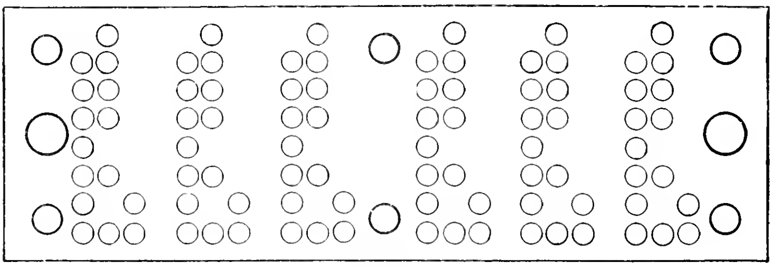


Fig. 275.

the first hook in the row nearest the cylinder head and count that the first hook in the machine. The other hooks in the same row will be counted as the second, third, fourth, fifth, sixth, seventh, and eighth hooks. The next row follows on consecutively; the first hook being counted the ninth. This is continued until the full extent of the machine is reached.

This arrangement of the machine necessitates, for the convenience of the card cutter, as well as for the designer, a special arrangement of the design paper. Each small square of the design paper represents one of the upright hooks (A in Fig. 274) and consequently the warp threads which are actuated by that hook. These small squares are divided by a heavier line, according to the number of hooks in one row of the machine. Thus, the number of small squares contained in each large square represents the number of hooks in each row.

A thorough understanding of the above is very essential to ensure a knowledge in the use of the design paper. As an example, take a machine that has eight hooks in a row (and so is necessarily tied up in rows of eight) and design paper which has eight small squares in each direction between the large squares; in other words 8 x 8 paper. Beginning at the left, the first small square represents the first hook, the next square represents the second hook, and so on to the extent of the eight hooks which form the first row of the cylinder and the first eight squares of the design paper. A heavy line follows the eighth small square, and is in turn followed by eight more small squares in a horizontal line; these represent the second row of hooks in the machine. The small squares between the third and fourth heavy lines represent the third row of needles, and so on till the full extent of the

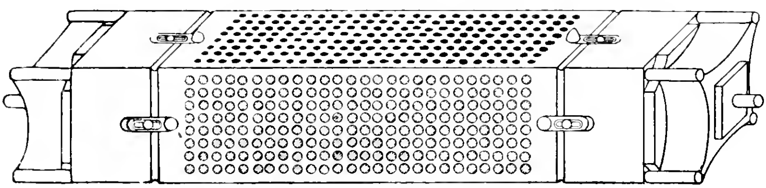


Fig. 276.

machine is reached.

It will be understood that each division of the horizontal lines and small squares represents one row of upright hooks in the jacquard machine, and the number of small squares between the heavy dividing lines correspond with the number of upright hooks in each row. This arrangement is for the benefit of the card cutter, each division representing a row of holes on the card and the keys in the cutting machine. To make this clearer, an explanation of card cutting is given.

Card Cutting. In designing jacquard designs, the same condition is necessary which is common to all branches of textile designing, *i. e.*, the design must join correctly on all four sides, so that, when repeated, the pattern will be continuous and perfect. But in this instance, there is one essential condition which is not necessary in designing for harness looms. That is, the pattern must be repeated a sufficient number of times to begin and end with full squares. This is primarily for the convenience of the card cutter.

In Fig. 277 is shown a design which occupies one full square and six extra threads. It will be inconvenient and very impracticable to work from this.

It has been explained that the reason for dividing the paper by means of heavy lines, is to make each division of squares correspond with a row of hooks in the jacquard machine, and the holes in the cylinder, therefore, it is apparent that when working on a machine that has eight hooks in a row, the card cutter, after cutting the first row in Fig. 277, would read for the second row and find only six threads, or two less than the number required. This would necessitate taking two threads from the beginning of the design to complete the second row, consequently, there would be four threads short on completing the fourth row; and so on. This would result in a great deal of confusion and perhaps a large number of mistakes. To obviate this difficulty, the design is carried out until it repeats on even sets of eight threads, as shown at Fig. 278.

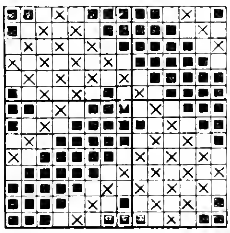


Fig. 277.

The rule for determining the number of squares on which a design will repeat evenly is as follows: Find the least common mul-

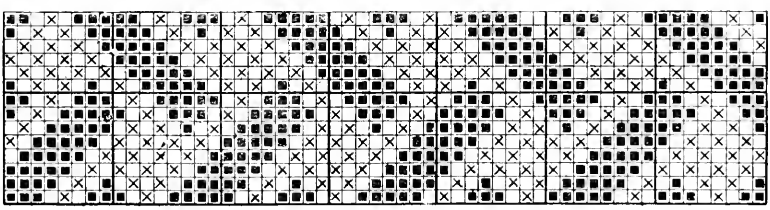


Fig. 278.

tiple of the number of threads occupied by the design and the number of hooks in each row on the cylinder; (or the number of squares in each division of the design paper.)

It is not necessary to carry out the design in the direction of the filling until it repeats on even squares, and in the case under discussion, there would be only fourteen cards required, as there are but fourteen picks in one repeat of the design.

Another example of this nature is shown at Fig. 279. One repeat of the design occupies eighteen threads and eighteen picks. This, of course, must be extended until it repeats on even squares of 8 x 8 paper, as the machine on which it is to be woven has eight hooks in a row. The completed design, as shown at Fig. 280, occupies seventy-two threads, this number being the least common multiple of eight and eighteen.

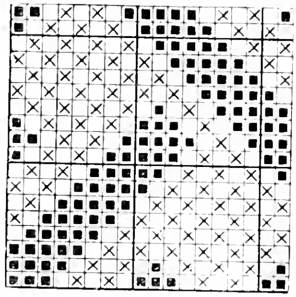


Fig. 279.

Another point in connection with design paper that should be thoroughly mastered is the proportion the number of squares in one direction bears to the number of squares in the other direction, and its influence upon the fabric. If the design is made upon paper which is ruled square, that is, 8 x 8, or 12 x 12, the cloth should have the same proportion of warp and filling. But suppose that it is necessary to change the construction of the cloth so that the filling is reduced in the proportion of eight warp threads to six filling threads, and the design for this construction is placed on 8 x 8 paper. It would, of course,

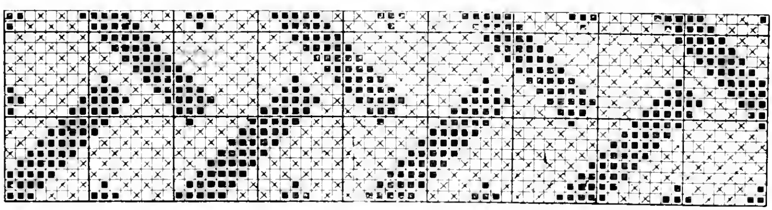


Fig. 280.

be out of proportion, the figure being elongated by the reduction in the number of picks per inch.

If the original design on 8 x 8 paper occupied eighty threads in each direction, and the cloth contained that number of threads and picks per inch, the design would be one inch square; but if the same cloth were constructed with eighty threads and sixty picks per inch, the design would be one inch wide and $1\frac{1}{3}$ inches long. To overcome this difficulty, the design must be drawn disproportionately, or the design paper must be ruled similar to the construction of the cloth. The latter alternative is the better.

In the instance mentioned above, where eighty warp threads and sixty picks are used per inch, the heavy lines would be ruled square, but instead of eight small squares being ruled in each direction, there would be eight squares in a horizontal direction and six squares arranged vertically. This is shown at Fig. 281.

It is sometimes necessary to construct a cloth with a larger number of picks than warp threads. In this instance, it will be necessary to have more squares in the direction of the filling, or vertically. If the proportion is ten to eight, or one hundred picks to eighty warp threads, the design paper would be ruled as shown at Fig. 282.

EXAMPLES FOR PRACTICE

1. Continue Fig. 283 on 8 x 8 design paper until it repeats on even squares.
2. Determine a method of calculating the number of squares on which a design would be complete.
3. What design paper would you use for a cloth constructed with seventy-two threads per inch and fifty-four picks per inch, if the design were to be woven on a jacquard machine which has eight hooks in a row?
4. What design paper would you use if the above cloth were woven on a jacquard machine which had twelve hooks in a row?
5. When it is decided to raise a thread on a specified pick, how is this brought about?

Casting Out. Casting out means omitting some of the hooks and harness cords from the calculations, when arranging a pattern to be woven on the jacquard machine. The hooks are not actually cast out of the machine, and in fact, the harness cords hang from these hooks the same as if they were in use, but no warp is drawn through them.

To make this condition clear, assume that a loom is weaving a pattern on eighteen harnesses, and it is desired to weave a pattern on sixteen harnesses. Ordinarily the two extra harnesses would be removed. But suppose these two harnesses are fixtures in the loom and cannot be removed. The only thing that can be done in such a case is to withdraw the warp from the heddles, allowing the harnesses to hang idle in the loom. The foregoing is exactly parallel to the condition found in the jacquard machine when some of the hooks are not used, or "*cast out.*"

As previously explained, the hooks in the jacquard machine represent a number of harnesses or their equivalent, and from the nature of the machine the hooks which are not required cannot be removed. However, the presence of hooks and harness cords does

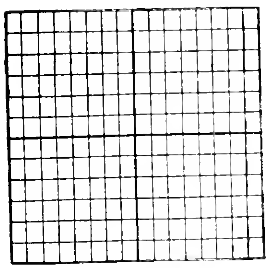


Fig. 281.

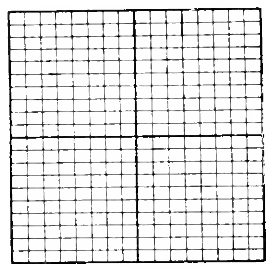


Fig. 282.

not make it necessary to use them, any more than the presence of the two extra harnesses in the ordinary loom makes it necessary to draw in the warp on them. In both cases the extra hooks or the extra harnesses are treated as having no existence.

The necessity for casting out, or leaving a portion of the machine idle, may be brought about by two causes. If the number of threads occupied by the pattern is one which will not divide into the number of hooks which the machine contains, without a remainder, a number of hooks as large as the remainder must be cast out or left idle.

What is known as the "*three hundred*" jacquard machine contains three hundred four hooks, or thirty-eight rows with eight hooks in each row. The "*four hundred*" jacquard machine contains four hundred eight hooks. The "*six hundred*" jacquard machine contains six hundred eight, or six hundred twelve hooks, according to whether there are eight or twelve hooks in each row. In the former there are seventy-six rows and in the latter fifty-one rows, which make this machine equal to two "three hundred" jacquards.

When one of these machines is tied up to its full capacity (that is, every hook having neck and harness cords attached) and the pattern designed to be woven occupies twenty threads, some of the hooks would have to be cast out, as twenty will not divide evenly into the total number of hooks. If the machine contained three hundred four hooks, there would be four hooks cast out, as three hundred four divided by twenty equals fifteen with four remaining. ($304 \div 20 = 15\frac{4}{20}$.) If the four hundred eight machine were used, eight hooks would be cast out; and so on.

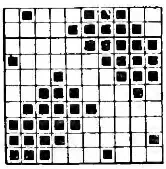


Fig. 283.

In many cases, however, the number to be cast out would not be so small as four or eight hooks. The pattern may occupy eighteen threads and have to be woven on a machine that has three hundred four hooks In this instance, it would be necessary to cast out sixteen hooks. If these hooks were not cast out an imperfect pattern would be formed at every division of the harness; or at every three hundred four threads. If the eighteen thread pattern had to be woven on a four hundred machine, there would be twelve threads left over. It will be understood that only complete patterns, or as many hooks as will work a number of complete patterns, must be employed.

There is another object in casting out, in addition to adapting a machine to weave complete repeats of a design. When a jacquard machine is tied up; *i. e.*, when the harness cords are arranged in the machine; it is arranged for a certain number of threads per inch. When all the hooks are employed the number of threads cannot be increased, but it may be reduced by having some of the hooks remain idle. To make this clear, assume that a loom is working with four ordinary harnesses on each of which there are fifteen heddles per inch, or a total of sixty heddles per inch for the four harnesses. If only fifty-two threads per inch were required, two heddles per inch on each harness would be taken off. If it were impossible to remove the extra heddles, the same result could be obtained by not drawing the warp threads through them. The latter method is the one adopted on the jacquard machines. The cords hang idle in the loom, no warp thread being drawn through them, consequently the "*sett*" or number of threads per inch is reduced.

The whole matter may be readily summarized as follows: If the full number of hooks contained in the machine are not employed, the number of threads per inch is reduced, but there is a consequent limitation of the pattern producing power, in extent, of the machine.

Casting out is resorted to for two purposes: *first*, when the number of threads occupied by the pattern cannot be divided evenly

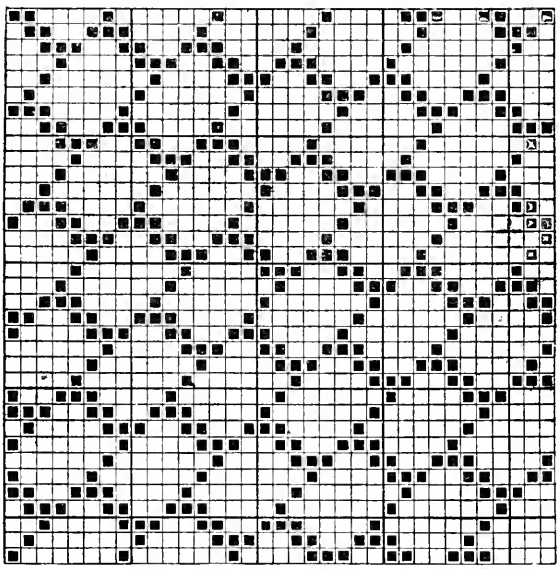


Fig. 284.

into the machine, and, *second*, when it is desired to reduce the sett or number of threads per inch carried by the harnesses. The first has the disadvantage of reducing the sett when this may not be necessary nor advisable. The second has the disadvantage of reducing the pattern producing power of the machine. However, these difficulties are part of jacquard designing and must be overcome, as it is impracticable to tie up the machine every time a new pattern is made.

To calculate the effect of casting out and thus enable the designer to obtain correct conclusions as to the sett and number of hooks available for the production of patterns, it is necessary to find a rule which will give the exact number of threads per inch, and the number of hooks that may be used. The question is one of simple proportion, for when there must be casting out to suit the pattern, the threads per inch are reduced in direct ratio.

For an example, suppose a machine contains three hundred four hooks, and is tied up for sixty threads per inch, sixteen of the hooks being idle. Three hundred four minus sixteen equals

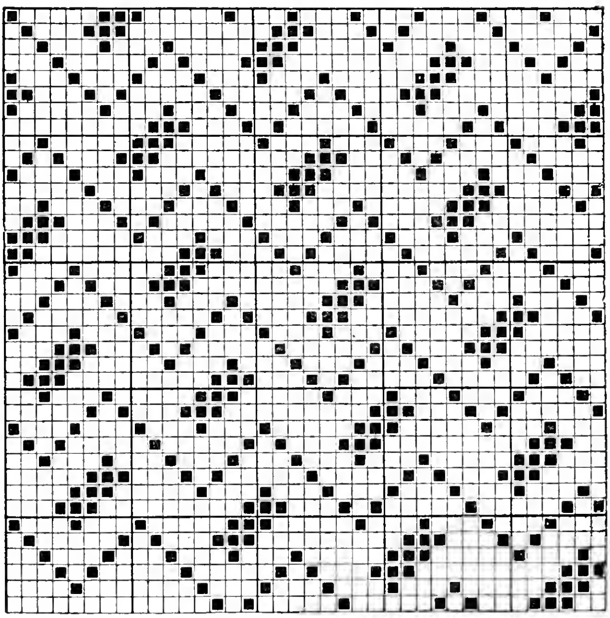


Fig. 285.

two hundred eighty-eight. ($304 - 16 = 288$.) This means that there are two hundred eighty-eight harness cords, of the three hundred four, available for actual work, and if the full number gives sixty threads per inch, the required number must give less, in the proportion of three hundred four to two hundred eighty eight: or $304 : 288 :: 60 : 56 \frac{84}{100}$. Consequently the only cloth that could be woven would be one with approximately fifty-seven threads per inch.

This of course would not be a serious matter, if the drawing amounted in the aggregate to a portion of an inch or any other small amount, but if multiplied, as it would be in most cases, it would become quite serious and for this reason the designer must pay careful attention to this question.

To emphasize the results of casting out and the methods and calculations involved, we will take Fig. 284 and find how many

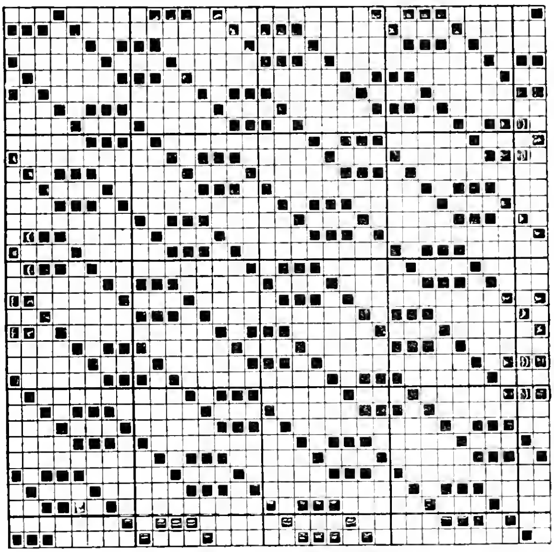


Fig. 286.

hooks must be cast out to weave it on the different machines, and the result upon the number of threads per inch which may be woven in the cloth.

The design shown at Fig. 284 repeats on thirty-five threads, so to weave this on a machine containing three hundred four hooks, it will be necessary to cast out twenty-four hooks; ($304 \div 35 = 8$ and 24 remainder).

If the machine were tied up for eighty threads per inch, a smaller number of threads must be used on account of some of the hooks, and consequently the harness cords, being cast out. The number of threads per inch which could be used bears the same proportion to the number for which the machine was tied up, as the number of hooks in use bears to the total number of hooks in the machine. Substituting the numbers and letting X mean the required number, the calculation would be as follows: 304 : 280 :: 80 : X. It will be found that X equals approximately $73\frac{2}{3}$ threads, which means that that number of threads could be used in each inch of cloth.

If a machine with four hundred and eight hooks were used, it would be necessary to cast out twenty-three hooks (408 ÷ 35 = 11 and 23 remainder). If this machine also were tied up for eighty threads per inch, it would be possible to have between seventy-five and seventy-six threads per inch in the cloth (408 : 385 :: 80 : $75\frac{1}{2}$).

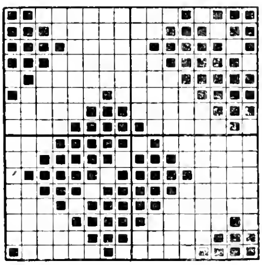


Fig. 287.

Distribution of Pattern. Having dealt with problems of adapting the machine to the pattern, both in extent and texture, it is necessary to deal with the arrangement and distribution of patterns and their arrangement upon the design paper.

In preparing the design upon the design paper, the first consideration must be as to how the figure is to be formed. In the explanations of various kinds of designs previously given, it is explained that there are many ways of changing the order of interweaving the warp and filling threads, which will produce a variety of figures upon the fabric; also that in many cases this production of figures necessitates a change in the structure of the ground cloth.

The design shown at Fig. 287 is an illustration of a simple style of figure prepared for jacquard work. This design could be woven on a dobby loom or head motion, as only sixteen harnesses are required, but it will answer the purpose of illustrating a simple explanation of the subject.

There are two important points to be considered in dealing with a design of this kind: *first*, the nature of the ground fabric; and *second*, the arrangement and disposition of the figures, and the determination of the areas they may occupy.

It will be best first to consider the influence of the ground weave and its probable interference with the figure. It should be understood that the figure is formed by either the filling floating loosely over the warp, or *vice versa*. In the illustration shown at Fig. 287, the blank squares represent the area occupied by the ground weave and the squares which are blocked in represent the figure.

It is apparent that if the filling floats under the squares which are blocked in, and over the blank spaces, as is usually the case in twilled fabrics, the cloth will be very loose in texture, unless very bulky yarn is employed or a large number of threads per inch in each direction are used. Even these would not always meet the requirements of the case, for a light cloth could not be made under these conditions; and furthermore, the figure would not have that

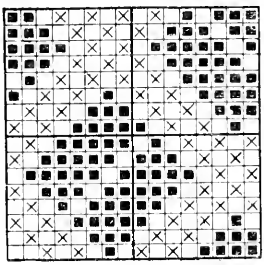


Fig. 288.

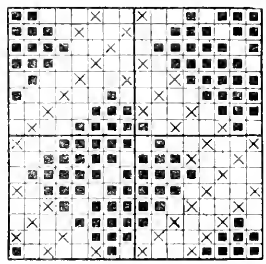


Fig. 289.

degree of prominence which is so desirable. Therefore, there should be a ground weave, and this must be varied according to the character or weave of the cloth to be produced.

For the purpose of making this matter clearer refer to Figs. 288 and 289. In Fig. 288 the ground weave is plain, as indicated by the crosses, and it works around the figure in such a manner as not to interfere with it, but rather to give it additional prominence. Of course, the blocked-in squares and the crosses, in the illustration, both represent risers and are merely varied in form to show clearly which is the true figure and which is the ground. It is perfectly clear that the ground or plain weave never comes in contact with the figure, but works around it without interference, so that the outlines of the figure will be clearly defined and the pattern will be perfect.

To appreciate the significance of the above remarks, refer to Fig. 289. In this design the ground is shown to be a three harness twill, and it will be seen at once that the figure interferes with the clear formation of the main figure, so there could not possibly be that sharp, definite form as at Fig. 288. If this pattern were made with a four harness cassimere twill for ground, the result would be even more disastrous to the prominence which should be given the figure.

From the above it will be understood that the designer must pay particular attention to the ground weave; also that if the design is one which is loose in the order of interweaving, there should be more material, or the cloth should be finer. In all cases, the ground weave must be arranged around the figure in the best possible manner considering the size of the figure and the form required.

EXAMPLES FOR PRACTICE

1. State generally the reasons why casting out in jacquards is resorted to and its effect upon the structure of cloth which may be woven.

2. Determine on which machine Fig. 285 could be woven by casting out the smallest number of hooks. Assume that the machine was tied up for ninety threads per inch and find the number of threads which could be used per inch.

3. Find how many hooks would have to be cast out of a "four hundred" machine to weave the pattern shown at Fig. 286, and the number of threads which could be woven per inch if the machine were tied up for sixty threads per inch.

4. Work out a design similar to that given at Fig. 287, using a plain weave for the ground.

5. Make an original design in which a twill may be used for the ground without interfering, to any extent, with the figure.

Areas. Special attention should now be given to the distribution of the main figures and the areas occupied by them. The design shown at Fig. 287 represents two parallelograms placed side by side in such a position that they form a square. These are placed at right angles to each other in such a manner that they form diagonal lines in both directions. (These lines would be much more pronounced if the design were repeated several times.)

For many purposes, and more especially for this form of figure, this arrangement is an admirable one, but for other purposes and other figures this arrangement is not at all suitable. Moreover, the number of threads occupied by the complete design may not be suitable for the number of hooks in a jacquard machine, or for the number of hooks being used. For example suppose that the design shown at Fig. 288 was to be worked with three hundred hooks instead of with three hundred four hooks, which would be the case if the ground were a three harness twill as shown at Fig. 289. The figure, occupying sixteen threads, is not a factor of three hundred; that is, it cannot be divided into three hundred without leaving a remainder, therefore some change would have to be made. If the ground weave was a five harness sateen, the same rule would apply.

There is still another difficulty to be overcome; the design occupies sixteen threads in each direction and the twill ground weave repeats on three threads, which is not a factor of sixteen. Therefore the design shown at Fig. 289 cannot be repeated on less than forty-eight threads. This creates another difficulty, as forty-eight will not divide evenly into three hundred.

Having conjured up all the difficulties possible, we shall endeavor to explain how easily they may be overcome. It will be understood that some change must be made, but ordinarily all these difficulties could be met by a slight alteration in the cast out. In this instance, however, it will be assumed that the change in the distribution of the figures is for the purpose of changing their positions in relation to each other.

The first matter to be taken up is the order of distribution, and the next is the space to be allotted. The latter will be dependent upon the character of the cloth, and the former upon the position in which it is desired to place the figures in relation to each other. The form of the figures will in many cases affect their relative positions. The most useful methods of distribution and those most commonly resorted to are based upon sateen orders.

To make the foregoing clear, all other considerations should be set aside and several methods of distributing the same figure should be worked so as to ascertain the effects produced, and to determine the methods of procedure. In all probability the altered arrangement would require that the same area should be allowed to each figure; that is, there should be the same space surrounding each figure as there is in the original. Taking this as a basis, the number of threads upon which to work must be ascertained.

In the design shown at Fig. 287 there are two figures occupying sixteen threads and sixteen picks. Sixteen times sixteen equals two hundred fifty-six ($16 \times 16 = 256$), therefore the two figures occupy two hundred fifty-six small squares, which gives an area of one hundred twenty-eight small squares to each figure. Assume

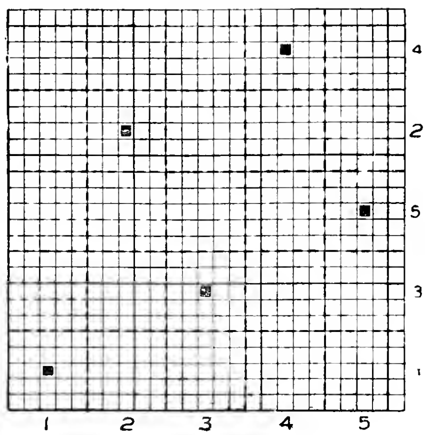


Fig. 290.

now that five figures are to be distributed in sateen order. Then, five times one hundred twenty-eight equals six hundred forty ($5 \times 128 = 640$), or six hundred forty squares will be required for five figures similar to those shown at Fig 287. As the original is on a square space, the new distribution will be arranged in a square, so to find the number of threads and picks the design will occupy, the square root of 640 should be extracted. This being 25, a space upon the design paper of twenty-five squares in each direction is marked off.

This is the area required for five figures similar to those given at Fig. 287 to be arranged in five harness sateen order. Before placing the figures upon this space, it must be divided into five parts in each direction, and when so divided the divisions on one side should be numbered in sateen order and the divisions on the bottom numbered in consecutive order. Then suppose each of these divisions to have lines enclosing a square at the intersection corresponding to the numbers. The process worked up to this point is shown at Fig. 290.

From this point the most convenient method of procedure is to find the center of the figure or some point as near the center as possible. A mark should now be placed at any point within the enclosed square and used to represent the center of the intended figure, (shown at Fig. 290). Care should be used that whatever

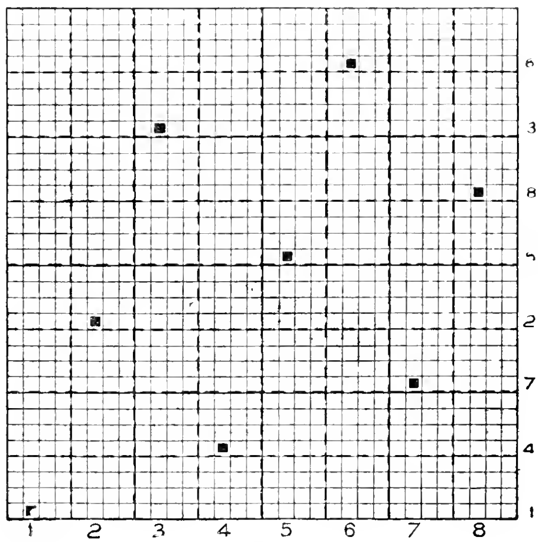


Fig. 291.

position is used for the first figure a corresponding position must be selected for each of the others. The figures are now formed around this mark.

The example shown in Fig. 290 serves as a simple illustration of the methods employed in determining the area, but it would be rather difficult as a first example of the methods employed in arranging the order of figures. For this reason, we will use the same figure as in the previous example and distribute eight figures in eight harness sateen order.

Referring back to the previous example, it is found that one figure occupies one hundred twenty-eight squares, so eight figures will occupy 8 × 128 or 1024 squares. The square root of 1024

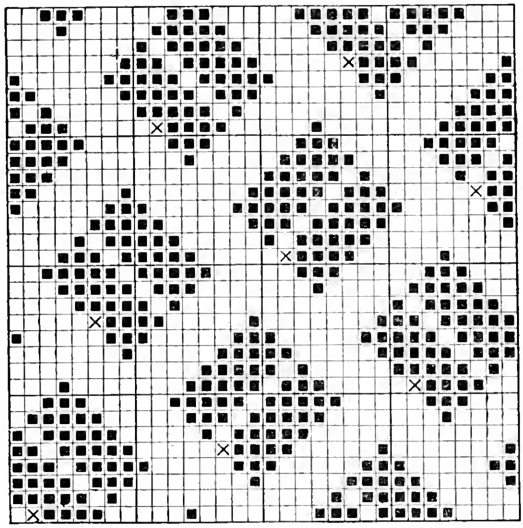


Fig. 292.

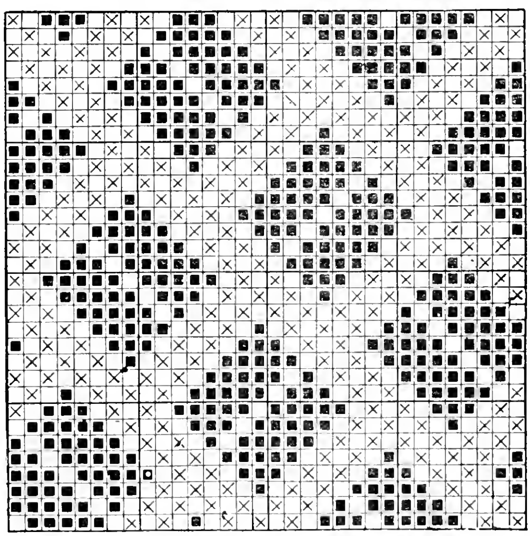


Fig. 293.

is 32, so that the area will be 32 × 32 squares. Marking off this area and dividing it into eight spaces (as there are eight figures), and numbering these divisions in consecutive and sateen order we have Fig. 291. The points around which each figure must be filled in are also shown in Fig. 291.

Fig. 292 shows the figures filled in with relation to the starting points; and in Fig. 293 the design is shown completed with the plain weave added for the ground weave.

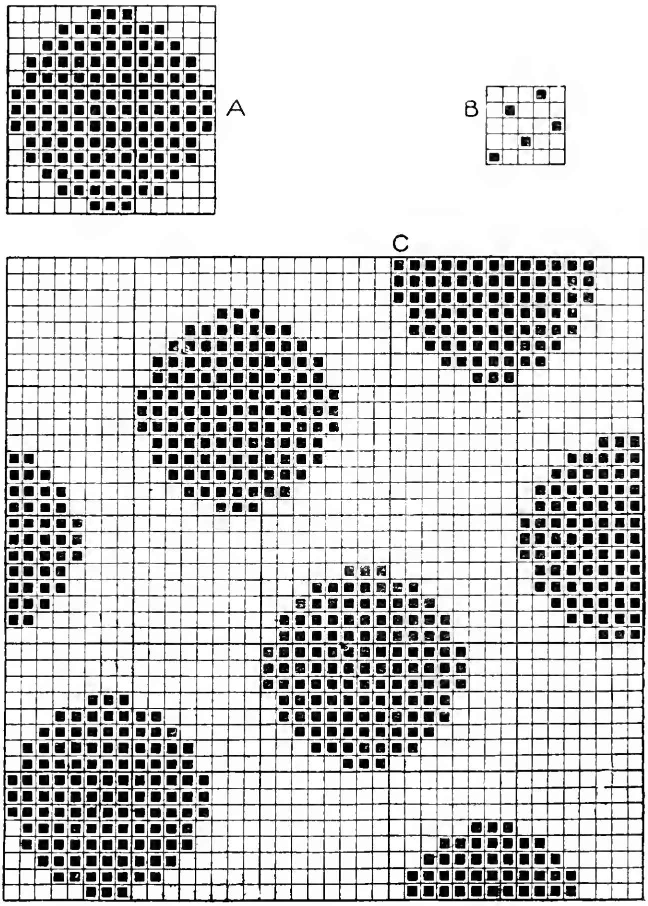


Fig. 294.

Fig. 294 shows another design with the spots arranged in very good order. A, is the spot which must be developed in five end sateen order (shown at B) on 40 × 40 squares. Following the methods outlined above the design is worked out as shown at C.

A number of ground weaves might be used with good success in this design, but to get the best effects a filling flush weave should be used, as this would give a greater contrast with the warp figure.

Arrangement of Figure. Following the questions of distribution and the methods of determining the areas, attention must be directed to the arrangements most suitable for figures of different forms, for, as suggested, these affect the appearance of the pattern to a more or less extent, according to the form of the figure.

When the figure forms a perfect square and is placed diagonally upon the paper, as was the case in Fig. 287, there is little

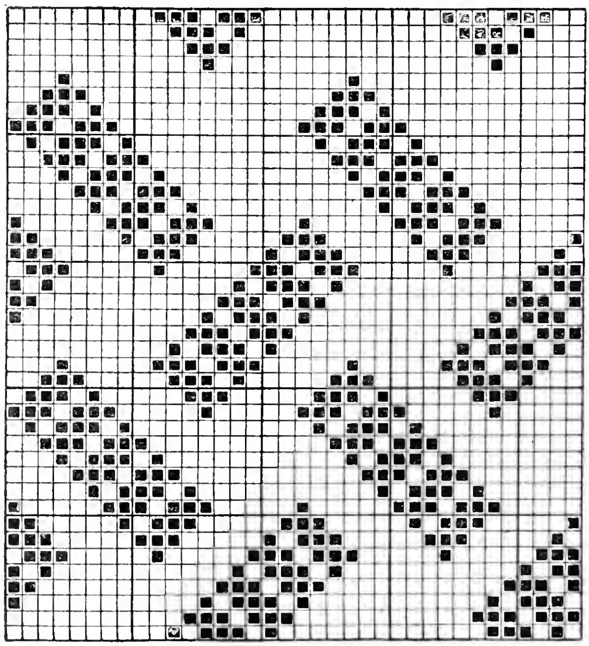


Fig. 295.

difficulty in forming a suitable arrangement, as almost any form will make a very good appearance. Of course, some methods would give better results than others, but the ordinary purchaser would probably not notice such a small difference. This, however, is not the case when dealing with other forms of figures, as in many cases the result would be practically valueless as a design. For instance, if we find the number of threads and picks which would be required for five figures (similar to those shown at Fig.

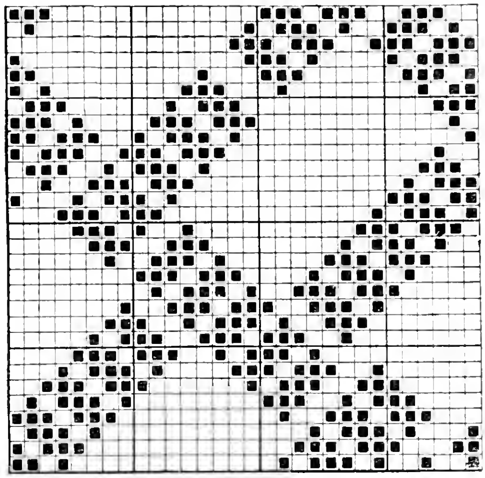


Fig. 296.

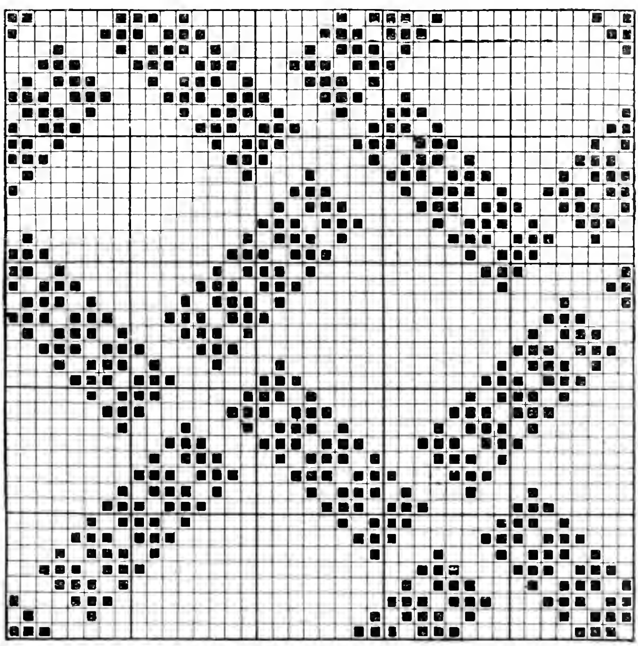


Fig. 297.

295), allowing each figure the same area as is given in Fig. 295 and using the same order of distribution, some of the figures will overlap each other if their positions are reversed, consequently this is an impracticable arrangement.

The arrangement at Fig. 296 shows six figures placed in the best possible order of a broken sateen. Of course, the sateen order for six figures must be irregular, but it is very useful for some purposes. In this case, the figures are almost touching each other. Compare this carefully with Fig. 295 in which there is ample space

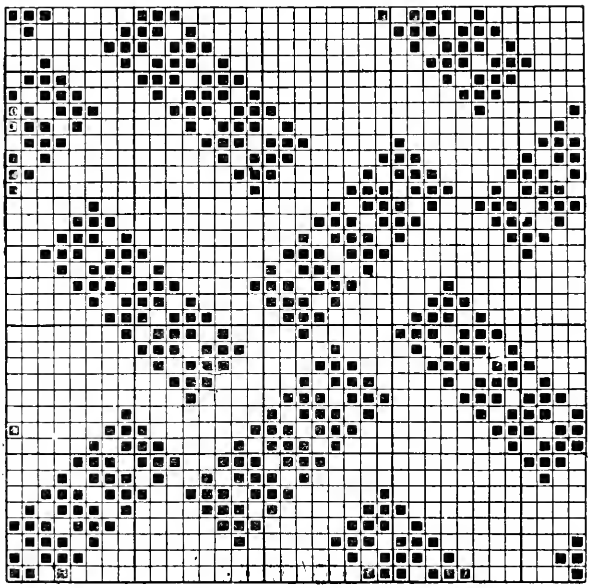


Fig. 298.

all around the figures, yet the area allowed in each case is practically the same. Note also that the plain weave could not be used for the ground in Fig. 296 unless every alternate figure were moved one thread, so as to prevent interference with the ground weave. No arrangement could be made which would be satisfactory, so this arrangement may be condemned as impracticable.

Now study the arrangement given at Fig. 297, which consists of ten figures in sateen order, and contrast this arrangement with the previous example. This arrangement is excellent but it presents a very different appearance to the one given at Fig. 295.

The figures are closer together at their extremities and enclose a larger square of ground cloth. It would, of course, be a matter of consideration which of the two would be best suited to the purpose for which it might be intended, but it is quite clear that neither one could be substituted for the other as the appearance of the two patterns is so totally different.

Still another arrangement is given at Fig. 298. It will be noted that this consists of eight figures in sateen order. This arrangement more nearly approaches in appearance Fig. 295. The area is distributed in almost the same proportions and one might almost be substituted for the other. There is, however, the same fault here as regards the plain weave as at Fig. 296, which arises from the manner in which the total space must be divided. The area occupied is 36 x 36 squares, which, of course, cannot be divided evenly by eight (which is necessary on account of there being eight figures), so the divisions must contain four and five squares alternately. This, of course, makes an irregularity which prevents interference.

The question must be considered as to whether the number of threads occupied is suitable for the number of hooks employed in a jacquard machine. Figs. 295, 296, 297, and 298 occupy such widely different numbers, with the exception of Figs. 295 and 298, that they could not be worked on the same machine, so the designer would have to take this into consideration in determining which of the arrangements it would be best to adopt.

EXAMPLES FOR PRACTICE

1. If two figures occupy three hundred thirty small squares, what is the area of each figure?

2. Make an original design with five figures arranged so that a plain ground weave may be used.

3. Make designs for five, eight, and ten figures, using a figure similar to the one in Fig. 294.

4. How would you proceed to distribute figures in sateen order?

5. Why should a filling flush ground weave be used in a design where the figure is formed by the warp?

Figures Formed With Both Warp and Filling. Attention must now be directed to another feature which is always present in the arrangement of small figures, and for the purpose of explaining this thoroughly the figures given represent the most difficult type of patterns.

In designing figured goods, it is quite common to have figures formed with both warp and filling at the same time, and not with but one material, as is the case in all previous examples. In this case it is essential that the figures be so arranged that there will be no possibility of the pattern forming stripes in any direction; in other words, that there shall be perfect distribution. Take for

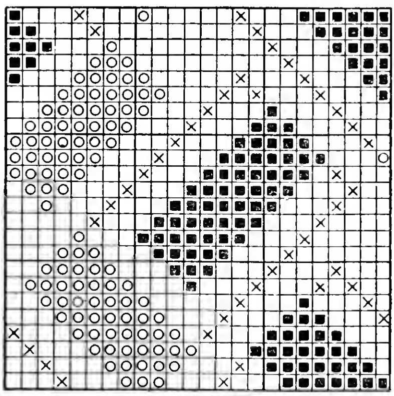


Fig. 299.

example Fig. 299, and assume that the warp and filling are different colors, say black and white, and that the solid black squares of the design represent where the warp comes to the surface, while the circles represent where the filling comes to the surface.

It will be noted at once that were cloth woven from this design, the result would be alternate stripes of black and red running in the direction of the warp. The form of the figure tends to make this defect more prominent. It must be assumed that the filling figure and the warp figure are placed at right angles to each other and must always be in the same relative position to form one figure. For the purpose of alternately placing the figures in reversed positions, and following the plan adopted in previous lessons, the whole figure may be supposed to be contained in a parallelogram, as shown by the crosses. If this is done and the figures are turned upon their centers, the two figures are apparently placed in their proper positions; however, this is not the case as the filling figures will overlap each other to a large extent, while the warp figures also will overlap slightly.

The cause of this is at once apparent from the form and posi-

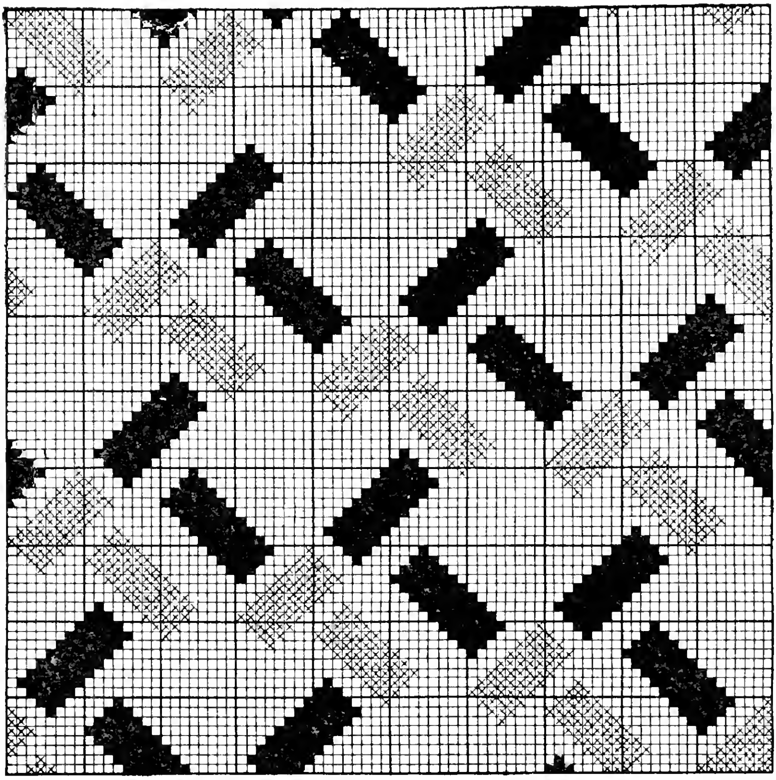


Fig. 300.

tion of the two portions of the figure in their relation to the parallelogram. Thus it will be seen that the arrangement of the figures is very imperfect, while the form of the figure also may be improved. In this arrangement of the two figures the parallelograms are placed as near to each other as possible, thus tending to increase the difficulties when other orders of arrangement are resorted to.

We will now take up the suitability of other orders of arrangement. In Fig. 300 the arrangement consists of five spots in sateen order, which is repeated four times, so as to obtain the best order of reversing the figures. This arrangement is far superior to the one shown at Fig. 299, and for many designs of this class is very suitable, but it is not perfect, as indeed no order of arrangement could be with this type of figure.

It will be noted that the filling portion of the figures, which are indicated by crosses, come together in pairs. This in itself is not necessarily objectionable, in fact, in some cases it gives a good effect to the pattern, but on examining the design closely the

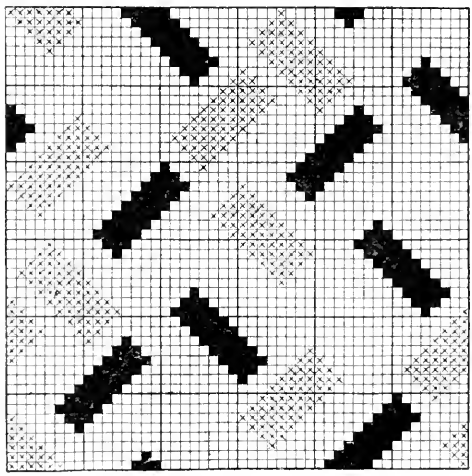


Fig. 301.

appearance suggests the formation of a diagonal pattern. This might be considered an objectionable feature and must carefully be kept in view. It need not in all cases be looked upon as a defect, but should be guarded against in such cases where it might be considered defective.

The design shown at Fig. 301 shows an arrangement of eight figures alternated in pairs. The result of this arrangement is to form groups of three figures, with the filling portions coming together, and two figures which are isolated from the groups. It requires but a glance to see that in this design a distinct stripe would be formed in the cloth, as at some points only the warp comes to the surface over a number of threads, and at other points there is a great preponderance of filling. Other orders of arrangement of eight figures might be adopted, but there would be faults of one kind or another, and most likely stripes would be formed.

If an attempt be made to arrange ten figures in sateen order in a small area, the figures will overlap each other, but if the area be increased, good arrangements may be made. As previously stated, the areas in these examples have been reduced to the lowest possible point, so as to increase the difficulties and thereby assist in making clear the defects which are inseparable from this class of designs. A slight increase in the area would remove many of the difficulties, but they would still exist to some extent.

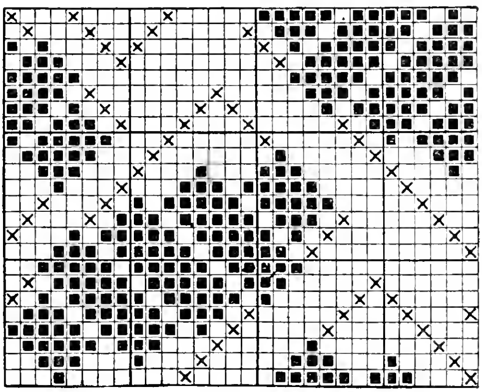


Fig. 302.

Figures Not Square. In the previous examples, the number of threads and picks have been equal, but there are some forms of figures which should not occupy a square space. If the figure shown at Fig. 302 were placed on the same number of threads and picks, the result would be most unsatisfactory, as will be shown later. When the form of the figure is such that when laid upon design paper more threads than picks are occupied, or *vice versa;* and when two figures alternate in the manner shown at Fig. 302, the space occupied by each figure should be a parallelogram of the character shown in the illustration. If this were not so, the figures would overlap at the ends, or there would be a clear blank space between them, caused by one terminating before the other commenced.

If this rule applies to the space occupied by two figures, it should also apply for any number of figures. This shows the necessity of a rule to calculate the area for any other number of figures than two, and to determine the respective number of threads and picks to be occupied.

There are two methods which might be adopted for ascertaining these particulars. The first one is to find the total number of small squares occupied, in the same manner as if the area were to be a small space. To illustrate this, take Fig. 302 as an example. There are thirty threads and twenty-four picks occupied by two

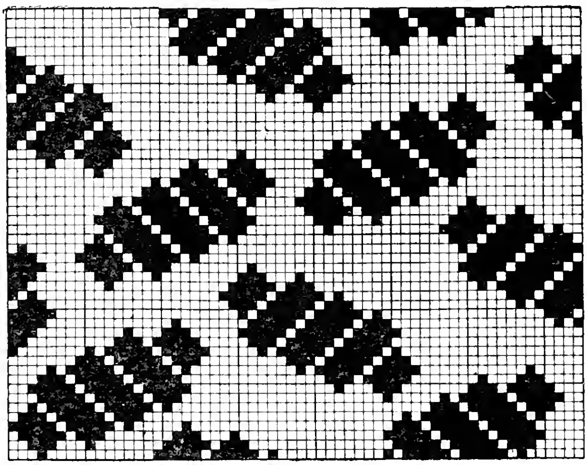


Fig. 303.

figures. Multiplying these together we find that 720 small squares are required for two figures, which is equivalent to 360 squares for each figure. If five figures were to be distributed 1800 small squares would be required ($360 \times 5 = 1800$).

To find the number of threads and picks required it would be necessary to treat the matter as a problem in proportion, as follows: 30 : 24 : : 1800 : 1440. The square root of 1440 is 38, so there will be 38 picks required.

To find the number of warp threads the problem would be 24 : 30 :: 1800 : 2250. The square root of 2250 is 48, so there would be 48 threads required. To prove the above, the number of warp and filling threads may be multiplied together. $38 \times 48 = 1824$, the slight difference being due to the use of full numbers instead of fractions.

The second method is to square each set of threads separately and treat the problem in the manner shown on Page 203. Following this method the threads would be: $30 \times 30 = 900 \div 2 = 450$. For five figures, $450 \times 5 = 2250$, which when the square root is extracted gives 48 warp threads.

The picks would be found in the same manner $24 \times 24 = 576 \div 2 = 288$. For five figures, $288 \times 5 = 1440$, the square root of which is 38, the same as obtained by the first method.

A design for eight figures is shown at Fig. 303. The design is extended in the same manner as in previous lessons, so as to

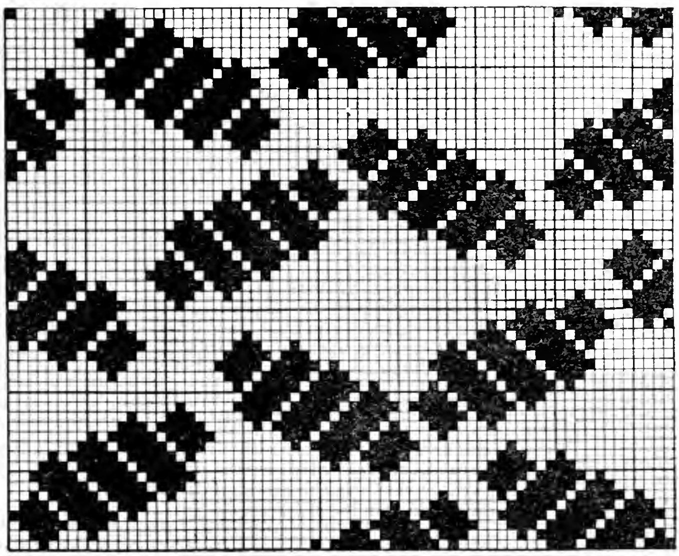


Fig. 304.

alternate the figures. Fig. 304 shows a design of ten figures carried out in the same manner.

A feature of these designs is the different order of arrangement. This must be studied in order to master the principles of making designs of this nature. It will be excellent practice for the student to use the figure shown in these illustrations to form a design on a square space, comparing the results obtained with these illustrations.

Diagonals. With a view to dealing with patterns which run all over the cloth it will be helpful to consider the arrangement of figures which run in a diagonal direction, as in most cases this class of patterns has some definite order of arrangement as its base.

The illustration at Fig. 305 shows a simple diagonal design which repeats on thirty threads and thirty picks. In a design of this kind, the first matter which requires attention is the determination of a complete pattern. This is governed by the relationship of the figure running between the diagonals and the total number of threads occupied by the diagonal. A diagonal pattern running across the paper at an angle of forty-five degrees must occupy exactly the same number of threads in each direction, and if

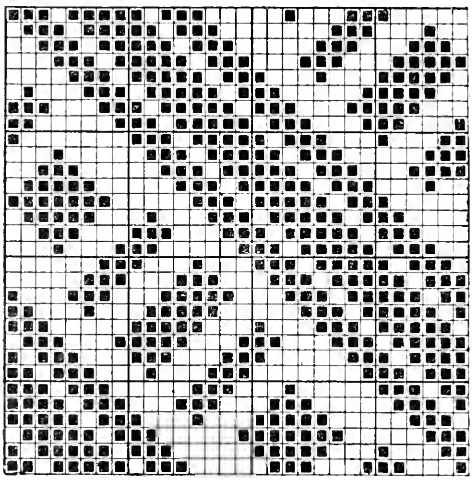


Fig. 305.

extended beyond the number of threads necessary for a repeat, there must be a complete repetition or the pattern will not join properly. It is just as essential that the figure also should join perfectly.

There is one point here to which particular attention is called, so as to facilitate a thorough understanding of the reasons which will be given for determining the completion of the patterns. Knowing that the diagonal must occupy a square space, it is quite immaterial whether the threads are counted in a horizontal, vertical, or diagonal direction, but with the fancy figures running between the diagonal lines, this is not the case, as it is repeated continuously in a diagonal direction only, therefore, it can be counted only in the direction in which it runs.

Referring to Fig. 306, it will be readily seen that there is no

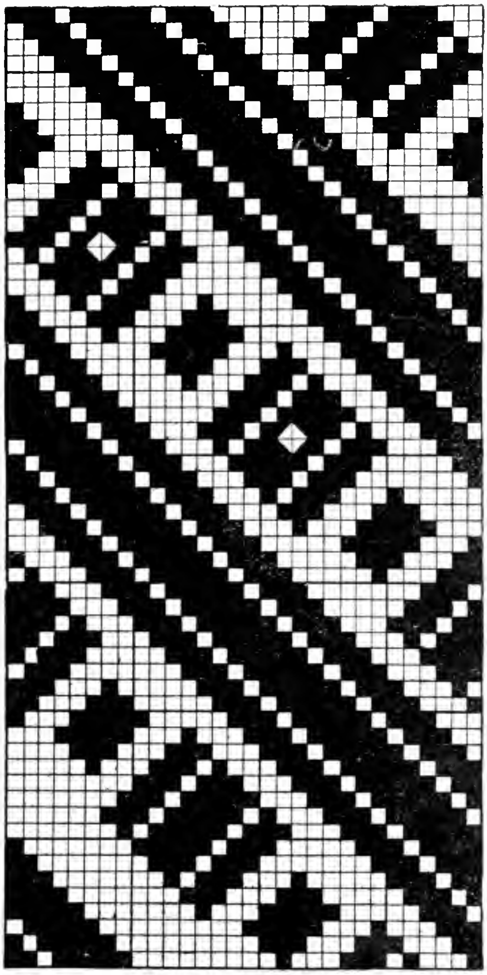


Fig. 306.

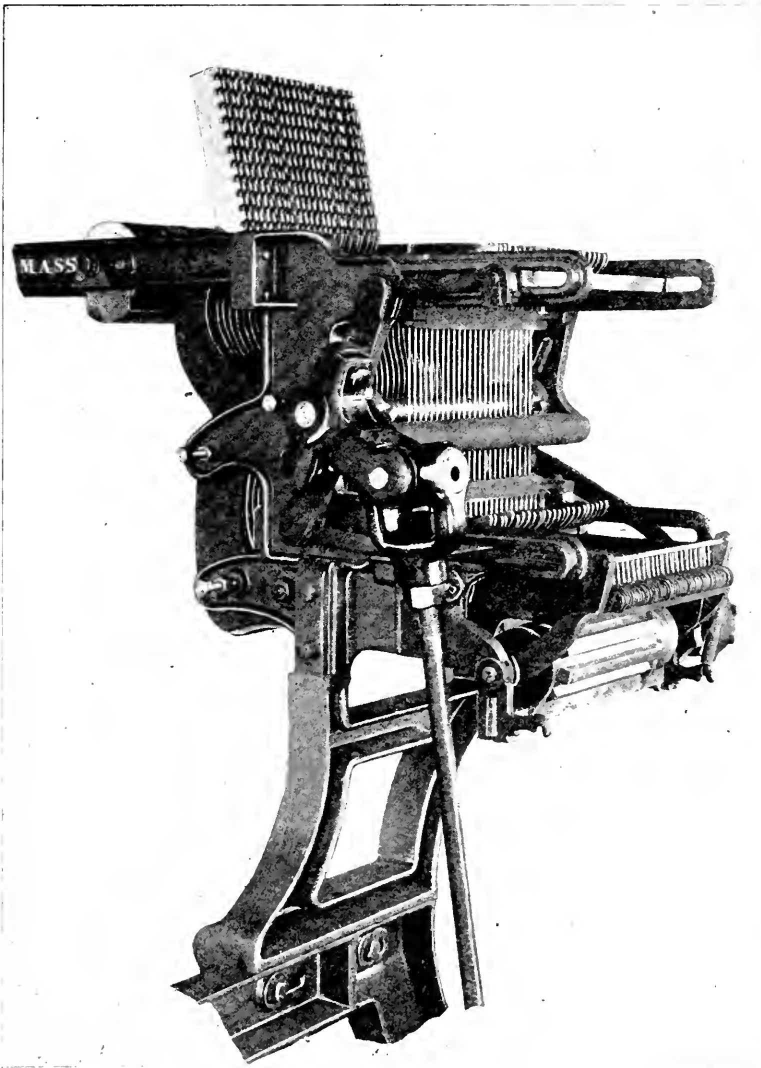
possibility of counting the distance from one figure to another, except in a diagonal line, because there is no repetition in either a horizontal or vertical direction, until the whole design is completed. It should be understood that the meaning of the distance from one figure to another, in a diagonal direction, does not mean the open space between one figure and the next, but it does mean the distance from any point in one pattern to the same relative point in the next repeat of the pattern. This is indicated by the diamond shaped space in the figure.

If the design shown at Fig. 305 be counted, it will be found to occupy fifteen threads from the center of one diamond shaped figure to the center of the next similar figure, and as the diagonal occupies thirty threads each way, and as fifteen is half of that number, the figure is repeated twice within the square occupied by the diagonal, consequently there is no difficulty. But a reference to Fig. 306 will show that the figure occupies twelve threads, and as twelve will not divide evenly into thirty, the design must be carried to a greater extent before arriving at a point where the figure is complete.

Referring back to the statement made above to the effect that if the diagonal is carried beyond one complete pattern it must be carried to another complete pattern, it will be understood why the design does not repeat on a smaller area. In this instance, the design must be extended to occupy sixty squares in one direction or the other.

The foregoing may be stated in this form: Both the figure and the diagonal must be continued until a number of squares has been reached into which both the number of squares occupied by the diagonal and the number of squares occupied by the figure will divide without leaving a remainder. In this case when the diagonal has been repeated twice, the number of picks occupied will be sixty, and as twelve will divide into sixty, the design is complete on that number.

Assuming that the number of threads from a point in the one figure to a similar point in the next figure was fourteen instead of twelve, it would be necessary to carry the design to the extent of two hundred ten squares in one direction and thirty squares in the other. If the distance between similar points was thirteen threads, the design would require three hundred ninety squares in one direction.



MASON DOBBY WITH CAPACITY FOR 24 HARNESSES
Mason Machine Co.

TEXTILE DESIGN

PART V

GAUZE AND LENO

The principle of crossing one set of warp threads over a second set of warp threads—or *cross-weaving*, as it is commonly termed—represents the last and perhaps the highest type of woven-fabric structure. Cross-woven fabrics may easily be distinguished from fabrics belonging to other divisions of woven cloth by their characteristic lace-like texture; in fact, they are termed the connecting link between ordinary woven cloth and lace.

In order to avoid confusion, the whole range of fabrics in which one or more of the warp threads are crossed will be classified as *cross-woven* fabrics; and this general heading will be subdivided into *plain gauze, full gauze*, and *leno* fabrics.

PLAIN GAUZE

Construction. The simplest kind of gauze or cross-weaving is termed "plain gauze." Fig. 307 shows the manner in which the threads interlace, the upper diagram being a plan of the cloth, and the lower diagram showing a sectional cut. It will readily be seen that there are two sets of warp threads and one set of filling threads. The warp threads marked A are termed *ground threads*, and those marked B are *crossing threads*. The filling threads are marked H. The straight warp thread A is always under the filling, while the crossing thread B is raised over every pick of filling. The crossing thread passes under the straight warp thread between every two picks; being interwoven on the right side of the straight or ground thread at one pick, and on the left side at the next pick. As the plain gauze weave repeats on two picks, the third and fourth picks are a repetition of the first and second.

To produce this effect, a special arrangement of harnesses and heddles is required. The ground thread A will, of course, require one harness, while the crossing thread B will require a harness to lift it on one side of the ground thread and a standard and doup to lift it on the other side of the ground thread. The standard and doup are shown in Fig. 308; and for comparison, a regular heddle—such as is used on the harness for the ground thread—is shown in Fig. 309. The standard and doup is a combination of a regular harness and a half-harness.

Standard and Doup. The doup is a silk or linen cord made in the form of a loop and attached to the lower frame of a harness shaft. Referring to Fig. 308, it will be noted that one end of the cord is

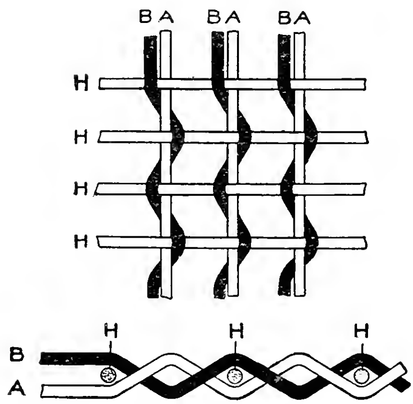


Fig. 307.

fastened to the frame at 3, while the other end is passed through the eye of the standard heddle at 4. It is then passed back through the space 5, which is above the eye, and fastened to the frame at 3. The crossing thread is drawn through the doup as shown by the sectional cut 6.

Fig. 310 shows the threads drawn through the harnesses and illustrates the method of crossing the thread B to the doup and standard harness. Two ground harnesses and a standard and doup are required to weave plain gauze. The warp is first drawn in on the two harnesses marked 1 and 2, then the crossing thread B is passed under the ground thread A and through the loop formed by the doup and standard harness. The two threads are then drawn in the same dent in the reed. This operation is repeated for every pair of threads in the warp.

As the method of drawing in the warp threads is the fundamental principle of cross weaving, it is essential that it be thoroughly understood before any designs can be made; therefore, it will be explained in a different manner, as follows: There are two sets of harnesses. The back set consists of two regular harnesses through which the warp is drawn as required for plain cloth. These are marked 1 and 2. The front set consists of a standard harness S, which is the same in every way as an ordinary harness, and a skeleton or doup harness D. The first thread A is a ground thread and is drawn through the harness 1, while the second thread B is a crossing thread and is drawn

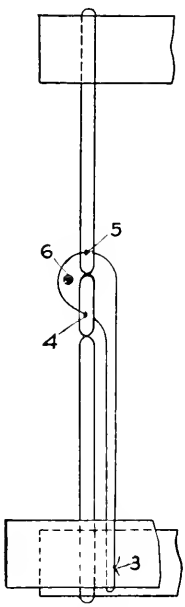


Fig. 308.

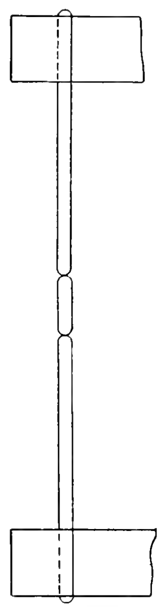


Fig. 309.

through the harness 2. The second thread B is then passed under the first thread A and drawn through the doup, the two threads being drawn in through the *same* dent in the reed. Therefore, all the odd-numbered threads are ground threads, and all the even-numbered threads are crossing threads.

Too much emphasis cannot be laid on the statement that each pair of threads should be drawn in the same dent in the reed, for it is evident that if they are crossed behind the reed and drawn through different dents, the crossing could not take place in the cloth.

It follows that with the arrangement given above the crossing thread B is capable of receiving movement at two places; *i. e.*, at C and at E. If lifted at E, by raising the standard and doup, the thread will be drawn on one side of the ground thread A, while if lifted at C by the harness 2, it will be lifted on the other side of A, or parallel to it.

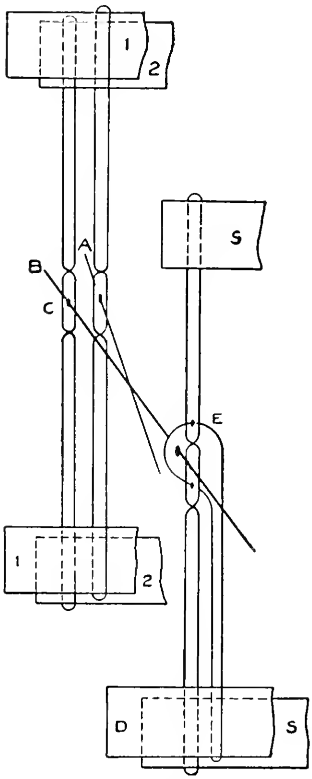


Fig. 310.

But it will be understood that if C is raised, the crossing thread must raise at E, or in other words, it must be released at E, to form the shed for the shuttle to pass through. This is shown at Fig. 311. The crossing thread B is lifted by the harness 2, and the doup also is lifted, which allows E to slide up through the standard heddle with the result that the crossing thread B is parallel to the ground thread A, instead of being crossed under it. H shows the filling which was put into the cloth when the threads were crossed.

The formation of the cross shed (the one in which pick H is placed in Fig. 311) is shown at Fig. 312. It has already been explained that the standard and doup must be raised to cross the threads. The harnesses 1 and 2 are down and the crossing thread B is raised at the point E.

These two movements represent the whole principle of cross weaving and if thoroughly understood will make the explanations of the more generally used and more useful leno fabrics, which are given later on, seem very simple indeed.

As may be seen by referring to Fig. 312 there is a great strain on the crossing thread B when the standard and doup are lifted, by reason of its being passed under the ground thread A. To ease this strain there is an attachment placed on the loom for "easing" the crossing threads on this pick, but as this work does not assume to cover the processes of weaving we shall not take up any more of that subject than is necessary for a thorough explanation of cloth construction and designing.

The harness chain and the drawing in draft for plain gauze is shown at Fig. 313. Letters D and S and numbers 1 and 2 illustrate

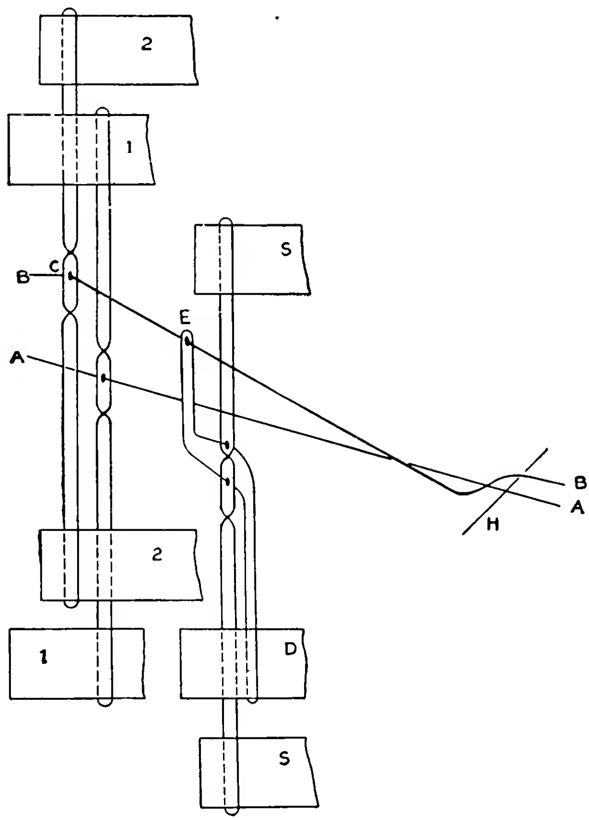


Fig. 311.

the harnesses shown in Figs. 310, 311, and 312, and the crosses indicate which harnesses the threads are drawn through. The ground thread A is drawn through the harness 1 (also shown in Figs. 310, 311, and 312), as indicated by the cross, and the crossing thread B is drawn through the back harness 2, then crossed under the thread A and drawn through the doup.

For the first pick the doup harness and the crossing harness (or No. 2 in the diagrams) are raised, so the ground and crossing threads lie in a parallel position. On the second pick the doup and standard harnesses are raised, so, of course, the crossing thread is drawn under the ground thread to the other side. The third pick is the same as the first, and the fourth pick is like the second.

FULL GAUZE

Construction. In plain gauze, all the crossing threads work in the same direction; every crossing thread is exactly like every other crossing thread, the pattern repeating on one ground thread and one crossing thread. In full gauze, two crossing threads and two ground threads are required for a repeat; one crossing thread being drawn to the left of the ground thread and the other being drawn to the right. The ground threads weave in the same manner as in plain gauze.

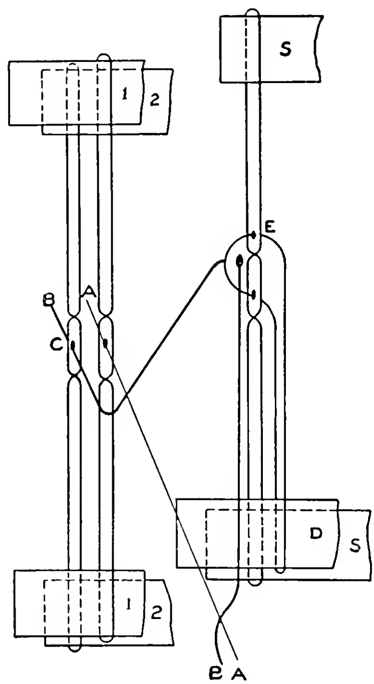


Fig. 312.

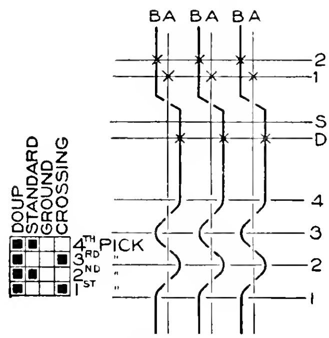


Fig. 313.

The illustration in Fig. 314 is a plan of full gauze, and by comparing it with Fig. 307 the difference between the two cloths may be observed. In plain gauze all the crossing threads pass under the ground threads to the right on the same pick, and pass back to the left of the ground thread on the next pick. In full gauze the first crossing thread passes under the ground thread to the left, while the second crossing thread passes under the next ground thread to the right, on the same pick. On the next pick both crossing threads return to their original positions.

The illustration shown in Fig. 315 represents the drawing-in or harness draft, harness chain, and the manner of crossing the crossing thread under the ground thread to the doup, also the plan of a full gauze cloth. The first thread is a ground thread and is drawn in on the ground harness G. The second thread is a crossing thread and is drawn in on the back harness C, which is the crossing harness. The second thread is then passed under the first thread to the left, and drawn through the doup, D. The third thread also is a crossing thread so is drawn through the back harness C. The fourth thread is a ground thread so is drawn in on the ground harness G. The third thread is then passed under the fourth thread to the right and drawn through the doup. This is a full repeat of the draft.

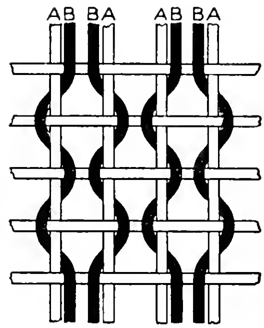


Fig. 314.

When drawing the threads through the reed it will, of course, be necessary to draw the first and second threads in one dent, and to draw the third and fourth threads in another dent, or, as explained in *Plain Gauze*, no crossing can take place. The effect of this cloth is that one crossing thread crosses to the right and the other to the left on one pick, and this order is reversed on the next pick.

This style of weaving is more effective if heavy, or rather coarse, filling is used. Different sizes of warp used alternately or in any systematic method is also very useful in the production of many fancy effects on this weave.

The harness chain shows how the harnesses are lifted to give the effect. For the first pick the crossing threads are on the *doup side* of the ground threads so the standard and doup are lifted. For the second pick the crossing threads are parallel to the ground threads, so the back or crossing harness and the doup are lifted. The third pick is like the first, and the fourth is like the second.

This is exactly the same as the previous example, except that in the plain gauze figure the plan commences with the crossing thread parallel to the ground thread. Thus the only difference between plain gauze and full gauze is that in the latter the threads cross in opposite directions. This result is caused by having the doup and standard at the left of every alternate ground thread and at the right of the other ground threads.

LENO DESIGNS

The combination of gauze and other methods of interweaving is perhaps where the greatest value of cross weaving lies. If plain gauze and full gauze are thoroughly mastered, their combination with

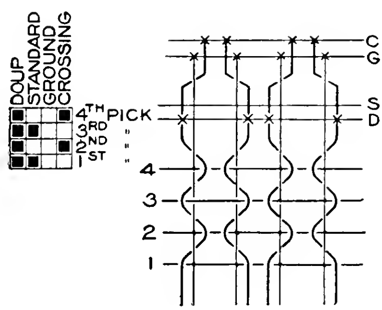


Fig 315.

other weaves to form leno effects will not prove a difficult subject. The illustration shown in Fig. 316 has been selected as an example of a simple leno effect.

Comparing Figs. 313 and 316 the following similarities and differences between plain gauze and leno may be noted: The same number and order of harnesses are used, and the method of drawing in the warp threads and crossing them is practically the same. In Fig. 316 the crossing threads have been crossed to the left, but this is not a serious difference as the crossing threads in Fig. 313 could be crossed in the same manner. Thus the same arrangement of threads and method of drawing-in is used. The plan of the cloth, however, is different, so the method of lifting the harnesses also must be different.

The harness chain shows that the standard and doup are raised for the first pick, which of course raises the crossing thread over the first pick of filling and on the doup side of the ground thread. On the second pick the ground harness only is lifted, and the crossing thread passes under the filling while the ground thread passes over it. On the third pick the standard and doup are again lifted; thus raising the crossing thread over the filling.

The crossing and ground threads have thus woven plain cloth for the first three picks. On the fourth pick the crossing harness and doup are raised which draws the crossing thread under the ground thread to the other side, where it passes over the filling. The next

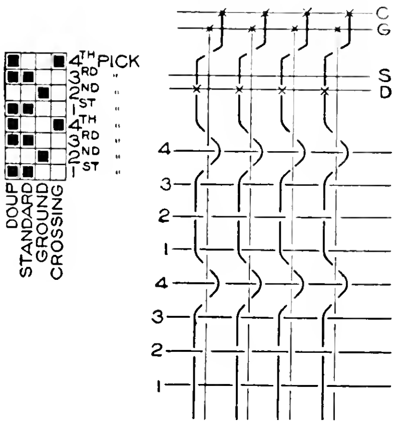


Fig. 316.

four picks are repeats of the first four. The crossing thread is on the right side of the ground thread for only one pick, and weaves plain on the left side for the remaining three picks; thus forming a leno design by combining plain weaving with plain gauze.

Attention is called to the fact that the crossing thread passes over picks 3 and 1, which are on each side of pick 4, where the crossing takes place. If this were not done the gauze crossing would not be so clear and decisive. It may be taken as a general rule for leno designs that to have an uneven number of picks for plain work between the gauze crossings is convenient as it will allow the crossing thread to be raised over the picks on each side of the gauze crossings. This is not absolutely necessary and may not be followed in all cases, but it is a safe rule to follow for the present.

The illustrations shown in Figs. 317 and 318 are variations of the principle of combining the plain weave with gauze.

In Fig. 317 the usual arrangement of harnesses is used and the crossing threads are passed under the ground threads to the left, and drawn through the doups in the usual manner.

Referring to the harness chain, the first pick shows that the crossing and doup harnesses are raised, which of course weaves the crossing thread on the right of the ground thread. On the second pick the standard and doup are raised, which weaves the crossing thread on the left or doup side of the ground thread. The third and fourth picks are the same as the first and second, while the fifth also is like the first. On the sixth pick the ground harness only is raised, so the crossing thread is under the filling. The seventh and ninth picks are the same as the first and the eighth is like the sixth.

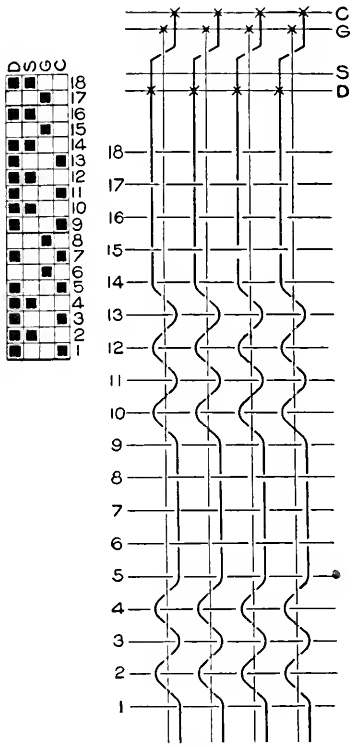


Fig. 317.

Up to this point there have been four gauze crossings and five picks on which the threads have woven plain. The tenth, eleventh, twelfth, and thirteenth picks show crossings, and the plain weave effect is given on the remaining five picks, but the crossing thread is on the left of the ground thread.

Fig. 318 shows the crossing threads weaving plain on the left of the ground thread for three picks and then changing over to the right for three picks, the pattern repeating on six picks. The pattern chain shows how this is accomplished. The explanation will not be repeated for this design as it is the same as in Figs. 316 and 317.

The next question is the power of producing a variety of designs upon the harnesses employed, and with as little trouble as possible by using one doup. It is very clear that if a crossing can be produced so readily, that is, if a gauze crossing can be obtained by the simple lifting of the doup once on each side of the ground thread, there must be a wide field for varying the design, and that the characteristic openness of gauze and leno fabrics can be infinitely varied.

The designs explained up to this point have been ones that would make stripes of plain and gauze across the cloth only. This will be varied and the designs produced which will make patterns in the direction of the warp.

Fancy Leno Designs. There are two methods of forming fancy leno designs, which are as follows; *first*, where the figure is formed by gauze on a plain ground; and *second*, where the figure is formed by plain on a gauze ground. This, however, important as it is, must be considered secondary to the arrangement of patterns for as few doups as possible. The significance of this statement is at once apparent when it is remembered that, among other complications, each doup must have an easing arrangement to reduce the strain caused by the raised position of the standard and doup.

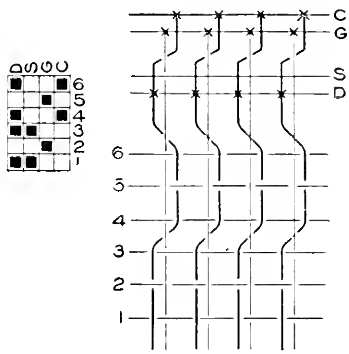


Fig. 318.

The illustration shown in Fig. 319 represents a design that forms a diagonal pattern of gauze across the fabric; and also shows the drawing-in draft and harness chain. The usual method of allowing each thread to work in its normal position, when plain cloth is desired, is adopted, and the crossing thread is lifted by the standard and doup when the gauze crossing is required. By using this method, four doups and four standards are used with eight ground and crossing harnesses.

This seems a large number of harnesses for a simple pattern, especially as there are more harnesses than there are threads in one repeat of the pattern. The number of harnesses, doups, and easing rods would be much more formidable than the pattern, but they are all required to produce the actual effect shown in the figure, because each pair of threads works independently and in no case do two threads cross at the same time.

The first doup and standard marked D^1 and S^1, and the first crossing and ground harnesses marked C^1 and G^1, may be referred to independently of the remainder of the chain and it will be a simple matter to see how the harnesses are raised for the first pair of threads.

On the first pick the first standard and doup are lifted and the first crossing and ground harnesses are down, which, of course, crosses the thread to the doup side of the ground thread. Reference to the plan will show this to be the case for the first crossing thread is crossed to the right side of the first ground thread on the first pick. On the second pick the doup and crossing harness are raised, which changes the crossing thread to the left again, as explained in previous examples. So each pair of threads may be followed in the plan and in the harness chain independent of the other threads.

Examining the standard and doup S^2 and D^2 in conjunction with the crossing and ground harnesses C^2 and G^2, the manner of lifting the harnesses for the second pair of threads may be followed. Each

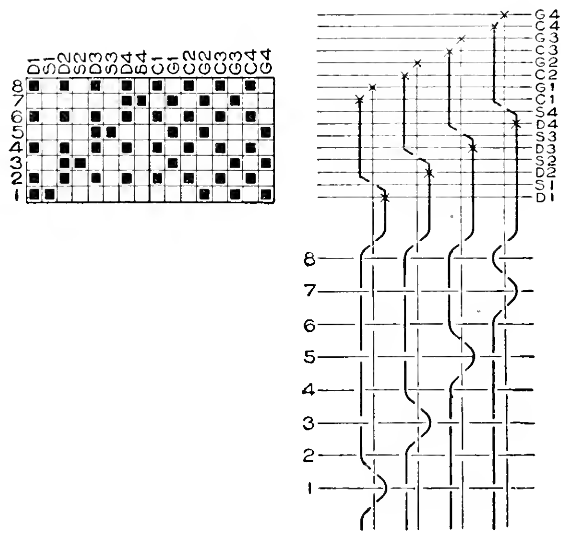


Fig. 319.

of the remaining two pairs of threads may be followed in the same manner by considering them the only threads in the pattern, and their respective harnesses the only ones in the harness chain for the time being. It will be understood that in this pattern each pair of threads requires its individual doup, standard, crossing, and ground harnesses, just as the first example of leno required them.

To show how an effect which is practically the same and which is certainly as good, may be produced with one doup and standard, Fig. 320 has been prepared.

A hasty comparison of Figs. 319 and 320 might not show any difference in the two designs; both have the standard and doup lifted over the odd-numbered picks, and the gauze crossings form a sort of diagonal running from left to right. The plain weave is used on all the threads and picks, except where the crossings take place, as may be proved by examining the picks.

On the first pick all the threads are working plain—*i. e.*, one up, one down—except the first pair. All the threads are working plain

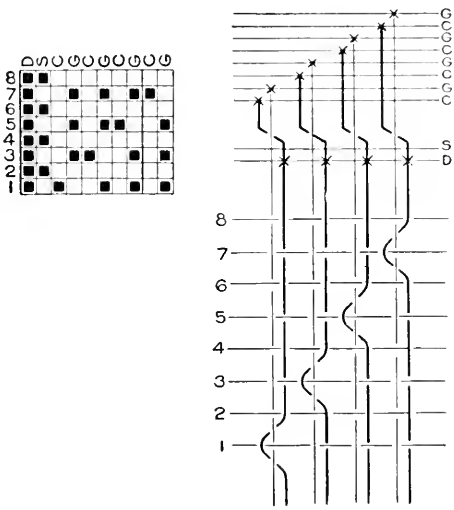


Fig. 320.

on the second pick, just as in a piece of plain cotton cloth. On the third pick the second pair of threads form a gauze crossing, the others weaving plain. The fourth pick is plain; and so on.

In all the above details, the two designs are identical, yet one requires four standards and four doups, and the other is woven on one standard and one doup; consequently, there must be some method of arranging the designs and lifting the harness to reduce the number of standards and doups necessary.

The ground and crossing threads in Fig. 320 are drawn through the harnesses in the usual manner, the crossing thread being drawn to the right the same as in Fig. 319. However, the crossing thread is at the right of the ground thread when weaving plain, and changes to the *left* to form the gauze crossing; while the crossing thread is at the left of the ground thread when weaving plain in Fig. 319, and crosses to the *right* to form a gauze crossing.

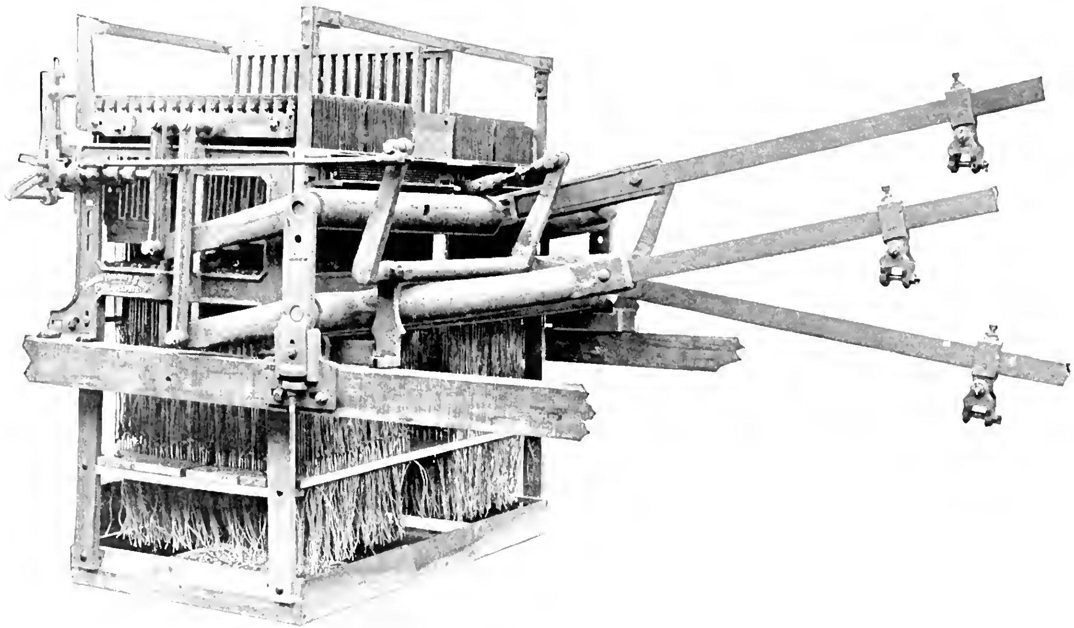
The side on which the crossing thread weaves when making the plain cloth is of no importance so far as the appearance of the design is concerned, but it makes a difference of three doups and standards if woven on the same side as the crossing harness, as will be noted by a careful comparison of the two illustrations; consequently, it is impracticable to make a design like Fig. 319, and use sixteen harnesses for its production, when the same effect may be produced on ten harnesses.

Analyzing Fig. 320 in conjunction with the harness chain, it will be noted that the doup, first crossing harness, and the second, third, and fourth ground harnesses are raised on the first pick, which has the effect of drawing the first crossing thread to the left of the first ground thread (which in this instance is the same side as the crossing harness) and raising the second, third, and fourth ground threads, as shown in the first pick of the plan of cloth.

If the previous explanations have been thoroughly studied, the reason why this is the case will be apparent, but as the construction of leno design is so much different than other divisions it may be profitable to repeat the explanation.

Each ground and crossing thread should be looked upon as a pair of threads, so to speak, and in determining how they are worked, the harnesses on which they are drawn should be considered quite apart from the other harnesses. On the first pick of the harness chain the first crossing harness and the doup are lifted. There are other harnesses lifted on this pick, but these have no connection with the first pair of ground and crossing threads, so should be ignored for the present. As is stated above the first crossing harness and the doup are raised, which has the effect of lifting the crossing thread on the same side of the ground thread as the crossing harness is on, as explained in plain gauze.

Considering the second pair of threads, the ground thread is raised, and the crossing thread is down, so the second crossing harness is not lifted while the second ground harness is lifted, as is shown in the harness chain. The third and fourth pairs of threads are the same as the second; the third and fourth ground harnesses being lifted and the crossing harnesses being down.



REAR VIEW OF FINE INDEX DOUBLE LIFT SINGLE CYLINDER JACQUARD MACHINE

Thomas Halton's Sons

The second pick weaves plain, passing over every ground thread and under every crossing thread. Reference to the second pick of the chain shows that the standard and doup are lifted and all the ground and crossing harnesses are down. In the explanation of plain gauze, a statement is made to the effect that where the standard and doup are lifted, the crossing threads are raised over the filling, and on the doup side of the ground thread. The plan of the cloth shows this to be the case.

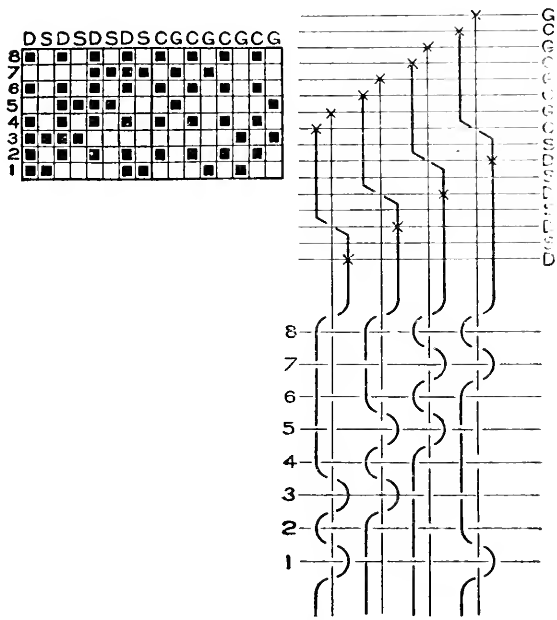


Fig. 321.

On the third pick the first ground thread is raised and the first crossing thread is down. The second pair of threads forms a gauze crossing in the same manner as the first pair of threads formed a crossing on the first pick. The third and fourth pairs of threads are weaving plain. Reference to the third pick of the chain shows that the doup, first ground harness, second crossing harness, third ground harness, and fourth ground harness are raised. A careful study will reveal that the gauze crossing is made by the same method explained in connection with the crossing on the first pick and also in *Plain*

Gauze; *i. e.*, the crossing harness and doup being raised, raises the crossing thread on the side that the crossing harness is on.

The fourth pick is the same as the second, passing over every ground thread and under every crossing thread, the standard and doup being the only harnesses that are raised.

The third and fourth pairs of threads form gauze crossings on the fifth and seventh picks respectively, by having their crossing harnesses raised in conjunction with the doup, in the same manner as

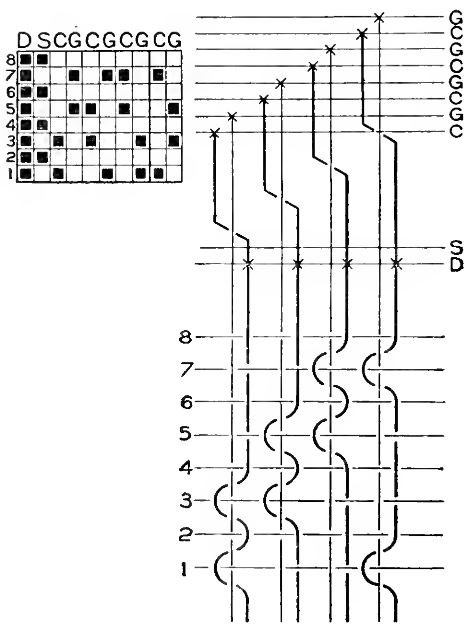


Fig. 322.

explained in connection with the first and second pairs of threads. The sixth and eighth picks are plain.

Summarizing the above, every even-numbered pick weaves plain with the warp threads, and on the odd-numbered picks gauze crossings are made in progressive order. The crossing threads are always on the right or doup side of the ground threads when weaving plain and cross to the crossing thread side, or what was termed the *position parallel to the ground thread* in the simple explanation used in the *Plain Gauze*.

To establish more forcibly the possibility of reducing the number of harnesses employed for an effect, when apparently the number of harnesses cannot be reduced, Figs. 321 and 322 have been prepared. This is almost a parallel case to the one just explained. Fig. 321 occupies sixteen harnesses, and practically the same effect is shown in Fig. 322 on ten harnesses. Both effects are the same, except that the threads weave plain with the crossing thread on the right or doup side in Fig. 322, while they weave plain with the crossing thread on the crossing harness side in Fig. 321.

It will be unnecessary to go into the details of these two designs, as the comparison may be made by the same method used on the two previous figures. Examples of this kind might be multiplied, but in the estimation of the writer this method has been made very clear by these explanations. Further examples will be made with as few doups and standards as possible, as in practical use the doups are a source of considerable expense for repairs, and complicate the weaving operation.

EXAMPLES FOR PRACTICE

1. How do cross-woven fabrics differ from ordinary woven cloths?

2. Describe the interlacings of the warp threads in both plain gauze and full gauze.

3. How are the crossings of the warp threads held in place, or bound into the fabric?

4. Write a description of the doup including the following features: Of what material is it made? How is it connected with the standard harness? Why could not an ordinary heddle be used in its place?

5. Make a sketch illustrative of the method of drawing in the crossing and ground harnesses for full gauze.

6. When reeding a warp, what must receive special attention? Why is this necessary?

7. What effect is produced by lowering the crossing thread and lifting the standard and doup?

8. Make from memory enlarged diagrams of plain gauze and of full gauze.

9. By what is the power of producing fancy patterns limited?

10. In plain work between gauze crossing, should an odd or an even number of picks be used?

Diamond Patterns. The diagonal pattern, formed by the use of one doup and standard, does not limit the variety of fancy effects possible on this arrangement, for with the possibilities of one doup and standard in mind, one may lay out a practically unlimited number of patterns.

The structure of the cloth is limited to plain gauze and the regular plain weave, and it is necessary to lift the standard and doup on every alternate pick and to lift the doup on the other picks so that gauze or plain may be formed, as desired, by lifting either the crossing or ground harness of each pair of threads in conjunction with the doup. Particular attention is called to this, so that the student will not think that the range of patterns made with one doup and standard is unlimited. Extensive and elaborate designs may be made, as shown in the illustrations, but they bear a marked similarity to each other, compared to the infinite number of leno effects that may be made on more complicated arrangements of the harnesses. For instance, one of the most valuable methods adopted by the leno designer to get special fancy effects, is to have more than one pick in the same shed. This cannot be done in the one-doup-one-standard arrangement.

There are innumerable other characteristic features of cross weaving that are not practical on the present arrangement; therefore, it may be stated that the number of patterns, which are possible on one doup and one standard combined with any number of ground and crossing harnesses, is practically unlimited, yet the construction of the cloth must be confined to plain gauze and plain cloth, and composed of a warp or filling figure, if a figure is desired. If a filling figure were being produced, a special arrangement must be made, such as weaving the cloth wrong side up. This is often resorted to, yet in some cases the doup is reversed to weave the pattern right side up. By reversing the doup is meant to have the cord hanging down from a harness placed above the yarn instead of below, as is the common custom.

Perhaps the simplest form of figure next to those of the diagonal character, are the ones in which a diamond outline in gauze is formed. An example of this effect is shown in Fig. 323. The gauze cloth runs diagonally in each direction, and encloses a diamond-shaped space of plain cloth. Of course, if the design were repeated a number of

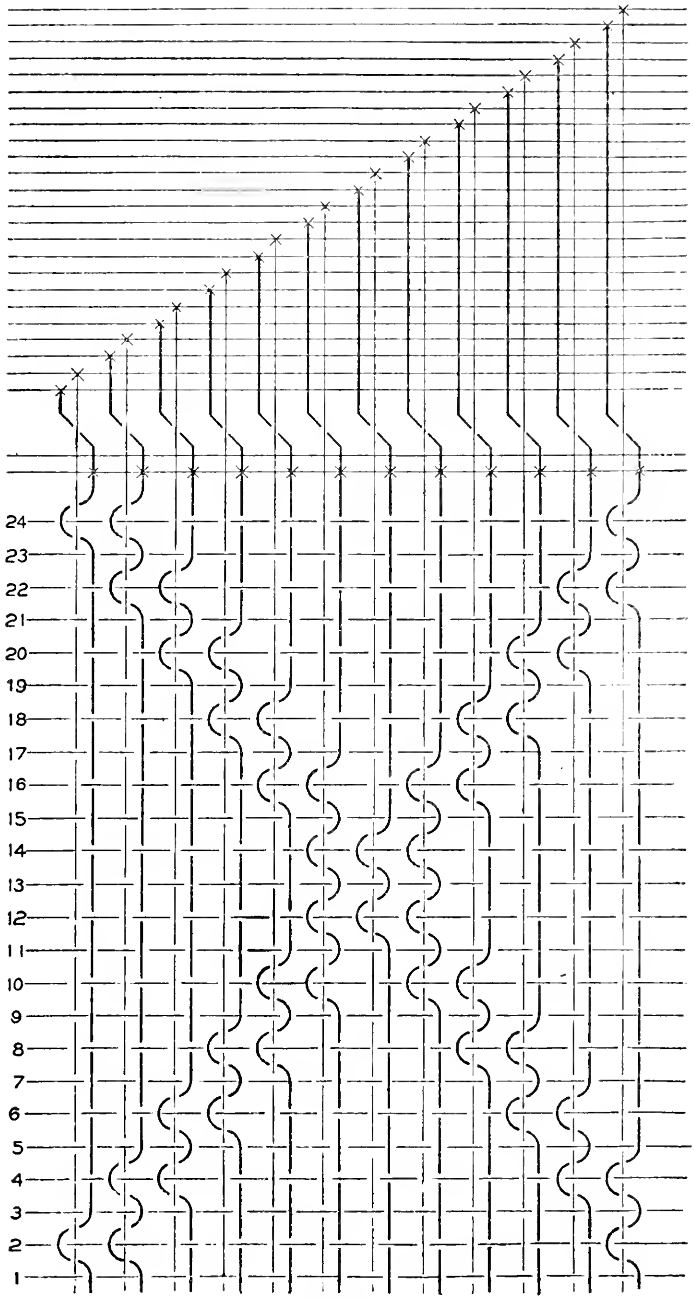


Fig. 323.

times, the figure would be more plainly visible, but little difficulty will be experienced in recognizing the outline of the figure. The design repeats on twenty-four threads and twenty-four picks.

The method of producing these diamond effects is very simple, being a further utilization of the principles employed in Figs. 319 and 320. The ground threads are drawn in on the ground harnesses and the crossing threads are drawn in on the crossing harnesses, as indicated by the crosses. Each crossing thread is then passed under its

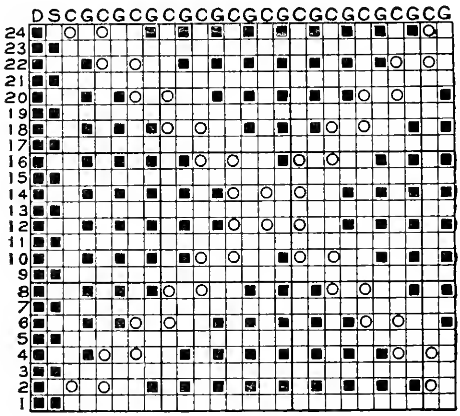


Fig. 324.

companion ground thread (to the right in this instance) and drawn through the doup. Each pair of threads is then drawn through the same dent as previously explained.

The harness chain is shown in Fig. 324. The doup, standard, crossing, and ground harnesses are marked in the manner adopted for previous examples, and the picks in the chain correspond to the picks in the plan. The circles are always on the crossing harnesses and indicate where a gauze crossing takes place. On every pick where a circle is found the doup also is lifted, so the crossing thread crosses over to the left of the ground thread. A careful examination of the disposition of the circles will show an outline like that formed in the plan by the gauze crossings.

Analyzing the harness chain in Fig. 324 in conjunction with the plan in Fig. 323, the following particulars are found. On the first pick of the chain the standard and doup are lifted, which, of course, raises the crossing threads over the filling and on the doup side of the ground thread. None of the ground harnesses is lifted so the first pick is perfectly plain, passing over every ground thread and under every crossing thread.

On the second pick of the chain, the doup is lifted, also the first, second, and twelfth crossing harnesses. This, of course, draws those threads to the left of the ground threads and over the filling. In the remaining pairs of threads: *i. e.*, the third to eleventh, inclusive, the ground threads pass over the filling and the crossing threads pass under it. Reference to the chain shows that the ground harness in each of these pairs is raised, and that the crossing harness is down; therefore, there are three gauze crossings (made by three crossings harnesses and the doup being lifted) and nine pairs or eighteen threads weaving plain, on the second pick.

On the third pick the standard and doup only are lifted, the same as in the first pick, and of course with the same result; the filling passing over every ground thread and under every crossing thread, and the crossing threads being on the doup side of the ground thread.

The fourth pick shows gauze crossings on the second, third, eleventh, and twelfth pairs of threads, the remaining threads weaving plain. Reference to the chain shows that the second and third, and eleventh and twelfth crossing harnesses are lifted in conjunction with the doup, which of course forms gauze crossings. The first, and the fourth to the tenth, inclusive, ground harnesses are raised, so the filling passes over the crossing threads and under the ground threads at this part of the design.

The fifth pick is the same as the first and third, the standard and doup being the only harnesses lifted.

It is so simple to compare each pick in the plan with the corresponding pick in the harness chain, that we will not continue this explanation for each of the twenty-four picks in the design. On every odd-numbered pick the standard and doup are lifted, and on the even-numbered picks, the doup and crossing, and the ground threads required to form the pattern, are lifted.

There is, however, one feature of the chain which might cause unnecessary trouble. Upon close examination, it will be noted that at some points on the even-numbered picks a square and a circle come together, as at the fourth and fifth squares of the fourth pick in Fig.

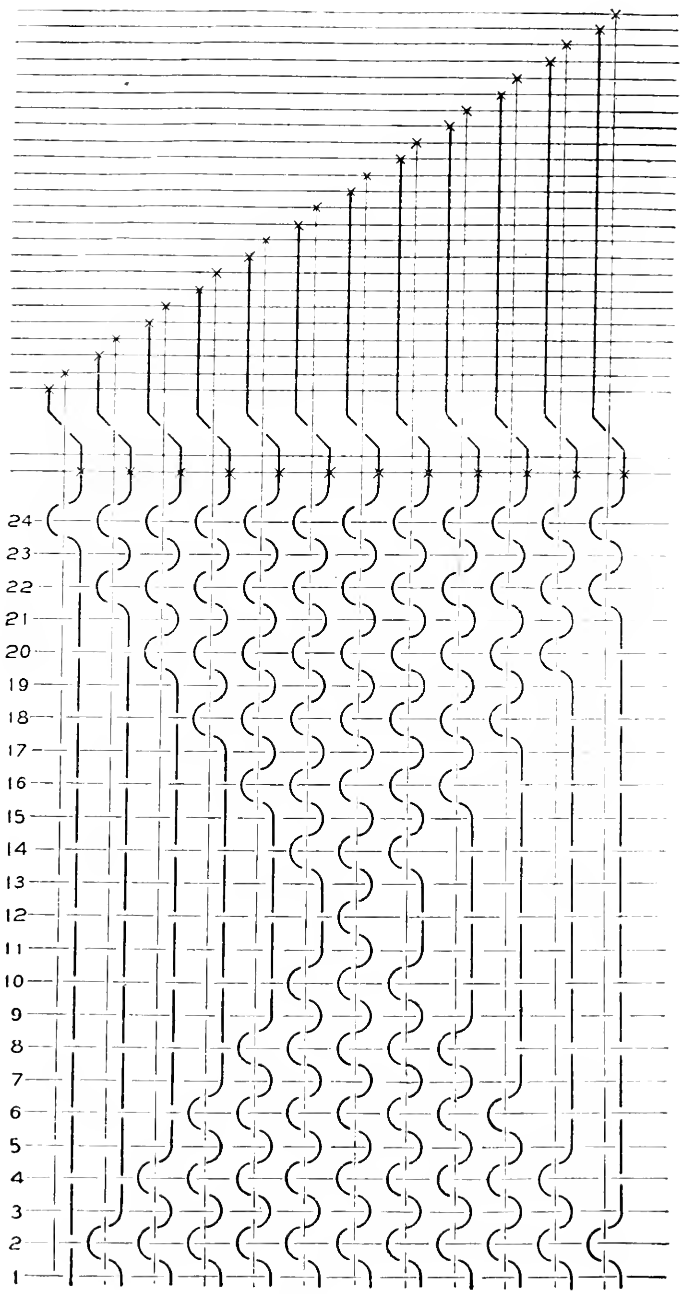


Fig. 325.

324. At other points two blank squares adjoin as in the sixth and seventh squares of the second pick. These would seem to suggest either a break in the plain weave or some sort of interference with the gauze, when as a matter of fact neither is the case.

In the course of various explanations, the threads have been referred to as working in pairs, and it will be found upon carefully examining the design that where two marks or two blank spaces come together, one of the blank spaces or marks belongs to one pair of threads and the other belongs to the next pair of threads, or the ground thread of one pair is lifted and the crossing thread of the next pair, or *vice versa*. It is obvious that it would not be correct to raise both the ground and crossing threads in one pair, or to leave both down; that is, it would not be correct in this design, but it might be done in forming a warp figure. This, however, will come under a different heading, and will be taken up later.

Another design on the same general principles as Fig. 323, is shown in Fig. 325, with the harness chain or design in Fig. 326. In the former instance, a diamond-shaped space of plain cloth is outlined by plain gauze, while in the latter there are two solid diamond-shaped spaces of plain gauze and plain cloth respectively.

We will not take up much space in explaining the method of drawing in the warp, as it is the same in every respect as in Fig. 323. Twelve ground harnesses and twelve crossing harnesses are required with one standard and doup. The design repeats on twenty-four threads and twenty-four picks.

The small circles in Fig. 326 show where the crossing harnesses are lifted, and correspond to the gauze crossings in the plan. The blocked-in squares show where the ground harnesses are lifted, and represent that portion of the plan occupied by the plain cloth.

An analysis of the first two picks of the design, in conjunction with the plan, will be sufficient to show the method of making this effect. On the first pick the standard and doup are lifted, which raises all the crossing threads on the doup side of the ground thread.

On the second pick, the doup, first ground harness, and the last eleven crossing harnesses are raised, which makes the first pair of threads weave plain, and forms gauze crossings on the other eleven pairs of threads.

The third pick is plain; the fourth pick has three pairs of threads weaving plain, and nine pairs forming gauze. The fifth is plain; and so on, till the space occupied by gauze tapers off to a point at the twelfth pick. From this point it gradually widens, until, at the twenty-fourth pick, it takes in every pair of threads in the design.

From the above examples it will be understood that the requirements, when working figured leno of this character with one doup and standard, are to lift the doup and standard on each alternate pick, weaving plain on the doup side of the ground thread; to lift the crossing harnesses and doup on the other picks, to form the crossings; and to lift the ground harnesses when plain cloth is desired.

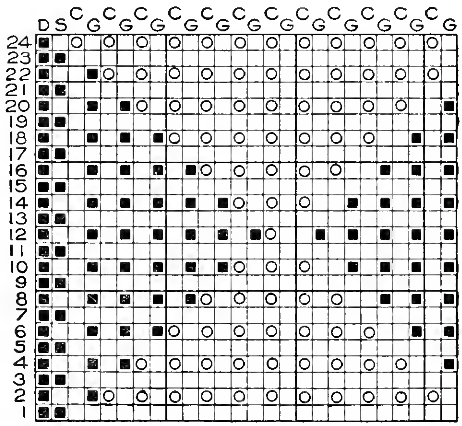


Fig. 326.

When studying any combination of weaves, it is an excellent plan to find the kinds of cloth and the classes of designs they are most suitable for. In this combination of plain cloth and gauze, the very manner in which the pattern is formed seems almost to suggest that the most suitable figures will be ones which have a geometrical base. Although patterns of a more or less floral character may be produced, there is a great tendency to produce an uneven appearance where curved lines are attempted, while this difficulty is wholly avoided in making figures of a geometrical form.

Note that the crossing threads pass over the picks on each side of the gauze crossings, thus forming clear definitions of the patterns.

Warp Figures with Gauze. Considering the designs taken up thus far, the suggestion is implied that in weaving leno designs with one doup and standard, the only effects which may be produced are combinations of plain cloth and plain gauze. This, however, is not the case, for various kinds of figures may be woven between lines of gauze.

For the purpose of producing variety of patterns or designs in leno fabrics, warp and filling figures are produced; *i. e.*, figures where the warp or filling floats loosely on the surface to form the desired figure.

In weaving ordinary spot or figured designs, there is no difficulty in floating either warp or filling threads on the surface of the cloth, but in cross weaving the method is not quite so simple.

As shown in the figures illustrating the methods of combining plain gauze and plain cloth with one doup and standard, the crossing thread works in the crossed position (which is the doup side) to form plain cloth, at all times except where the gauze crossings are formed. The crossing thread then passes from the crossed position to that which it would occupy in ordinary weaving, or if the standard and doup were not used, and passing back again to the crossed position makes a complete gauze crossing.

There is another feature which must be considered before passing further. By this method of working, the doup forms the ground on the alternate picks where the doup and standard are lifted, and the gauze crossings take place, not when the standard and doup are lifted, but on the picks where the standard is down; the object being to make it a matter of choice whether the harness carrying the crossing thread (to which we have previously alluded as the crossing harness, and which is marked C in previous illustrations) shall be raised to form a crossing or whether its companion thread shall be raised to form plain.

From this it will be seen that the doup and standard must be raised together on every alternate pick. There can be no departure from this, consequently a filling figure cannot be formed on the face of the cloth, because it is necessary that a number of threads shall stay down for a number of picks when the filling is interwoven, so that the filling can float over them to make a filling figure. This, of course, is impossible when using a principle where the standard and doup must rise at every alternate pick, so it is clear that a filling figure cannot be formed on the face of the cloth.

Warp figures can be formed, however, so it follows that if the warp is floated over the filling to make a warp figure, the filling must float under the warp to form a filling figure on the back of the cloth; therefore, filling figures can be made by weaving the cloth face down. This being understood, the warp figure will be explained, remembering that a figure of the same characteristics is being formed by the filling floating underneath.

The illustration in Fig. 327 shows a design or harness chain for two diamond-shaped warp figures on a plain gauze ground The arrangement of harnesses, drawing-in draft, and plan of the cloth are shown in Fig. 328. Before making a careful study of the chain and plan, the fact should be firmly fixed in mind that the standard and doup must rise at every alternate pick; of course raising the crossing thread; and for the formation of gauze the crossing thread is raised at the next pick by the crossing harness. For plain cloth the companion or ground thread is lifted by the ground harness, so that the plain cloth and gauze are made in the same manner as previously explained.

Now, in the formation of a warp figure, all threads must be raised so the filling will pass under them. When the standard and doup are lifted, all the crossing threads are raised without lifting any of the crossing harnesses, and the ground threads may be raised by lifting the ground harnesses. On the picks where the standard is not raised, the required threads are lifted by lifting the crossing and the ground harnesses.

This will be made clearer by reference to the third and fourth picks in Fig. 327. On the third pick the doup is lifted, but of course this will not lift any threads if either the standard or crossing harnesses are not also lifted; consequently, the first seven crossing harnesses are lifted as indicated by the small circles. In the figure five ground harnesses are lifted and two more crossing harnesses, making a total of fourteen harnesses, in addition to the doup, that are lifted on the third pick.

On the fourth pick the standard and doup are lifted, so none of the crossing harnesses is lifted, there being as many threads raised by lifting the standard and doup and three ground harnesses as were lifted on the previous pick with fourteen harnesses. This illustrates the reason why the odd-numbered picks in Fig. 327 have so many more risers than the even-numbered picks.

The circles indicate where a crossing harness is raised on the pick where the doup also is raised and shows where gauze crossings take place.

To become familiar enough with this principle to be able to tell at a glance to which set each thread belongs, and whether it is forming plain, gauze, or figure, it will be profitable to examine several picks of Fig. 328, in conjunction with the chain or design shown in Fig. 327.

On the first pick, the crossing threads of the first eight pairs are at the left of the ground thread and pass over the filling. In the

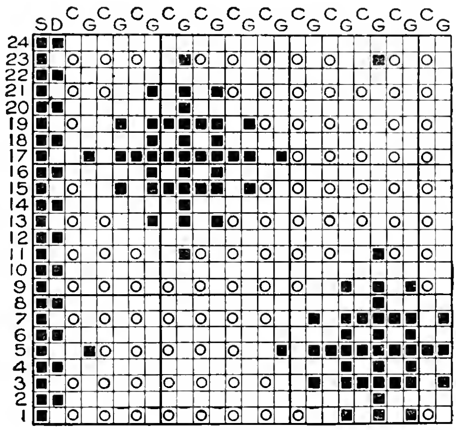


Fig. 327

ninth, tenth, and eleventh pairs, the ground threads are over the filling, and the crossing threads are at the right of the ground threads and under the filling. The last pair of threads is like the first nine. Reference to the first pick of the chain shows how this is brought about. The first eight crossing harnesses, being raised in conjunction with the doup, draw the crossing threads from the doup side and over the filling. The last crossing harness works in the same manner. The ninth, tenth, and eleventh ground harnesses are lifted, so these ground threads are raised, while their companion crossing threads remain down.

On the second pick, the standard and doup are lifted which, of course, raises every crossing thread, and on the doup side of the ground

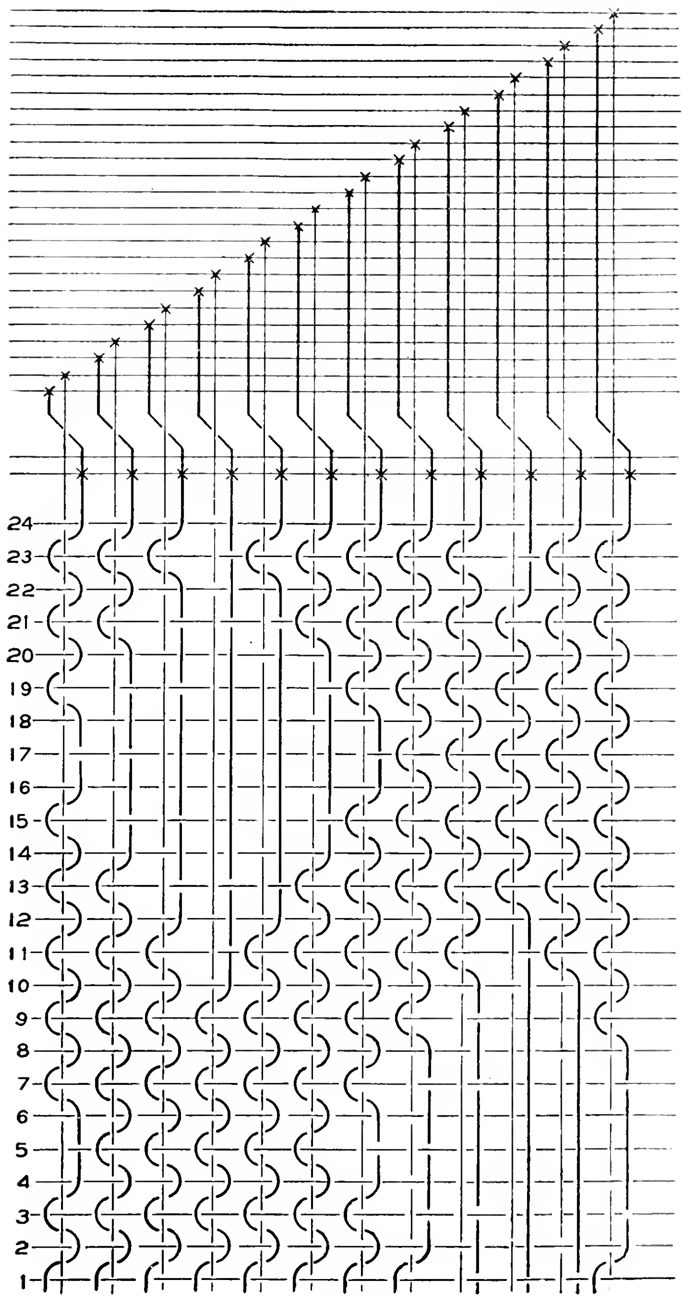


Fig. 328.

thread. The tenth ground harness also is raised on this pick, which lifts the tenth ground thread over the filling.

The third pick is similar to the first; the first to the seventh crossing threads being drawn to the left of the ground thread and over the filling, while the eighth, ninth, and twelfth crossing threads are at the right or doup side, and pass under the filling, their companion ground threads being raised. In the tenth and eleventh pairs of threads, however, both the ground and the crossing threads are raised.

Reference to the third pick of Fig. 327 will explain how the positions of the various threads are brought about. The first seven crossing threads in conjunction with the doup cause the gauze crossings on the first seven pairs of threads. The eighth, ninth, and twelfth ground harnesses are raised, while their companion crossing threads are down, which gives the relative positions of these threads, and the tenth and eleventh ground and crossing harnesses are both lifted which raises both ground and crossing threads over the filling, and forms part of the warp figure. The filling floating under these threads will, of course, form part of a filling figure.

The fourth pick is similar to the second, there being three ground harnesses, in addition to the standard and doup, raised on this pick.

The other picks may be followed in a similar manner, comparing the effect, as shown in the plan of the cloth, with the method of lifting the harnesses as shown in Fig. 327.

The principle of floating the warp on the surface may be used to form diagonal patterns, as is shown in the design at Fig. 329 and the plan of cloth in Fig. 330. Twenty-four threads and picks are required for one repeat, and the arrangement of harnesses and drawing-in draft is the same as in the previous example. The small circles on the even-numbered picks are always on the crossing harnesses and show where the crossing thread is lifted to form a gauze crossing, the same as in Fig. 328.

It will be unnecessary to go into a detailed explanation of this design, as it is made on exactly the same principle as Fig. 328. It will, however, be excellent practice for the student to carefully trace the interlacings of each thread and follow the risers in Fig. 329. It should be noted that the standard and doup are raised on the first pick of the design, while Fig. 328 commences with the doup and crossing harnesses raised.

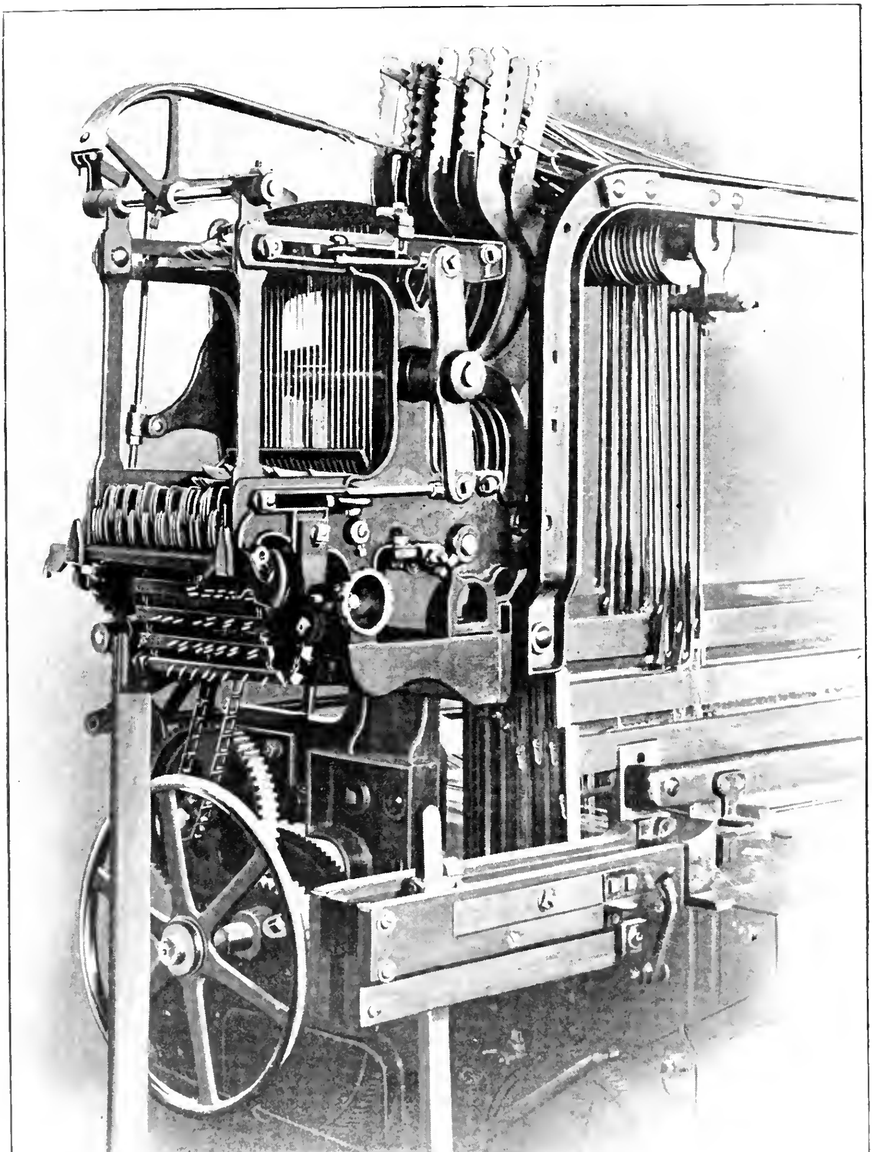
There are other considerations relating to this class of designs which demand attention. It is generally recognized that where a figure is formed by the same warp or filling that forms the ground floating over a number of threads, the texture, or number of threads per inch, should be sufficiently close to produce a compact fabric, or one which will have the appearance of compactness. This makes the use of a large number of threads and picks, or heavy yarn, necessary.

In both Figs. 228 and 230 there are long floats between the series of gauze crossings, so as many threads and picks per inch as possible should be used, but from the nature of cross weaving a large number of threads and picks cannot be used. If a heavier yarn is used, the number of threads and picks per inch will be reduced in proportion to the increased size or diameter of the yarn, because the crossing takes place between the picks and each pick will be separated from the next by at least the diameter of the yarn which is used. This difficulty will be met in making any kind of figures with plain gauze, and care should be used to select designs in which it may be overcome to at least some extent.

Another feature of plain gauze is that one of the chief objects is to produce as much contrast as possible between the gauze ground and the figure. To do this two things are necessary; *first*, to form a close compact figure; and *second*, to have the texture of the ground as open as possible.

It has just been shown that it is not an easy matter to obtain a close figure by any of the methods described up to this point, because of the influence of the crossing. At the same time, it is not an easy matter to obtain the desired degree of openness in the gauze because of the thickness of the yarn, or the attempt to press it closely together to improve the appearance of the part that is not gauze. The fact may be stated generally that, with the method of working just explained, the two important conditions, *i. e.*, openness of gauze and compactness of the rest of the cloth, cannot be obtained with any degree of perfection. It is, therefore, necessary to resort to other means.

There are two distinct methods of obtaining the requisite openness in the gauze, and a close texture in the plain and figure, and they may be employed either separately or combined. The first is to introduce more than one pick of filling into one shed between the



IMPROVED DOBBY WITH ATTACHMENT FOR LENO WEAVING

Crompton & Knowles Loom Works

crossings, and the second is to cause the crossings to take place with more than two threads, as has always been the case up to now.

It is very practical to take four, six, or almost any other reasonable number of threads and cross two over two, three over three, or in any manner desired to produce the requisite openness, because by so doing there is greater bulk at the point of crossing and of necessity there is a greater space between the threads so crossed than if they had simply been crossed in pairs.

Taking up the first method, it is quite clear that if only one doup is employed, and if that doup has to share in the formation of plain,

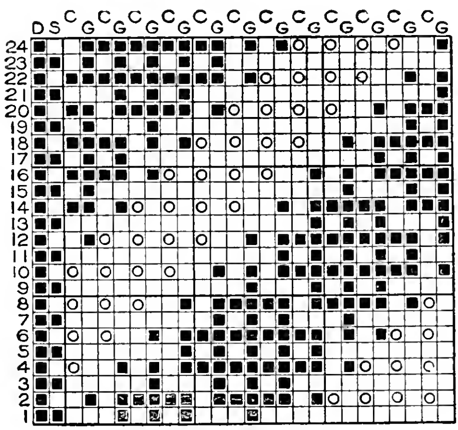


Fig. 329.

that more than one pick cannot be inserted between the crossings, because of the doup having to rise at alternate picks. It is therefore clear that the method of working with one doup crossing one thread is out of the question. It is equally clear that if more than two threads are to cross each other a different system of douping must be resorted to.

The following chapter takes up this matter and explains methods of combining parallel and cross-woven methods of interlacing so as to produce any texture required.

Open-Work Leno Designs. The need of other methods of crossing in addition to the one-thread-crossing-one system has been shown by the effect of this method on the texture. Furthermore,

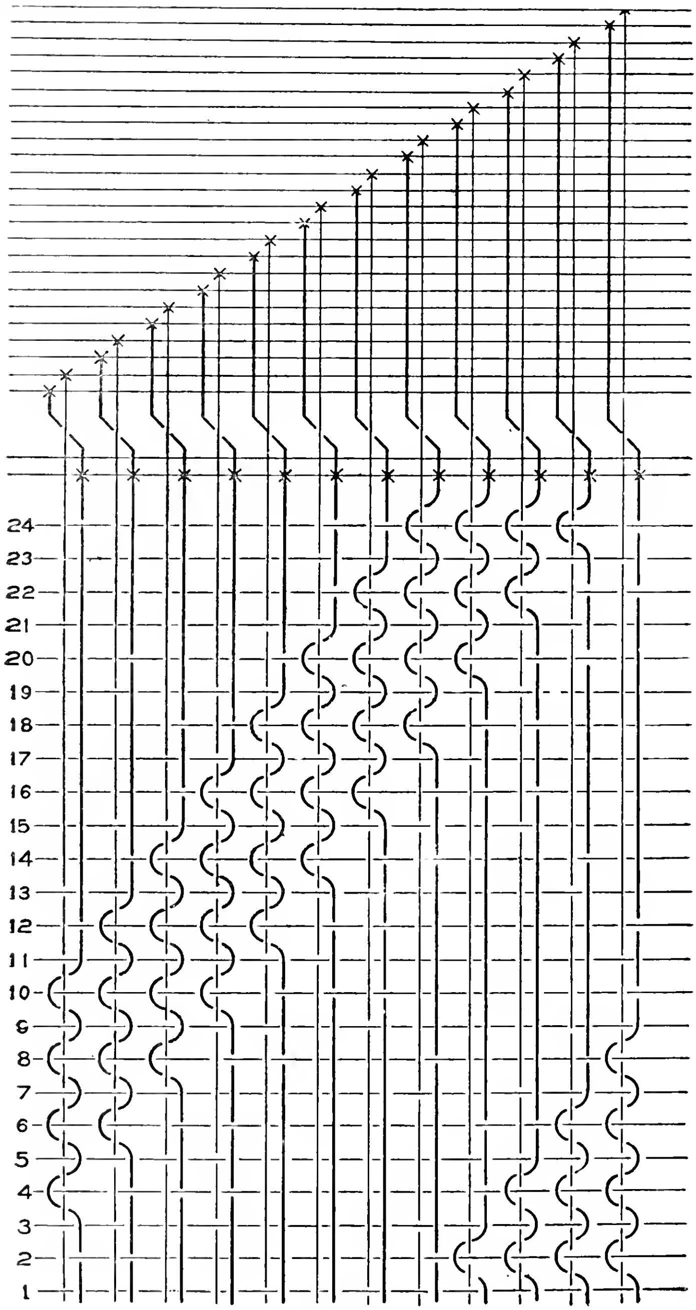


Fig. 330.

many patterns are formed by varying the methods of crossing, no attempt being made to form figures, such as produced by ordinary weaving. This class, however, is the highest type of cross-woven fabric, or any other class of woven fabric, and has the appearance of lace, the filling and warp both being deflected to form the characteristic open work. The largest class of leno designs is between the fine lace-like patterns and those made on the one-thread-crossing-one system.

Crossing threads may pass over or under any practical number of threads, as easily as they cross one thread, and these crossings may be the groundwork for figured cloths, or they may form figures. If they form ground for figures, the latter may have a compact texture, because the threads which are worked together in the crossings may have different methods of interlacing in the figures. This system may be applied equally well when the crossings form the figure and the ground is a compact weave, by running several threads together to form the gauze.

These are perhaps the most useful applications of the one-thread-crossing-more-than-one principle; *i. e.*, to form a compact figure on an open ground or to form an open figure on a compact ground. Other useful features will become apparent in the course of the explanation.

Following the same methods as were used in plain gauze, the system will be taken up in a graded manner, the simplest principles being illustrated and explained with a view to establishing firmly the differences between one thread crossing one, and one thread crossing more than one.

The illustration in Fig. 331 shows one thread crossing three others, which are interlaced in plain order between the crossings. Other illustrations show twills combined with cross weaving. Each individual thread in these designs should be followed, and especial attention should be given to the interlacing of the crossing threads.

Assume that it is necessary to form a pattern in which plain and cross weaving are combined, the effect to be alternate stripes of plain and cross weaving running across the cloth. This pattern is shown in the section on simple cross weaving, but the cross-woven effect in the present instance is to be of a more open character than the previous example. From previous remarks it will be inferred that the open effect can be obtained only by having a larger number of crossing threads, or by having a larger number of threads crossed by them. It may be obtained by one thread crossing two threads, by one thread crossing three, by two threads crossing two, or by any similar arrangement.

For a first example, it will be convenient to deal with one thread crossing three, as by that method the general principles can be brought out in such a manner that the details will be thoroughly understood.

Fig. 331 shows a pattern which consists of five picks of plain cloth and one pick on which the crossing takes place. To make the space

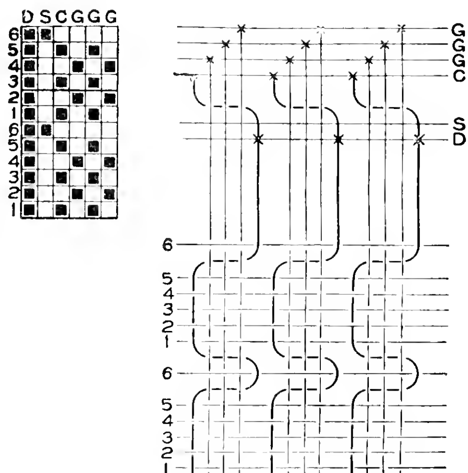


Fig. 331.

between the crossing pick and those on each side of it larger than it would be with one thread crossing one, the crossing thread crosses three threads. To produce this effect, the method of drafting and douping the pattern is different from any of the examples previously explained, and will perhaps require a little study.

The illustration shows a plan of the cloth, also the arrangement of harness, drawing-in draft, and chain. The ground harnesses are marked G, crossing harness is marked C, and the standard and doup are marked S and D respectively. The ground threads are drawn in on the ground harnesses and the crossing thread is drawn in on the crossing harness, then passed under the three ground threads and drawn through the doup.

Analyzing the plan in conjunction with the harness chain, the effect of lifting the harnesses is found to be the same as in previous examples, except that the standard and doup being lifted, draws the crossing thread under three threads instead of under one. This is due to the doup being at the right of three threads instead of being only one thread to the right.

It is equally impossible for the crossing thread, drawn in on the arrangement where the doup is one thread to the right of the crossing harness, to cross under three threads, as it is for the crossing thread drawn in on the present arrangement to cross under only one thread. Therefore, it may be accepted as a general rule that when the crossing thread is drawn under the ground threads, it must be drawn under as many threads as it is crossed under when passed from the heddle on the crossing harness to the doup.

Returning to the analysis of the plan and harness chain, it will be noted that the first pick on the harness chain has the doup, crossing, and the second ground harness lifted, which raises the crossing thread over the filling on the left of the ground thread, and also raises the second ground thread, as this is the one drawn in through the second ground harness.

On the second pick, the doup and the first and third ground harnesses are lifted, which of course lifts the first and third ground threads over the filling. The crossing thread and second ground thread are under the filling, as neither the standard nor crossing harness nor the second ground harness is lifted.

The third and fifth picks are like the first, and the second pick is like the fourth. The crossing takes place on the sixth pick by raising the standard and doup in just the same manner as in plain gauze weaving.

The first pick after the sixth is like the first pick at the bottom of the design, and shows how the crossing thread is drawn back to the left of the ground threads by raising the crossing harness and doup. Two repeats of the pattern are given in the direction of the filling, and three repeats in the warp, the object being to show the continuity of the pattern and to give a better idea of the effect.

There is one feature of this design which merits special attention. In the pages on simple leno effects, it is stated that there should be an uneven number of picks of plain between the crossings so that the crossing thread may pass over both the pick preceding and the pick following the crossing. Note that this plan is followed, as is shown at picks five and one.

Summarizing the operation of making this pattern, and comparing it with others made on the one-thread-crossing-one system,

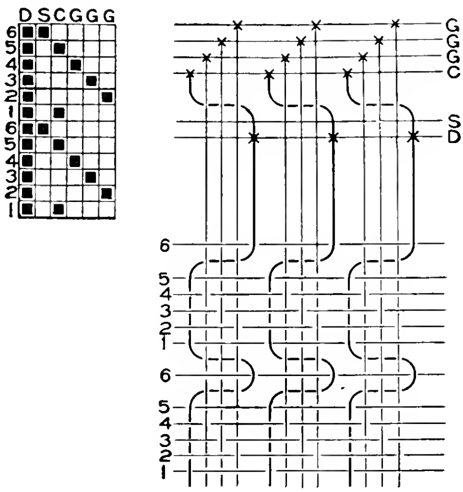


Fig. 332.

the differences are as follows: The arrangement of harnesses and the operation of drawing-in the warp are different, and when the standard and doup are lifted the crossing thread crosses three ground threads instead of one. The latter is a direct result of the former, so practically the only new feature is the method of drawing in the warp threads.

When four harnesses in addition to the standard and doup are employed, as in Fig. 331, it is not necessary to confine the ground to the plain weave, as other weaves may be combined with this principle of crossing. As there are four harnesses, a four harness twill may be used, as shown in Fig. 332, the ground weave in this illustration being the one up three down *swansdown* weave. Note that the crossing thread is over the picks on each side of the crossing, as in previous examples.

A careful study of Fig. 332 shows that the arrangement of harnesses and drawing-in draft is the same as in Fig. 331, the difference in the plan of cloth being due to the harness chain. Referring to the chain we find the one up, three down weave on the ground and crossing harnesses, the crossing being formed by lifting the standard and doup in the usual manner. Of course, the ground weave might be repeated any number of times between the crossings, if this were

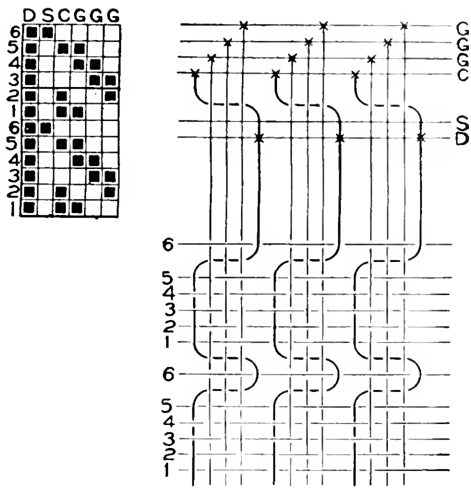


Fig 333.

necessary, but it would be a good plan to have one pick more than even repeats, so that the picks on each side of the crossing would be the same.

The illustration, Fig. 333, is another example of the four harness ground weave combined with a crossing. In this instance the four-harness cassimere twill, two up, two down, is used. The method is the same as in previous examples, so it will be unnecessary to go into details. It will be valuable to study these illustrations comparing the plan and drawing-in draft with the harness chain or design, for the principles illustrated in these three examples are extensively used in leno designing. The method of crossing one thread under more than one may be extended and used in connection with other weaves to produce more elaborate patterns by the use of a larger number of harnesses.

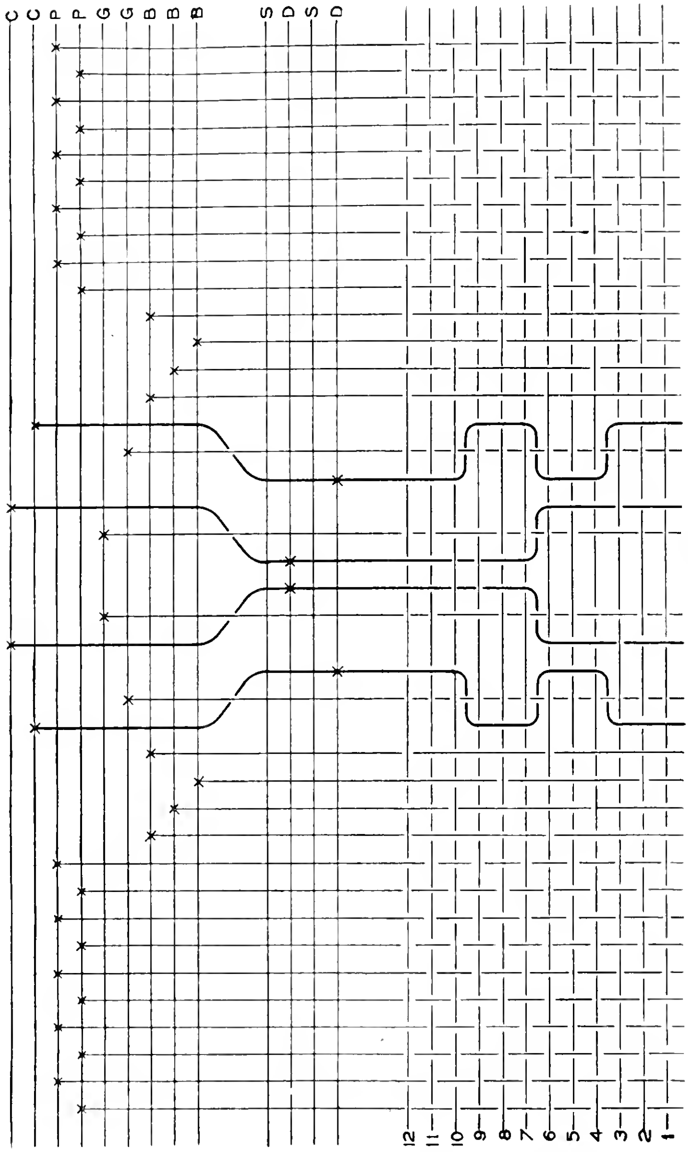


Fig. 334.

Leno Stripes. It has been previously stated that large varieties of patterns can be formed by simply varying the number and position of the ground and the crossing picks, and it is unnecessary to illustrate this further, but most of the patterns formed in this manner would show stripes crossing the cloth. While this is not always objectionable, stripes running lengthwise or in the direction of the warp may be more desirable. These are made by the arrangement shown in Fig. 334.

The threads which are to form the cross-woven portion of the pattern are drafted and douped in the manner shown in the illustration, while the threads forming the ground between the stripes are drawn in on the ground harnesses in the usual manner. This necessitates the use of what are known as stripe harnesses and doups, which are harnesses arranged in such a manner that there will be a number of heddles at specified distances, and then a space in which there are no heddles. The spaces on some of the harnesses correspond to the places where there are heddles on other harnesses, which gives the required number of heddles for each repeat of the pattern.

The plan of the cloth shows a combination of leno, sateen, and plain weaving. The threads forming the leno stripe are drawn in on the doups, ground and crossing harnesses, which are marked D, G, and C, respectively. The threads forming the sateen stripe are drawn in on the harnesses marked B, and the threads for plain are drawn in on the harnesses marked P.

Two doups and standards are required, as the first and fourth pairs of crossing and ground threads do not "work" in the same manner as the second and third pairs. In fact, the first and fourth pairs, although drawn in on the same harnesses, do not work the same, but the difference is merely a difference in the side of the ground thread on which they weave, the first crossing thread being on the right side of the first ground thread when the fourth crossing thread is on the left side of the fourth ground thread, and *vice versa*. This is obtained on the full gauze principle, one crossing thread being drawn through the doup at the right of the ground thread and the other being drawn through the doup on the left of the ground thread.

The same difference will be noted in the second and third pairs of threads. Two harnesses are allowed for the plain weave, and three harnesses are allowed for the threads weaving in sateen order, which makes a total of nine harnesses, in addition to two standards and doups.

The harness chain is shown in Fig. 335. The letters correspond to the letters on the harnesses in the plan, and the numbers correspond to the figures on the picks. A cursory examination of the chain shows nothing unusual, except perhaps that there are no risers on the first ground harness. The ground threads in the first and fourth pairs of threads forming the leno stripe are drawn in on this harness, and a reference to the plan shows that they are never raised over a pick of filling, so of course the harness on which they are drawn is never lifted.

An analysis of the first two picks would show the following: On the first pick of the chain, both doups, the first three harnesses marked B, the first harness marked P, and both crossing harnesses are lifted. The result as shown in the first pick of the plan is that every odd-numbered thread in the first ten, which are weaving plain, is lifted; four threads on each side of the leno stripe are raised; the crossing threads are all on the crossing harness side of the ground threads and lifted over the filling; and the last ten threads weave in the same manner as the first ten.

On the second pick of the chain the doups, second and third harnesses marked B, second harness marked P, and the crossing harnesses, are raised. The effect as shown in the plan is to raise the even-numbered threads of those weaving plain. The first, second, and fourth of those forming the sateen stripe, and the crossing threads on the same side of the ground threads as in the first pick. Other picks may be followed in the chain and plan in the same manner.

The stripes of plain sateen or leno may be varied in width and texture, or other weaves may be added at the designer's pleasure.

In laying out an original design of this nature, it would be necessary to take into consideration the textures of the various weaves. For instance, the leno stripe would, of course, be as open as possible. The plain cloth ought to be quite firm, so would require a medium number of picks per inch, depending upon the size of the yarn. The sateen stripe would be "crowded" in the reed to give the characteristic sateen effect.

In the arrangement of harnesses in Fig. 334, only two harnesses are allowed for the plain weave. In some instances, where there is a large number of threads per inch, consequently a large number of heddles on the harnesses, it might be necessary to increase the number of harnesses used for the plain cloth to four, in order to avoid excessive breakage in the warp.

In combining leno stripes with stripes of other weaves, the crossing thread usually crosses more than one ground thread. When one thread crosses three or five ground threads, better effects are possible, because the chief object is to obtain as much contrast as possible between the openness of texture of the leno stripe and the closeness of the other sections of the pattern. This result is obtained by inserting more than one pick in each shed of the cross weaving, so as to allow a large number of picks to be used, and having the other stripes woven with the twill or any weave which will make a compact texture. This arrangement will give a marked contrast between the cross woven and the ordinary woven stripes.

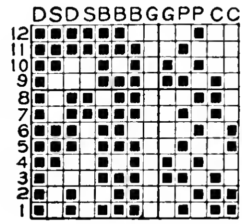


Fig. 335.

The limit of variation has not been reached with varying the texture, however, for the threads which are forming the leno stripe may change from cross weaving to ordinary weaving, and form plain, twilled, or even figured cloth. This simply means that, as shown in previous examples, the crossing harnesses would work in the same manner as regular harnesses, just as though the doup had no connection with the pattern.

The form of cross weaving might also be changed, thus forming different degrees of openness in the leno stripe. It will be understood that the jacquard may be used in the same manner as an ordinary loom, when the patterns are too elaborate to be woven or a practical number of harnesses. The threads would be drawn through the eyes of the harness cords in the usual manner and those which are to form leno would be drawn through a doup, just as if a dobby or head motion were being used.

The jacquard is not used, however, except when it is impossible to produce the patterns on harnesses, on account of the expense of operating the jacquard machine. Patterns which are seemingly beyond the range of harnesses may be woven on them by a judicious arrangement of the harnesses.

The illustration Fig. 336 shows a design which consists of cross weaving, plain cloth, and small figures. The plan of the cloth and the drawing-in draft are shown in Fig. 337. It might be supposed that this design is beyond the range of a dobby or head motion, but by careful arrangement it may be woven on sixteen harnesses with one standard and doup, as shown by the harness chain in Fig. 338.

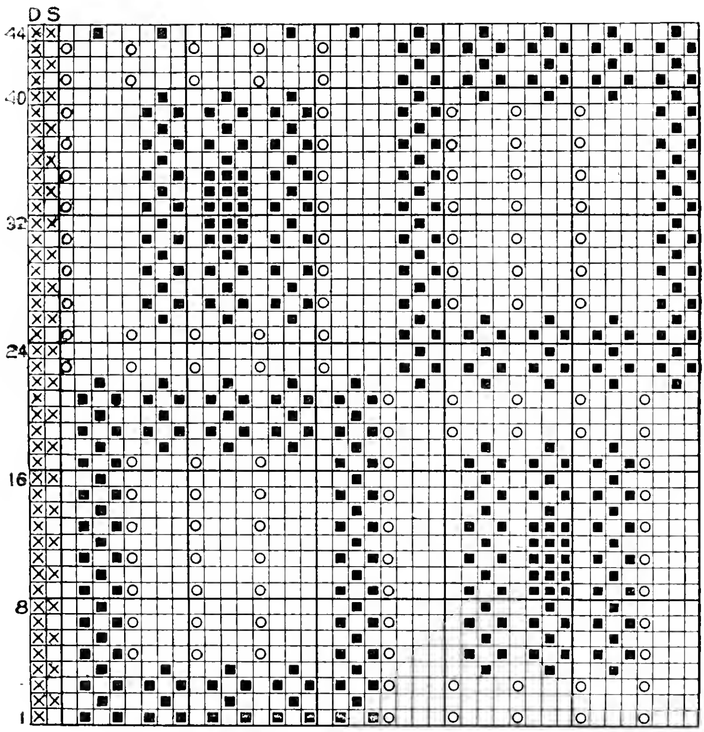


Fig. 336.

Reference to the drawing-in draft shows that every crossing thread is drawn under three ground threads, and the chain shows that the standard and doup are lifted at every alternate pick, to weave plain cloth between the crossing places. This is similar to previous examples, and limits the design to one pick in each shed. Sufficient openness of the texture is obtained, howeve., by the crossing thread passing under three ground threads.

If this pattern required the crossing thread to be on the crossing harness side of the ground threads when weaving plain, more har-

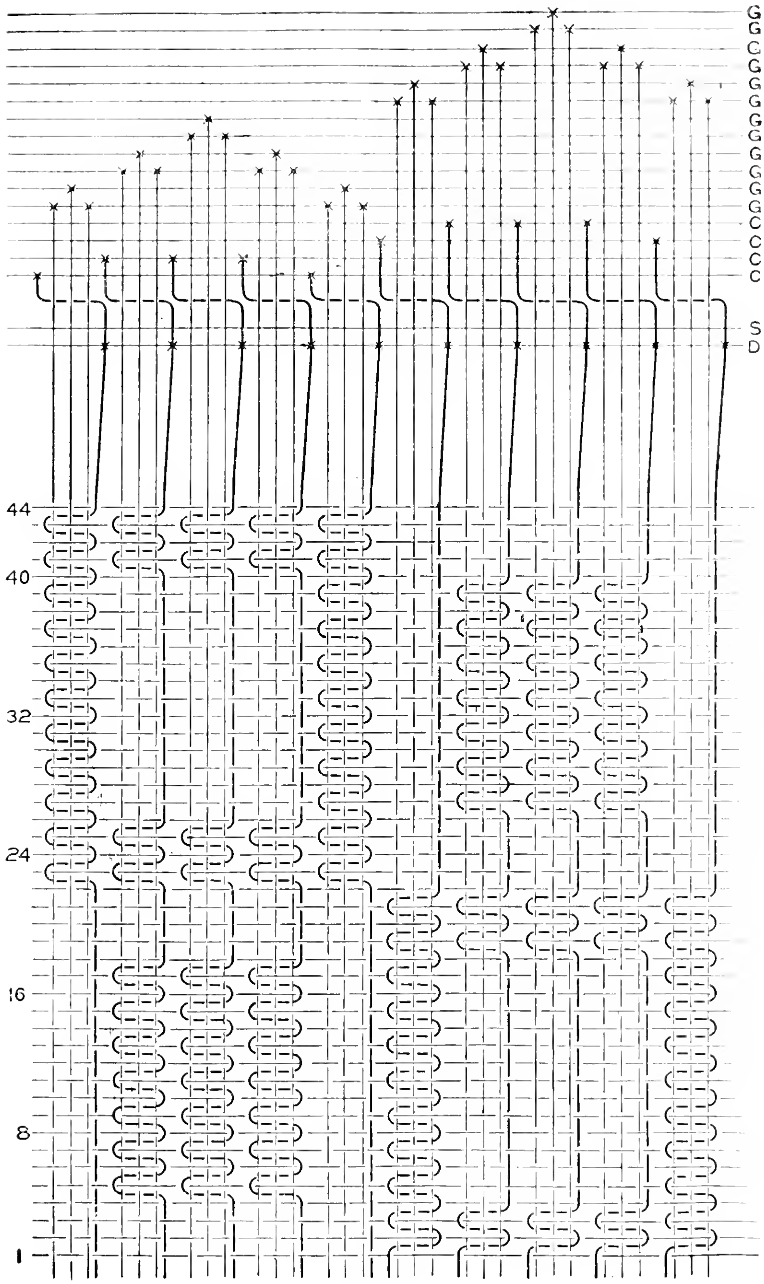


Fig. 337.

nesses would be needed than could be operated by a harness motion, consequently the jacquard machine would have to be used.

It is unnecessary to explain how each crossing is formed, as the full design, chain, and drawing-in draft may be compared, and the result observed by studying the enlarged plan of cloth. The circles show where the crossing harnesses are lifted and the crosses in the full design, Fig. 336, are on the standard and doup, as these are not, strictly speaking, a part of the design.

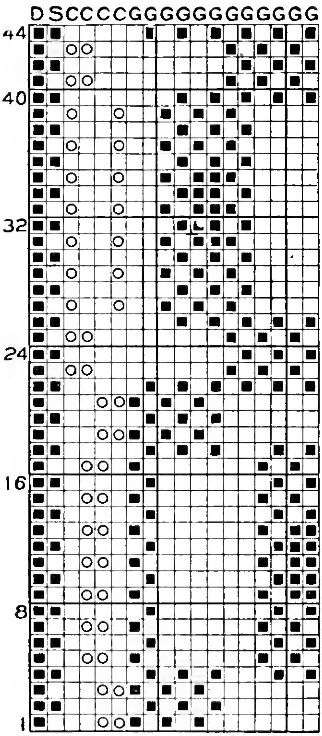


Fig. 338.

On the first pick of the harness chain, the doup, third, and fourth crossing harnesses and the first, third, and seventh ground harnesses are raised. The result shown in the first pick of the enlarged plan is as follows: The crossing threads drawn in on the third and fourth crossing harnesses—the sixth, seventh, eighth, ninth, and tenth—are raised over the filling at the left of the three ground threads with which they work. The ground threads drawn in on the first, third, and fifth ground harnesses (shown in the drawing-in draft at the top of Fig. 337) are raised to form plain cloth. All other threads are under the filling and the crossing threads which are not crossed; *i. e.*, those drawn in on the first and second crossing harnesses, form part of the plain cloth.

On the second pick, the standard and doup, and the second, fourth, and sixth ground threads are raised. The effect shown in the second pick of the plan is as follows: All the crossing threads are on the doup side of the ground threads and raised over the filling. The ground threads drawn in on the second, fourth, and sixth ground harnesses also pass over the filling. The third pick is like the first and the fourth is like the second.

From this point other crossing and ground harnesses are raised with the effect shown in the plan. Each thread should be carefully followed and the two small warp figures, on the third and ninth sets of threads respectively, noted in their relation to the harness chain.

TEXTILE COLORING

Up to this point, with the exception of a few pages in Part I in which the method of forming simple stripe and check effects by combing various colored warp and filling threads with suitable weaves, the weave or combination of weaves used in textile designing have received most of our attention. The manner of interlacing the threads does not, however, represent all that requires attention, for in many cases the colors are quite as important as the texture or form.

By most textile writers the elements of woven patterns are stated as *weave* and *color*. The first is the basis of cloth manufacture and relates to the build or structure of the fabric. Though weave may be regarded in textile designing as a constructive and not an ornamental component of the pattern, there are numerous examples in which it possesses both these characteristics. For instance, the gauze and leno designs explained in previous pages do not rely upon schemes of color for their effect. The structural plan of the cloth is such that a firm and even cloth, which is decorated with a pronounced and decided pattern, is produced. Common twills, piqué designs and other combinations of weaves also have this combination of constructive and ornamental powers.

Color is very differently related to textile design. Its specific province is to brighten and improve the qualities of the design produced by the weave.

An analysis of woven cloths will show the extensive use of color in textiles. In some branches, such as woolen goods, it is the distinguishing element of the cloth. To remove color from such goods as cassimeres, shawls, or rugs would remove the chief qualities of the cloth, so in this instance, color is at least as important as weave. In other instances color is a supplementary element giving precision to the composition of the weave.

Theory of Color. The science of color teaches the nature and causes of color, their distinctions, their relations to each other, their classification, the mental effects that attend them, and the causes and laws of color harmony.

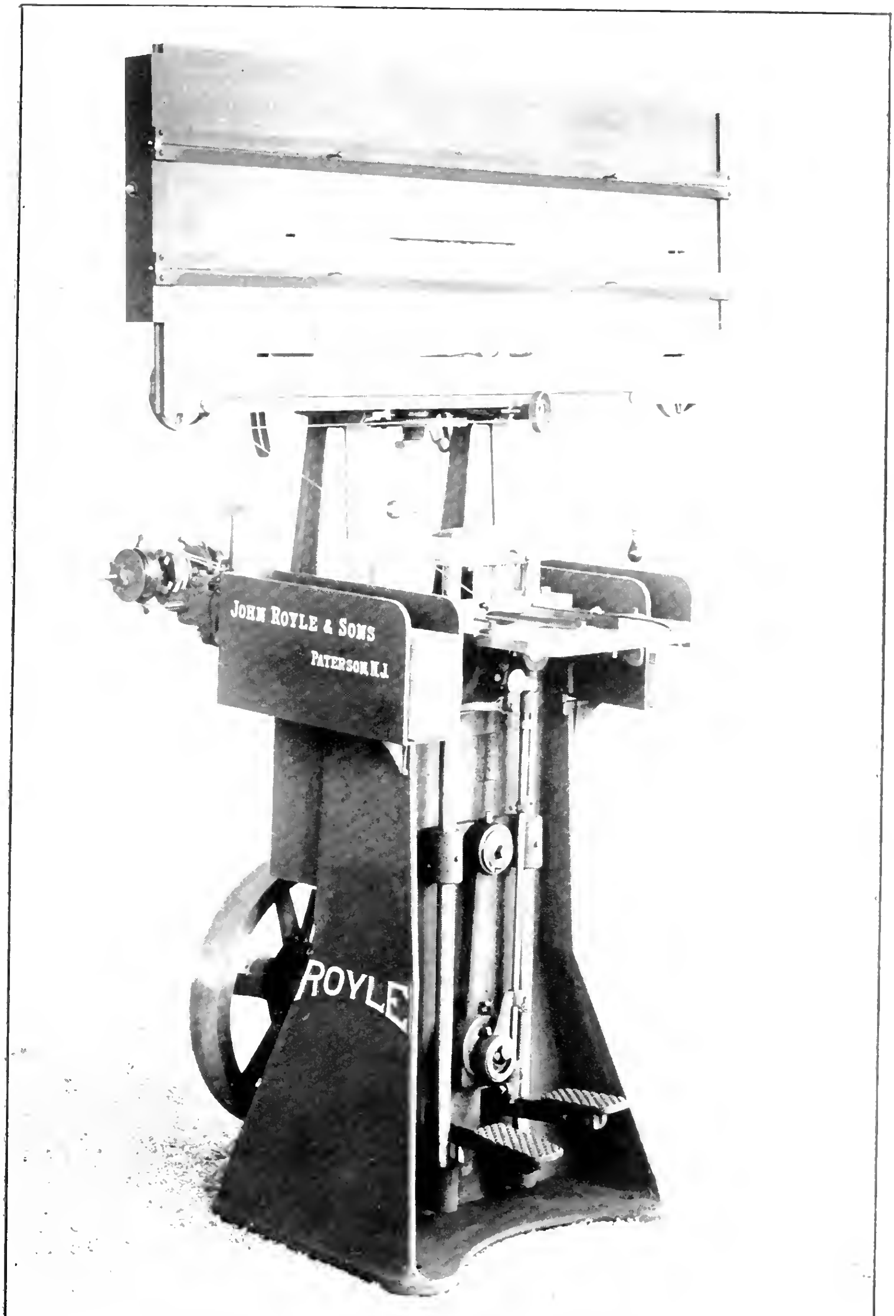
There are two important theories of color: *i. e.*, the pigment theory and the light theory. The light theory will be explained first for it deals with the phenomena of color and explains the laws which control the modification of the intensity, tone, and hue of colors.

In the light theory, white light is said to be pure light and to contain all colors. By a simple and inexpensive experiment it is possible to acquire a useful knowledge of the composition of white light. A glass prism is fixed in a darkened room so that a ray of light may pass through it. This gives an analysis of light which shows it to be composed of different colors. Thus, when the ray of light passes through the prism it is bent out of its path, and thereby decomposed, producing what is termed a spectrum. The spectrum shows every gradation of color but the following division is generally accepted as most satisfactory: red, orange, yellow, green, blue, and violet.

The results obtained by this prismatic experiment form profitable and suggestive exercises in color combinations. They are always harmonious and the colors are much richer than those obtained by pigments.

The pigment theory deals with color as an active element in decorative design and is adopted in the applied arts. It is the theory that can be worked out in practice. According to its principles, red, yellow and blue are separate pigments and by mixing them in variable proportions, and, of course, toning and tinting with white and black, every possible tone and hue of color may be obtained. Thus yellow and blue give green; yellow and red give orange; and red and blue give violet.

Classification of Colors. All colors belong to one of two distinct classes: *i. e.*, *Simple Colors* and *Compound Colors*. Simple colors cannot be divided into other hues or colors; in other words they are individual colors. Compound colors, being the result of combining two or more other colors, may be divided into their constituent colors. Various writers on the subject do not agree on the classification of colors, but when the color is considered with a view to its practical application it is necessary to base all combinations on New-



ROYLE'S POWER PIANO CARD CUTTING MACHINE

ton's theory, that red, blue, and yellow are simple colors and all other colors are the result of mixing these three in various proportions.

There are two classes of compound colors, namely, *Secondary Colors* and *Tertiary Colors*. The Secondary Colors are green, orange, and violet; and the Tertiary Colors are russet, citrine and olive. The constituent parts of these colors will be taken up later.

The principles and classification of colors being understood we will confine our attention to the color pigments in their relation to textiles. To know the value of color it is necessary to learn something of the laws which govern color harmony. The influence of one color over another as to whether the effect is pleasing or otherwise is the subject which occupies the attention of the textile designer, for the success of his patterns depends upon a judicious selection and use of materials.

There are two reasons for applying colors: *first*, to give objects a better appearance; and *second*, to assist in the separation of objects, or parts of objects, thus giving assistance to form. The truth of the first reason is self-evident and need not be discussed. The value of the second reason is evident, but a brief explanation may make it clearer.

If objects of the same, or nearly the same, color are placed near one another, there will be more or less difficulty in determining the boundaries of each object. If widely different colors are used, there will be no difficulty in determining the extent of the figures or objects.

Thus color assists in the separation of form, or renders form apparent. In textile goods, this applies to almost all patterns where there is a ground fabric with some form of ornamentation.

The following axiomatic statements will serve to explain the subject of color and make following statements clear.

(*a*) Regarded from a scientific point of view there are but three colors; *i. e.*, blue, red and yellow.

(*b*) Blue, red and yellow are termed primary colors, as they cannot be formed by the admixture of any other colors.

(*c*) All colors except blue, red and yellow result from the admixture of the primary colors.

(*d*) By mixing blue and red, purple is formed.

(*e*) By mixing red and yellow, orange is formed.

(*f*) By mixing yellow and blue, green is formed.

(*g*) Colors resulting from the mixture of two primary colors are termed secondary colors. Thus, purple, orange, and green are secondary colors.

(*h*) Colors formed by mixing two secondary colors are termed tertiary colors.

(*i*) By mixing purple and orange, russet, the red tertiary, is formed.

(*j*) By mixing green and purple, olive, the blue tertiary, is formed.

(*k*) By mixing orange and green, citrine, the yellow tertiary, is formed.

The diagrams A, B, and C in Fig. 339 will be found useful in studying the various colors. Diagram A represents the primary colors. Diagram B shows the secondary colors in their relation to the primary colors. For instance, orange is formed by the mixture of red and yellow, so that orange is represented between red and yellow. Diagram C shows the secondary and tertiary colors in their proper positions with relation to the manner in which they are formed.

Relation of Color to Textiles. There are peculiarities of textile manufacturing which make impracticable many of the rules which apply in ordinary surface decoration. The structure of the cloth and the purpose for which it is to be used determine the coloring and the systems of distribution. An arrangement of colors might be excellent for a rug or carpet which would hardly become fashionable in clothing.

The effects of the various animal and vegetable fibers on colors also are interesting. On cotton colors are dull; on woolens color has a peculiar depth; on worsteds they are bright and definite; while on silk they are brilliant. These results are due to the properties of the various fibers, therefore, it is clear that while ordinary surface decorating has laws which are impracticable in textile designing, the latter also has laws which do not apply to the former.

In addition to the method of forming simple stripe and check effects, as explained in Part I, by employing various colored threads in the warp and filling with suitable weaves, there are three other methods of employing color as follows:

(*a*) By blending various colors of material in the raw state.

(*b*) By combining colors to form twist and novelty yarns.

(*c*) By using an extra set of warp or filling threads.

In the first method, the materials are combined before carding, being thoroughly mixed in the carding operation. This system of

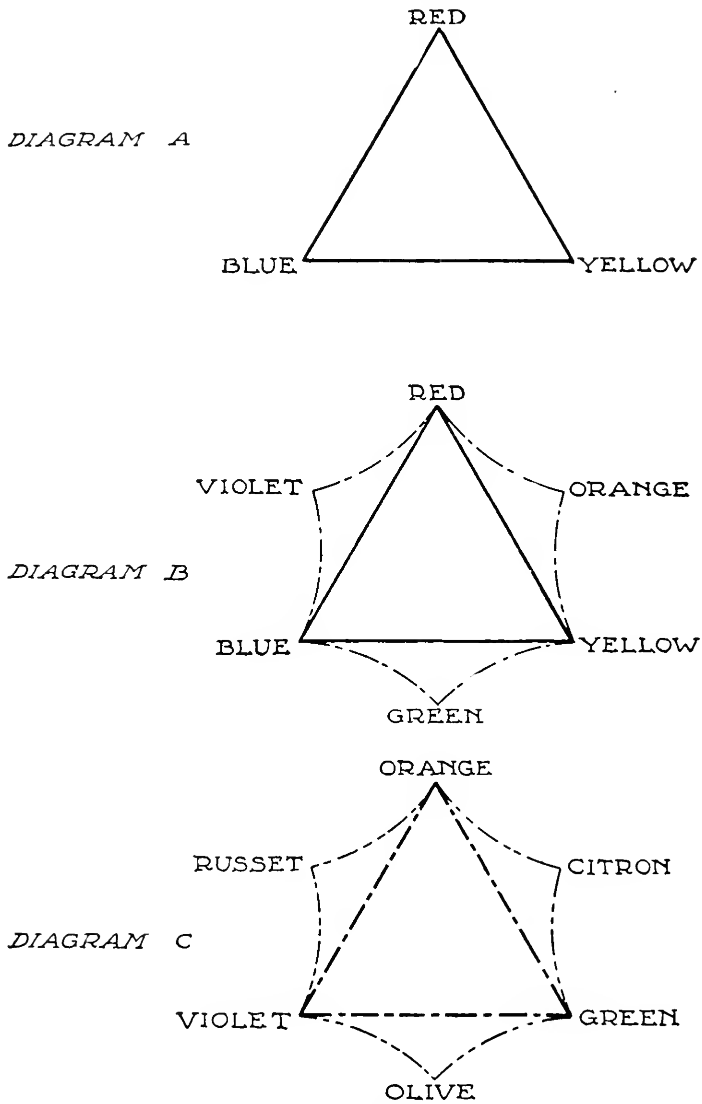


Fig. 339.

forming mixtures produces yarns in which the separate particles of color are uniformly distributed. The mechanical arrangement of carding offers every facility for obtaining perfectly mixed and soft-toned blends.

The second method produces yarns in which distinct colors are visible, while the third method is used in making spot designs by employing extra yarns.

To become a good colorist one must have the ability to discriminate between good and inharmonious combinations, and one of the best methods of acquiring this quality is to form collections of the best fabrics of each season. This method is helpful also because a designer is, to a large extent, governed by fashion, and fashions move in cycles.

The primary and secondary colors are very potent and are generally mixed with white or black to reduce their intensity. They are seldom used for the ground work patterns, their chief use being in the form of *fancies* to give additional tone to the pattern.

A list of the characteristics of the various colors will be given to guide the efforts of those who are not familiar with the qualities of colors in woven fabric structure.

Colors of the Spectrum. By passing a beam of light through a glass prism a spectrum is formed, as previously explained, by the white light being divided into its constituent colors. These colors are the primary and secondary colors, previously explained on the pigment theory. As it is necessary to adopt a standard of color, the six colors of the spectrum, *i. e.*, red, orange, yellow, green, blue, and violet, are sometimes referred to as colors, and all variations in tints, shades and hues are considered modifications of these six colors.

The colors of the spectrum are referred to by different writers as standard, spectral, positive, pure, full, and saturated colors. The name normal is generally accepted as it expresses the natural condition of color when affected by light.

Tones. The term tone covers the entire scale of color from the darkest shade to the lightest tint, so in a perfect scale of tones the grading from one shade to another or from one tint to another, would be so slight that it would be almost imperceptible. A scale of tones ends in white in one direction and in black in the other direction. It follows that tones are produced by adding white or black to the normal color.

Tint is a tone which is lighter than the normal color. Tints are produced by adding white to the normal color. Shade is a tone which is darker than the normal color. Shades are produced by adding black to the normal color.

Hue. This term is applied to a color when the normal color has been modified or changed by the addition of another normal color. For example, if a small amount of blue is added to red, a blue-red would be formed. This blue-red would be a hue of red. If a small amount of green is added to blue the result would be a green-blue. The last name indicates the normal color in the scale and the prefix is the color added.

Broken Colors are the normal colors dulled more or less by the addition of a gray.

Value is the luminous intensity of a color, tone or hue in its relation to other colors, tones or hues. It is very necessary to keep the values of the various colors used in composition to produce a harmonious balance of tone or intensity so that the combined effect will not be injured by an excess of any color.

For example, a light blue and a pink will combine and harmonize as far as values are concerned. However, equal quantities of a normal red and light blue would not harmonize in value because the greater intensity of the red would overpower the light blue. When the intensities differ the quantities used must be in proportion. It is very seldom that equal quantities of two or more colors can be used in combination to produce a harmonious effect.

Potentiality is the power of a color, tone, or hue to affect other colors, tones, or hues, when associated with them. The degree of potentiality of the six normal colors is in the following order: yellow, orange, red, green, blue and violet.

Scaling is the arrangement of colors in the order of their intensity. It may be by colors, tones, or hues, or by these combined. The scale of the normal colors consists of their regular spectrum arrangement; *i. e.*, red, orange, yellow, green, blue, violet. A scale of tones would be as follows: lighter blue, light blue, blue, dark blue, and darker blue.

While the term tone covers all the variations of a color that may be produced by adding black or white to the normal color, but one of these may be added otherwise the result will be a broken color. A scale of hues consists of a normal color and its hues. The scale of hues of red would be violet-red, red, and orange-red.

Luminous Colors are those that reflect light in large quantities.

Yellow, orange, red, and green reflect the largest quantity of light and of these yellow is the most luminous color.

Neutral Colors. The effect of these colors is most important. Assume that alternate stripes of red and green are used, or that red figures are used on a green ground, or *vice versa*. The result would be a blurring sensation if the combination were looked at for several minutes. But if the two colors are separated by black or white, or by a tertiary or neutral color, the sensation of blurring will be avoided. In the same manner, if blue and orange are placed next to each other, a blurring sensation will result. The use of dividing lines of neutral colors will prevent this. If violet and yellow are placed together the effect is not so unpleasant, because the two colors although complimentary are more nearly allied to darkness and light respectively. Yet even in this instance the effect is improved by the presence of tertiary or neutral colors.

In addition to this quality of modifying the effect of complementary colors, neutral colors also possess the property of modifying the effect of other colors, possessing the same common element. As is stated above, colors placed side by side have the effect of detracting from each other, but if separated by black or white, or by neutral colors, this mutual detraction is prevented or modified. If, for example, green and blue are placed together, one color will partly destroy the other and the point of junction of the two will hardly be discernible, but if separated by a suitable method the effect is improved, In the same manner any other powerful or bright colors may be dealt with, with the same result.

Combination of Colors. A study of the following combinations will be helpful, and will at least serve as a basis for a more extensive knowledge of the effects produced by various combinations of color.

Red and Blue. In small quantities this is a useful combination, but if used in large quantities the good effect is spoiled. The action of the colors upon each other is that red assumes a bluish cast, or what is termed crimson, while the blue assumes a greenish cast.

Red and Yellow. This combination is very powerful, and great care and skill is needed to use it successfully. Red appears scarlet and yellow assumes a greenish color.

Yellow and Blue. Each color increases in luminosity, lustre and depth. Being contrasting colors, yellow and blue do not suffer much change in hue by association. In such combinations one color gives precision to the qualities of the other.

Red and Green. Red appears exceedingly bright, the lustre and fullness of the hue being emphasized. The softness of hue is emphasized in the green. Being complementary colors, they also give precision to the qualities of each other.

Red and Violet. Red becomes more scarlet and assumes a yellowish cast, while the violet assumes a greenish cast. This combination cannot be used to good advantage.

Red and Orange. This is a very powerful blend, and therefore is little used. Red becomes more violet and orange becomes yellowish.

Yellow and Violet. This is an excellent combination, both colors gain in lustre, luminosity, and strength, and form a perfect or complete contrast.

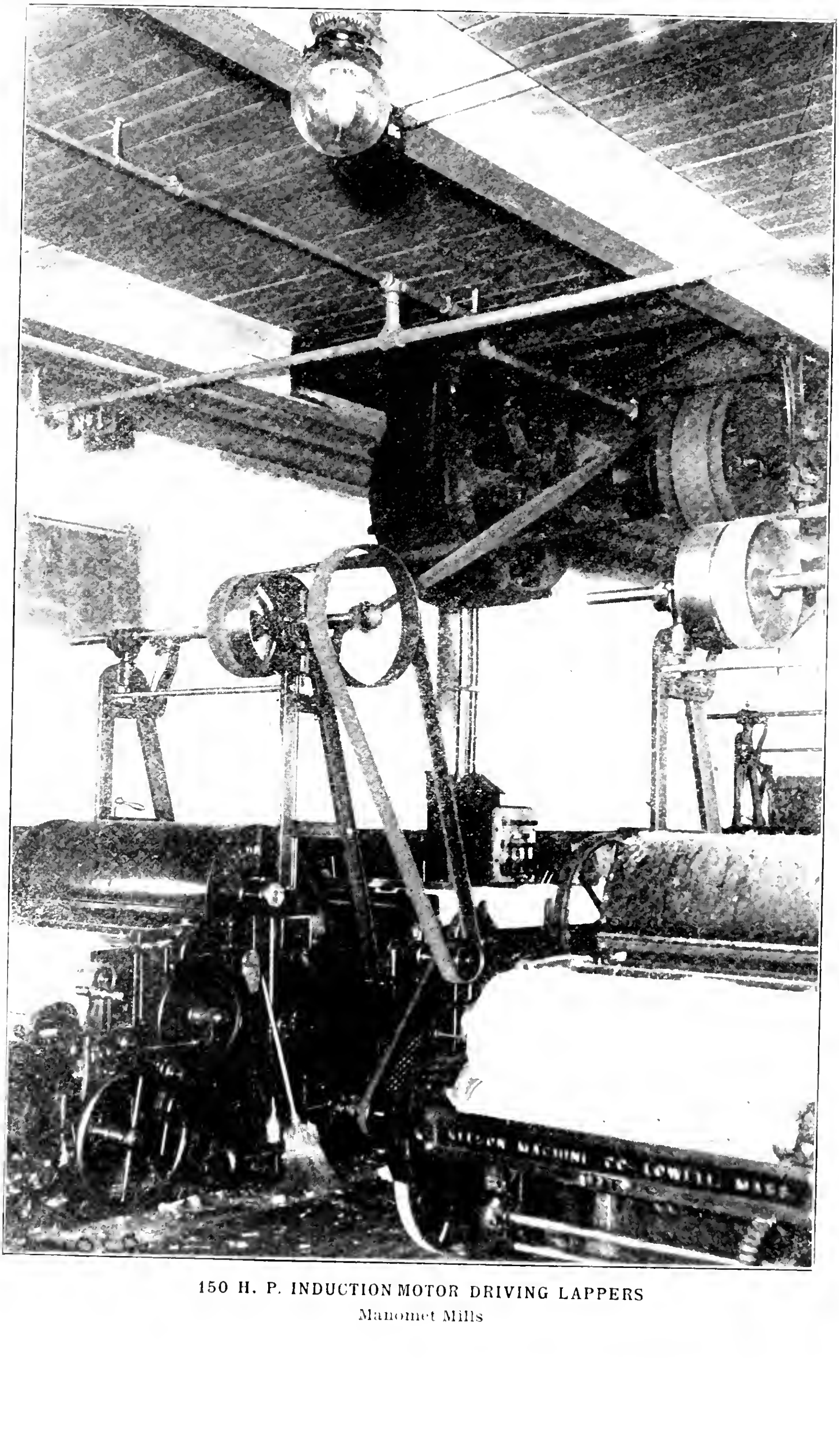
Blue and Orange. Both colors are increased by association, but must be used with great care.

Orange and Green. This is a very strong contrast; orange appears scarlet, and the green assumes a violet cast.

Violet and Green This is not a good combination, although it is used to a great extent. Violet assumes a reddish cast, while the green appears yellowish and much flatter in tone.

Violet and Orange. This is considered an excellent and effective combination. The violet is slightly greenish and the orange becomes more luminous or yellowish.

The following qualities of colors should be kept in mind when they are being used. Blue is a cold color and appears to recede from the eye. Red is a warm color and is exciting; it remains stationary as to distance. Yellow is the color nearest to light and appears to advance to the eye. At twilight blue appears much lighter than it is, red appears much darker, and yellow appears much darker. By ordinary gaslight, red becomes brighter and yellow becomes lighter. Thus it will be noted that the color is determined by the nature of the light and the physical properties of the material to which the color is applied.



150 H. P. INDUCTION MOTOR DRIVING LAPPERS

Manomet Mills

COST FINDING

One needs but a casual acquaintance with the industrial world of the present day to be aware that the astonishing progress of the past few decades is due to the application of scientific and exact methods. One of the latest manifestations of this spirit is in the attention paid to, and the interest shown in, accurate and economical systems of accounting, and precise methods of determining costs of production or operation. Nor can the latter be separated from the former. It must be stated at the outset and with emphasis, that *a proper and accurate system of book-keeping lies at the foundation of any reliable cost determination.* It is therefore fitting to preface a study of cost finding in textile mills by some consideration of the methods of keeping books and accounts.

It is a primary purpose, in keeping the accounts of a business, to maintain a record of its receipts and expenditures, its assets and obligations, so that a statement can be made as often as necessary, showing the condition of the business, the quality and nature of its resources and liabilities, and the amount and source of its gains and losses.

These records may also be so extended as to be useful in showing the particular sort of product which is most profitable, the exact department where economy or extravagance is practiced, the present costs of departments or products as compared with former costs of similar work, the places where expense should be curtailed, and a basis on which to estimate new work.

When the Interstate Commerce Commission began its work, before any substantial progress could be made, it was found necessary to prescribe for the use of all railroads a method or system of keeping accounts which should be made obligatory in the preparation of reports, as no comparison could be made under the various systems formerly in practice. For instance, in the classification of operating expenses there are now four main divisions, and fifty-three headings of accounts. Some other kinds of business making government reports are similarly standardized; and, as these systems have been devised by experts in consultation, they are doubtless effective in accomplishing the desired object. If we were to compare methods of bookkeeping in textile mills, we should find equally various ideas worked up, and doubtless some curious evolutions.

To illustrate this, take the manner of charging up the purchase of oils. Some mills carry an Oil account, into which are charged purchases of castor oil, cylinder oil, lard oil, dynamo oil, spindle oil, and perhaps others, every one of which may be used for a different purpose and in a different department. Another mill will charge them all to supplies and perhaps charge to each department the amount used of various kinds. Another will reason thus: Cylinder oil is used in producing power and is as properly chargeable to Power account as the labor of the engineer or the fuel used. Lard oil is used on cutting tools in the repair shop, and therefore chargeable to repairs. Dynamo oil is used only on dynamos and therefore should be put into Lighting account. And so on. Of course, if all oils are charged to Oil account or under any other title, and a record kept of the quantities and kind delivered each department, these amounts may be charged against such department and the same ends will be served.

It is a valid principle that materials and supplies should be charged to the operations or departments in which they are used, rather than to an account of their own. For example, in a mill finishing its own goods, and buying starch for that purpose and for warp sizing, the starch purchased and used should be charged to each operation in either of the ways suggested above, rather than to a Starch account without proper division.

Perhaps the bills embracing the widest variety of accounts are those for freight, and they are also those which can be most certainly and satisfactorily divided and charged. A general Freight account is an abomination, and freight on a mill's *product* should in particular be separated from all other items, as it is not a charge upon manufacture but upon distribution.

The same principle applies also to labor. If in the outside yard department, one man is kept busy packing waste, a second is engaged in the care of tenements, two more in unloading coal, while another set is handling cotton, the cost of this work should be charged to Waste account, Tenement Maintenance account, and Cotton account, or whatever titles may represent these accounts, rather than be charged in a lump sum to Outside Labor account. The ascertainment of such charges is one of the purposes of bookkeeping.

The number of expense accounts which a mill should carry on will depend upon the character of its product. A mill making an ordinary variety of goods may make at least such divisions as follows and as many more as desired: Cotton, Waste, Manufacturing Labor, Supplies, Repairs, Sizing Materials, Taxes and Insurance, Lighting, Power (with subdivisions Fuel, Supplies, Labor), Salaries and Office Expense, General Expense. There are always some unclassified minor expenses which may be charged thus with propriety, but the temptation to make the Expense account a refuge for carelessness in analyzing expenditures should be resisted.

A cash book with separate columns for each of the principal accounts will save labor in posting, and the accompanying table (See pages 4 and 5) shows how one may be arranged.

It will be noticed that there are two sets of columns on both the debit and credit sides. One set is for a record of the cash, and the other is for the distribution of the charges and credits to the various ledger titles and accounts. One column in the cash record is for the cash in the drawer, and the other one (or as many more as may be necessary) may be used for a check register. No check book with stubs is needed, as checks are entered directly on the cash book.

The second set of columns is for such accounts as may have a considerable number of entries each month. On the debit side there are illustrated one for Rents and one for Cloth Sales. On the credit side are a number, such as Advanced Payments to Employees, Cotton, Sizing Materials, etc. The columns are footed and carried forward to the end of the month, when the footings of these columns are posted to the ledger.

It is not worth while to provide a column for any account in which the labor of posting each entry would be less than that of carrying forward the footings. One or more columns may be left vacant in the heading to be used when any account is receiving temporary money charges, such as Construction or Machinery.

CASH

Manf'd Goods	Rent	Transfers	Sundries	Local Bank	Cash Drawer	Date	Vou. No.	Account	Explanation	Folio	(1)
47 53	65 41	796 40	947 16	8947 82	241 60	Oct. 5		Amounts	Brought forward		(2)
			1000 00	1000 00		6		To John Smith	Deposited to our Cr.	347	(3)
	5 40				5 40			" Sundries	Jas Kent to Date		(4)
10 41					10 41			" "	Cloth Sold		(5)
						7	963	By "	B. & M. Ry to 6th		(6)
								" Machinery			(7)
							964	" J. Russel	On Account	361	(8)
		100 00			100 00		965	" Cash	Withdraw for Drawer		(9)
							966	" Sundries	Paid J. Wagner		(10)
							967	" "	" B. Colvin		(11)
			5000 00	5000 00				To Bills Payable	Discounted Note No. 15	103	(12)
							968	By Sundries	Local Bank 4 mos.		(13)
							969	" "	Eastern Coal Co.		(14)
		1400 00			1400 00	8	970	" Cash	Drew for Pay Roll		(15)
							971	" Sundries	Pay Roll to Oct. 1		(16)
								" Mfg Labor		47	(17)
			69 33					To Adv. Pmts	Collections on Pay Roll	142	(18)
4 60	51 50							" Rent a/c	" " " "		(19)
											(20)
62 54	122 31	2296 40	2016 49	14,947 82	1757 41			Amounts	Carried forward		(21)

RECORD

(1)	Cash Drawer	Local Bank	Sun-dries	Trans-fers	Adv. Pmts.	Power	Repairs	Sup-plies	Expense and Salaries	In-terest	Freight on Goods	Cotton
(2)	124 40	5955 40	346 18	796 40	46 13	842 12	540 00	176 72	250 00	120 00	241 12	2721 13
(3)												
(4)												
(5)												
(6)		261 20				87 62	17 20	5 40			123 10	
(7)			27 88									
(8)	50 00		50 00									
(9)		100 00		100 00								
(10)	13 20				13 20							
(11)	10 00				10 00							
(12)												
(13)		100 00								100 00		
(14)		321 10				321 10						
(15)		1400 00		1400 00								
(16)	1450 57					30 16	49 21		25 00			
(17)			1346 20									
(18)												
(19)												
(20)												
(21)	1648 17	8137 70	1770 26	2296 40	69 33	1281 00	606 41	182 12	275 00	220 00	364 22	2721 13

The sum of the footings of account columns on the credit side should equal the sum of the cash footings on the same side. The work may thus be checked for accuracy as it proceeds. In order to maintain this equality, however, it is necessary to provide a column for Transfers of Cash from Drawer to Bank, or *vice versa*.

The debit side of the cash may be proved in the same way, but due allowance must be made from the cash columns for the amount on hand when the month's business was begun.

Many mill men never realize the difference in the nature of the accounts of expense and income, which they carry upon their books. Probably a majority of establishments have at least three, and sometimes more of these various kinds of accounts.

1. Costs of Manufacturing, including Material, Labor and Supplies.

2. Costs of Distribution, such as Commissions and Freight on Product.

3. Expenses and Income not directly connected with manufacturing, such as Repairs to Tenements, Rent, Storage, etc.

It is not an unusual sight to see mill statements with these accounts reported upon in a confused manner. For instance, Rent account may be made to appear as a profit on Manufacturing.

For a proper system of cost finding it is necessary in addition to the books of debit and credit to maintain careful records of machinery. In each department there should be a permanent daily record of the amount and kind of machinery run on each class of work, and of the amount of work of each kind produced thereon. There should also be a record of all material used, such as cotton, yarn, etc., and of all the kinds of waste made and the amount of each kind. The pay-roll should be properly classified and the occupation of each employee designated. There will, of course, be a record of the product invoiced from the mill, but there should also be a record of its weight before any finishing or aging operation has added to or reduced it.

With these preliminary observations, we may take up the actual work of applying to the results of a period of manufacturing the necessary methods of examination and analysis of the expenses to approximate the costs of manufacture.

As by a mere description, without illustration, it would be difficult to explain the working out of the various processes with sufficient clearness, it will be best to take an imaginary mill, which we will name the Enterprise Cotton Mills, and a supposititious statement of its operations and expenses. These mills had been recently started, and run only about three months, when the manager directed that an inventory be taken of the stock in process of manufacture and of the supplies, fuel, packing, oil, repairs, cotton, waste, etc.; that all bills be paid; that the books of account be closed, and a statement of expenses and income be prepared, and also a statement of the financial condition of the mill.

The bookkeeper was without former experience in cotton mill accounts and some time after the inventory had been completed he came to the manager with an anxious face and reported that while he had not completely closed the books, he had made a few figures in advance and believed the mills were doing business at a considerable loss.

The manager replied that it was quite possible as expenses were heavy in starting up, but that he had expected that there would be a slight profit. He asked the bookkeeper to go over with him the work done in closing the books that he might set a few prices on stock in process.

The bookkeeper replied that he had taken the stock in process at the value per pound of the cost of the cotton used.

"That is not fair," replied the manager, "because for every ninety pounds of roving now on hand, we have used over a hundred pounds of cotton, and every eight hundred and fifty pounds of yarn has taken nearly a thousand pounds of cotton from the warehouse. So that your books show that cotton used cost us about ten cents a pound, while the cotton in every pound of yarn on hand is worth more than that, for it took nearly fifteen per cent more cotton to make it. It has lost that in waste."

"But," replied the bookkeeper, "we have sold the waste for money or we have it on hand, and I have it also in the inventory."

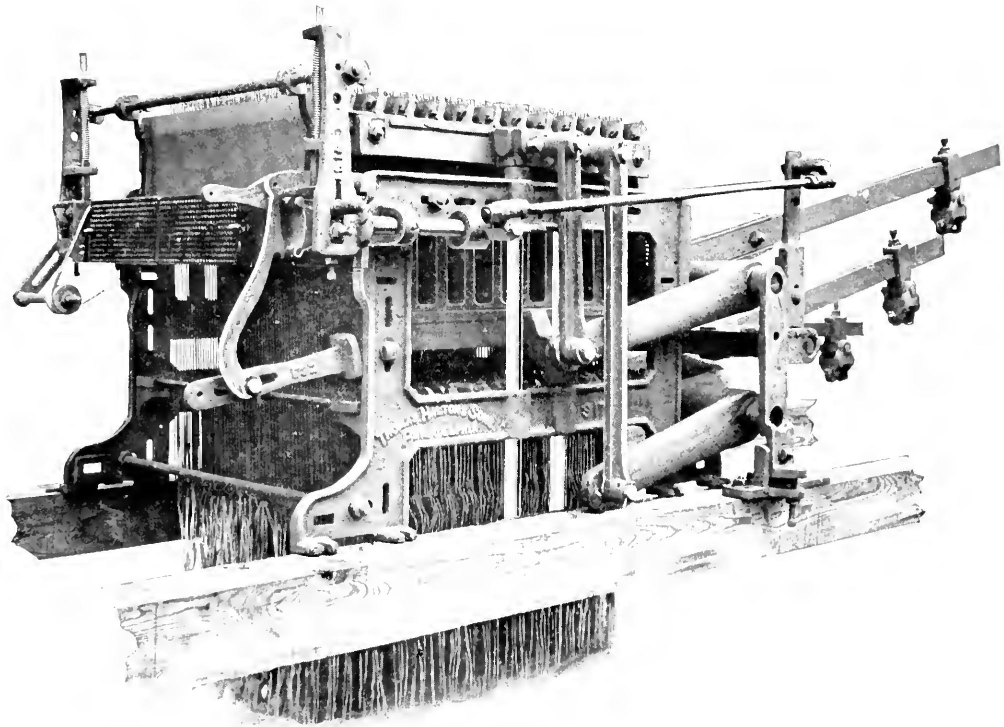
"That is true," was the reply; "but the value of the waste is small as compared with its cost. The balance of the cost of the cotton used in making the stock in process should be added to the inventory value of the stock in process. Do it this way: In setting a value on the stock in process, make it, say, twelve per cent per pound more than the cost of the cotton. Take fine roving at, say, ten per cent above cotton, and the balance of the card-room stock at five per cent per pound above cost of cotton. The full value of the cotton or stock in process should be charged to Inventory, and credited to Cotton account. More than that, we started four months ago with no work in process. We now have a mill full of partially manufactured stock. Some nearly ready for market. Some scarcely advanced from the raw material. We must make an estimate of the cost of labor bestowed on the unfinished material and make it a part of the inventory. Furthermore a considerable amount of power has been expended in bringing this cotton to its half-completed stage. Also make an entry covering this, crediting Power and charging Inventory account for its estimated cost. There have been other expenses, but they are of less importance, not so easily estimated, and we shall neglect them."

"This will make a decided difference in our statement," said the bookkeeper, "but I see that it is right and shall make entries to effect the change."

This having been done, the mill showed results of the three months run as follows:

PRODUCTION—406,840 lbs. No. 25 warp yarn, made and sold in warps.

COTTON—472,635 lbs. costing 9.80 c. per lb., or			$46, 318.23		
Less waste on hand and sold, value			1,584.63		
Net cost cotton used			44,733.60		10.96c
MANUFACTURING LABOR,	Carding	$3,091,90		.76c	
	Spinning	3,336.08		.82	
	Spooling	1,749.41		.43	
	Warping	876,42		.24	
			9,053.81		2.22
POWER	Fuel	1,938.50			
	Supplies	162.70			
	Labor	361.40			
			2,462.60		.61
INSURANCE AND TAXES			825.00		.20
REPAIRS AND SUPPLIES,	Material	1,265.20			
	Labor	512.00	1,777.20		.44
SALARIES AND EXPENSE			1,375.00		.34
INTEREST			750.00		.19
FREIGHT			3,017.62		.74
COMMISSION AND DISCOUNTS			5,887.60		1.45
Total cost per pound					17.15c



DOUBLE LIFT SINGLE CYLINDER JACQUARD MACHINE

Thomas Halton's Sons

As there was but one kind of product, and practically all of this sold, it is only necessary to divide the items of expense by the product in pounds to obtain the cost per pound of each item, and to add these together, or to divide the total expense, to get the total cost per pound.

Such simplicity of conditions is not often met with, however. Even yarn mills commonly have a diversity of product, and when another six months had rolled around, an inventory had been taken, and the accounts were ready to close, the bookkeeper called on the manager for directions, presenting the following statement of operations, after having charged to Inventory the value of the cotton, and the labor on stock in process.

PRODUCTION OF ENTERPRISE MILLS.

Six months ending June 30th.

YARN MADE AND SOLD	No. 25 warp, Chains	325,000 lbs.
	$\frac{2}{30}$ Skein	120,000 "
	No. 36 "	50,000 "
	$\frac{2}{25}$ "	175,000 "
	No. 25 "	380,000 "
	$\frac{2}{25}$ Chain	150,000 "
	$\frac{2}{16}$ "	30,000 "
CLOTH MADE,	Print Cloth 64 x 64	230,000 "
		1,460,000 lbs.

COSTING:

COTTON:	$144,500.00.	VALUE WASTE SOLD $6,100.	
LABOR,	Carding	$11,680.00	
	Spinning	13,140.00	
	Spooling	4,527.60	
	Warping	1,026.46	
	Twisting	3,230.00	
	Reeling	2,950.00	
	Dressing	690.00	
	Weaving	7,228.94	
	Packing Room	1,825.00	
	Repairs	3,000.00	
	Power	1,850.00	
	Yard	1,675.00	$52,823.00

The manager called for the superintendent and showed him the sheet saying "We want now to find out what we have made on these yarns which we cannot do until we know what each cost. Can you show us how to get at it?"

"Why I think it is easy to do that," was the answer; "the established method of distributing cost is from the basis of the average number. *First,* ascertain what processes and expenses are common to all the varieties of the product, such as Carding, Spinning, Repairs, Insurance, etc. These are termed Costs in Common. *Second,* separate the processes and expenses undergone by portions of the product alone, such as reeling for the skein yarn, sizing materials for cloth, different commissions for yarn and cloth, etc., and find how many pounds have been submitted to each special cost. *Third,* ascertain the average number of the mill product submitted to each special cost. *Fourth,* divide the sum total of the costs in common by the total pounds produced. This is the cost per pound in common, of the average number. This cost per average number is thus distributed over the whole product: each kind of product bearing the cost per pound in proportion to the number of the yarn. The special costs are divided in the same manner over the kinds of product they affect, through the medium of the average number of the products affected."

Following this method these costs must be rearranged, and some of them, as Power, Repairs, and Commissions must be divided. They are common to all, but Power and Repairs have a special cost for weaving, which we will estimate and set apart as a special cost, deducting it from the totals, and consider the remainders as common costs.

The Manufacturing Costs may then be listed as follows:

Costs Common to all the Product of the Mill		
Labor, Carding		$11,680.00
" Spinning		13,140.00
" Packing Room	$1,825.00	
Supplies, Packing Room	625.00	2,450.00
Labor, Repairs, 94%	2,820.00	
Supplies, Repairs, 94%	7,322.00	10,142.00
Labor, Yard		1,675.00
" Power, 96 %	1,776.00	
Supplies, Power, 96 %	7,055.00	8,831.00
Insurance and Taxes		2,800.00
Interest		3,000.00
Salaries and Office Expense		2,900.00
Expense Account		975.00
		57,593.00

The total costs in common to all the product was \$57,593.00 ÷ 1,460,000 (pounds produced) = 3.9447 cents per pound of yarn of the average number (26.866).

We proceed on the hypothesis that the cost of making yarns varies in the same ratio as the number. If the costs in common for No. 26.866 = 3.9447 cents per pound, then to find the cost for No. 10 yarn

26.866 : 3.9447 cents :: 10 : 1.468 cents per pound.

In the same way we find the costs in common per pound to be:

For No. 25 Yarn	3.670 cents
" 28 "	4.110 "
" 30 "	4.404 "
" 36 "	5.285 "

The special costs may be classified as follows, and the pounds subjected to each operation are tabulated for convenience of analysis, with the exception of the special costs on print, which are dealt with in bulk.

Special Cost on Chain Yarn, Ply Yarn, and Warp of Print Cloth		
Spooling		\$4,527.00
Special Cost on Chain Warps and Warp of Print Cloth, Warping		1,026.46
Special Cost on Ply Yarns, Twisting		3,230.00
Special Cost on Skein Yaans, Reeling		2,950.00
Special Cost on Print Cloth		
Dressing	\$ 690.00	
Weaving	7,228.94	
Repairs, Weaving, Labor (6%)	180.00	
" " Supplies (6%)	468.00	
Power Weaving, Labor (4%)	74.00	
" " Supplies (4%)	295.00	
Sizing Materials	506.00	9,441.94

The rule for finding the average number of a plain fabric, is based upon the principle of reducing the yarns to an equivalent weight of number one yarn, and then dividing again into the same number of threads, as the previous counts, but all of an equal size.

The rule is expressed as follows: Divide the threads per inch of warp, by the number of the warp yarn, and add the quotient to the picks per inch divided by the number of the filling yarn. Divide the sum of the picks and sley by the sum of the two quotients, above described, and the result will be the average size or number of the yarn.

The same idea will enable us to find the average number of the mill product as follows:

No. 10 Yarn			30,000 lbs. x 10	300,000
" 25 "	Warp Chains	325,000 lbs.		
" 25 "	Skeins	380,000 "		
" 25 "	$\frac{2}{25}$ Chains	150,000 "	855,000 lbs. x 25	21,375,000
" 28 "	$\frac{2}{28}$ Skeins	175,000 "		
" 28 "	Print Cloth Warp	128,800 "	303,800 lbs. x 28	8,506,000
" 30 "	$\frac{2}{30}$ Skeins		120,000 lbs. x	303,600,000
" 36 "	Skeins	50,000 "		
" 36 "	Print Cloth Filling	101,200 "	151,200 lbs. x 36	5,443,200
			1,460,000 lbs.	39,224,600

39,224,600 ÷ 1,460,000 = 26.8662 = Average number spun.

	SPOOLING	WARPING	TWISTING	REELING
$\frac{2}{10}$ Skein Yarn as $\frac{1}{10}$	30,000 lbs.	lbs.	lbs.	lbs.
" $\frac{2}{10}$			30,000	30,000
25 Warp Chains	325,000	325,000		
$\frac{2}{25}$ Chain as $\frac{1}{25}$	150,000			
" $\frac{2}{25}$	150,000	150,000	150,000	
25 Skeins				380,000
$\frac{2}{28}$ " as $\frac{1}{28}$	175,000			
"			175,000	175,000
28 Print Cloth Warp	128,800	128,000		
$\frac{2}{30}$ Skein as $\frac{1}{30}$	120,000			
" $\frac{2}{30}$			120,000	120,000
36 Skein				50,000
	1,078,800 lbs.	603,800 lbs.	475,000 lbs.	755,000 lbs.

The cost per pound of each of these operations on each variety of product is estimated after the same manner, as the cost in common. This we will illustrate in the cost of spooling. It will be noticed that the two-ply warps undergo spooling twice, first as single yarn, and again as double yarn. In determining costs, ply yarns are considered single yarns of equal weight, that is $\frac{2}{28}$s is treated as single 14s.

SPOOLING

No. 10 Yarn		30,000 lbs.	×	10	=	300,000
" 25 Warp Chain	325,000 lbs.					
" $\frac{2}{25}$ Chains as $\frac{1}{25}$	150,000 "	470,000 "	×	25	=	11,875,000
" $\frac{2}{25}$ " " $\frac{2}{25}$		150,000 "	×	12.5	=	1,875,000
" $\frac{2}{28}$ Skein as $\frac{1}{28}$	175,000 "					
" 28 Print Cloth Warp	128,800 "	303,800 "	×	28	=	8,506,400
" $\frac{2}{30}$ Skein as $\frac{1}{30}$		120,000 "	×	30	=	3,600,000
Total Pounds Spooled		1,078,800 "				26,156,400

26,156,400 ÷ 1,078,800 = 24.246 Average Number Yarn Spooled.

The total cost of spooling was $4,527.00 which divided by 1,078,800 equals the cost per pound of spooling the average number or .4196 cents per pound for spooling No. 24.246 yarn.

.4196 cents ÷ 24.246 = .017306 cents cost per unit of number, or cost per hank of spooling number one yarn.

.017306 × 10	=	.17306	cents	cost	of	spooling	No.	10	Yarn
.017306 × 25	=	.43265	"	"	"	"	"	25	"
.017306 × 12.5	=	.21632	"	"	"	"	"	$\frac{2}{25}$	"
.017306 × 28	=	48457	"	"	"	"	"	28	"
.017306 × 30	=	.51918	"	"	"	"	"	30	"

The correctness of these figures can be proved as follows:

30,000	lbs.	of	No.	10	Yarn	Spooled	at	.17306	Cost	$ 51.92
475,000	"	"	"	25	"	"	"	.43265	"	2,055.08
150,000	"	"	"	$\frac{2}{25}$	"	"	"	.21632	"	324.58
303,800	"	"	"	28	"	"	"	.48457	"	1,472.12
120,000	"	"	"	30	"	"	"	.51918	"	623.02
										$4,526.62

By the same methods we find the cost of the special costs of Warping, Twisting and Reeling to be as follows:

Cost	of	Warping	No. 25	Yarn	.1886	cents	per	pound
"	"	"	" $\frac{2}{25}$	"	.0943	"	"	"
"	"	"	" 28	"	.2112	"	"	"

Cost	of	Twisting	No. $\frac{2}{10}$	Yarn	.2573	cents	per	pound
"	"	"	" $\frac{1}{25}$	"	.6434	"	"	"
"	"	"	" $\frac{2}{28}$	"	.7206	"	"	"
"	"	"	" $\frac{2}{30}$	"	.7720	"	"	"

	2-10 Skeins	25 Skeins	25 Chains	2-25 Chains	2-28 Skeins	2-30 Skeins	36 Skeins	Print Cloth 56.2% Warp 43.8% Fill.
Cotton	5.000	1.0000	10.000	10.000	10.000	10.000	10.000	10.000
Strippings	3.000							
	8.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
Less Waste Value	.242	.484	.484	.484	.484	.484	.484	.484
	7.758	9.516	9.516	9.516	9.516	9.516	9.516	9.516
Costs in Common	1.468	3.670	3.670	3.670	4.110	4.404	5.285	2.309 wp 2.314 fill
Spooling as Single Yarn	.173		.433	.433	.485	.519		.273
" " Double "				.216				
Warping			.189	.094				.119
Twisting	.257			.643	.721	.772		
Reeling	.083	.412			.231	.248	.594	
Dressing etc., Print Cloth								4.105
	9.739	13.598	13.808	14.572	15.063	15.459	15.395	18.636
Freight	.591	.591	.591	.591	.591	.591	.591	.650
	10.330	14.189	14.399	15.163	15.654	16.050	15.986	19.286
Commissions	1.018	1.399		1.494	1.542	1.581	1.575	.375
Full Cost of Each Product	11.348	15.588	14.399	16.657	17.196	17.631	17.561	19.661

Cost of	Reeling	No.	$\frac{2}{10}$	Yarn	.0825	cents	per	pound
"	"	"	" $\frac{2}{28}$	"	.2310	"	"	"
"	"	"	" $\frac{2}{30}$	"	.2475	"	"	"
"	"	"	" 25	"	.4125	"	"	"
"	"	"	" 36	"	.5940	"	"	"

Cost of Special Operations for Print Cloth 230,000 lbs. \$9,411.94.
\$9,411.94 ÷ 230,000 = 4.1052 cents per pound.

The stock used in these yarns and goods is the same, excepting that the $\frac{2}{10}$ Skein Yarn has been made one-half of cotton and one-half card strippings.

The balance of Cotton account showing the cost of cotton for the mill is therefore divided by the total product, less one-half the amount of $\frac{2}{10}$ skein made.

1,460,000 – 15,000 lbs. = 1,445,000 lbs.

\$144,500.00 ÷ 1,445,000 = 10 cents per pound for cotton for each pound of yarn made, excepting $\frac{2}{10}$ skeins. The $\frac{2}{10}$ skeins were one-half strippings worth 60 % of the cost of cotton, or for the whole amount of yarn made:

15,000 lbs. @ 10 cents for cotton	\$1,500.00
15,000 " " 60 % of 10 cents	900.00
30,000 lbs, at an average price of 8 cents =	\$2,400.00

The value of the strippings used should therefore be added to the value of waste sold. That much of waste used not having been credited to waste account, previously, it should now be credited to the products made from clean cotton.

A deduction for the value of waste may now be made from the cost of cotton.

Waste sold \$6,100.00 plus \$900.00 waste also made but used = \$7,000.00. \$7,000 ÷ 1,445,000 = .484 cents credit to cost cotton per pound of product for waste sold. (Only one-half of this per pound of $\frac{2}{10}$ skein.)

The only two items now remaining undistributed are the Freight on product and Commissions.

The freight paid in this case is more on the print cloth than on the yarn, per pound, being 65 cents per hundred, and the balance divided among the other products, equally. Of commissions it should be said, before the division of the cost, that those on the print cloth amount to above 2 % of the cost, the No. 25 chain warps were sold direct, and no commissions were paid on these, while the balance amounting to about 9.85 % was divided among the other products on a percentage basis of the cost as shown below.

At this stage the proof of the accuracy of the mathematical work may be had thus:

30,000	lbs.	of	$\frac{2}{10}$	Skein	at	10.330	cents	per pound,	cost	$ 3,099.00
380,000	"	"	25	"	"	14.189	"	"	"	53,918.20
325,000	"	"	25	Chain	"	14 399	"	"	"	46,796.75
150,000	"	"	$\frac{2}{25}$	"	"	15.163	"	"	"	22,744.50
175,000	"	"	$\frac{2}{28}$	Skein	"	15.654	"	"	"	27,394.50
120,000	"	"	$\frac{2}{30}$	"	"	16.050	"	"	"	19,260.00
50,000	"	"	36	"	"	15.986	"	"	"	7,983.00
230,000	"	"	Print Cloth		"	19.286	"	"	"	44,361.80
										$255,547.75

Cost of Cotton	$144,500.	
Less value of Waste sold	6,100.	
	$138,400.	
Labor	52,823.	
General Charges, without Commissions	34,746.	$225,969.00
This discrepancy might be avoided by carrying the work to further decimals.		421.25

The bookkeeper having worked out the costs of manufacturing as above under the supervision of the superintendent, the processes and results were shown to the manager. The costs of some of the yarns were more and of others less than he expected, and after an examination of the tables, the manager once more sent for the superintendent.

"I have examined the way you get at the cost of the different numbers of yarn, etc., and think I understand it, and believe it is about right. But there are one or two inquiries I wish to make. *First*, the idea underlying the whole operation seems to me a mere assumption that the cost will vary as the number or fineness of the yarn. This may be so or it may not. I do not see anything to prove it. How do you know this, or don't you know it? There may be some reason for believing so; if there is, I would like to know it, but I confess that it seems to be taking a great deal for granted."

"The average number system of cost finding," replied the superintendent, "was not original with me. For many years it has been used by mill men as a convenient and ready way of reckoning costs and making estimates on cotton goods. I have been told that early New England manufacturers adopted it after a careful examination in detail of the cost of various operations on different organizations of goods. I suppose they were satisfied of its approximate accuracy. Some justification is afforded by such figures as the following, which represent actual results in a large mill in New Hampshire for the six months ending May 2, 1885. This company operated three mills, making various organizations, and you will note that the total manufacturing labor costs vary very nearly as the average numbers. In fact, do not vary from this standard more than the same mill might vary its own record in the changing vicissitudes of continuous operation."

	No. 1 Mill	No. 2 Mill	No. 3 Mill	Average
Average No. of Product	26.83	22.93	18.12	21.64
Labor, Carding	1.131 cts.	1.004 cts.	.757 cts.	.919 cts.
" Warp Spinning	.566 "	.394 "	.331 "	.406 "
" Filling "	.465 "	.438 "	.385 "	.420 "
" Dressing etc.	.517 "	.454 "	.348 "	.420 "
" Weaving	2.779 "	2.527 "	1.825 "	2.260 "
	5.458 "	4.817 "	3.646 "	4.425 "

Based on the cost of the average number for the whole plant, the costs would be as follows:

5.487	4.680	3.705

By these figures it will be seen that the variations of the actual cost from the estimated cost by the average number is as follows.

No.	18.12	.059	cents per pound
"	22.93	.128	" " "
"	26.83	.029	" " "

The greatest variation is therefore less than three-tenths of one per cent.

"Further than this, I think I can show you why this method has some basis of reason in it. As you are well aware, a most important element in the cost of any product is the amount that can be produced in a given time. If I were spinning, say, number 30 yarn, and some one should come along with an invention which would enable me, other factors remaining the same, to double the production per spindle, the cost of spinning would be reduced nearly one-half. So, if I should change to a coarser yarn the production would be increased, and the cost per pound decreased. Not proportionately decreased, but in *nearly* that ratio. As the amount of product increases, however, there is so much more material to be handled, so that there is more expense for labor in attendance and handling.

"If you examine the tables of production of spinning frames you will find that the pounds per spindle decrease as the yarn grows finer, in a ratio somewhat exceeding the reverse ratio of the change in number. For example, one of the production tables in common use gives the production in pounds per spindle per day as follows:

No. 8 Yarn	1.082 lbs.
" 16 "	.497 "
" 24 "	·294 "
" 32 "	.200 "
" 40 "	.152 "

"It will be noticed that 8 (yarn) is one-fifth of 40 (yarn) but the production of No. 8 is rather more than five times as great. This increase in ratio approximately covers the increased cost of attendance and handling of the coarser yarns. It is thus that it comes about that the cost of manufacture varies in nearly the same ratio as the number. To be sure the spinning frame is not the only machine in a mill, but it is to a considerable degree the gauge of the production, and the elementary principle holds in all departments that the higher the number of yarn the greater the cost of production and manipulation. Labor Costs are not the only ones affected by production. The cost of Power, Taxes, Insurance, Salaries, Repairs, Interest, and some other items of expense are similarly affected by the rate of production.

"The same New Hampshire mill I have mentioned had a practice of charging Interest, Insurance, Taxes, General Expense and Salaries at an equal amount per pound whether the average number were 17 or 27, and whether the production were consequently greater or less. This seems to me denying the principle in its most evident application. For an increase or loss in production would not affect the gross amount of these expenses, but the more pounds produced the more to divide them among and proportionately the less per pound."

"I concede the force of much you have said," answered the manager, "and I imagine that for numbers of a moderate range such a system might be very convenient and as efficient as any that could easily be devised. I can also see that it might find a widespread and proper application in mills under the circumstances apparently prevailing in the mill you instanced where there are a number of organizations not widely dissimilar, and without a wide range in the numbers of yarns spun. Its weakness lies in there being no means of proving its results, no certainty that its limitations have been observed, and no recognition of varying conditions.

"As an illustration of my first objection, you cannot, in any way, prove that the costs of Reeling, as distributed by you over the yarn made into skeins the last six months, are just. In fact they do not very well agree with the prices per pound we paid for the work. This also illustrates my second point. Further, I do not suppose you would claim that making number 100 yarn would cost just ten times as much as making number 10 yarn. That is, there is a limit to the average number method of reckoning costs.

"And lastly, suppose two sateens, woven, one with a warp face, and another of a similar organization but with a filling face. They would both have the same average number, but would both cost the same? And two fabrics of utterly dissimiliar organization might have the same average number and according to your theory would have the same cost per pound, which I do not think probable.

"Furthermore, the changes and extensions we propose in this plant will bring in such varying factors, that our past methods will be crude and incomplete. It has been so, to some extent, already, for our weaving has introduced an element which along with, and in addition to, our yarn, makes the separation of expenses of operating the departments a problem for serious study.

"I have been thinking and enquiring about this matter for some time and I propose in another six months to install a system by which I may *know* what our goods cost, prove the estimates to my own satisfaction, and challenge any one to dispute their accuracy.

"In the first place, I propose to separate the Manufacturing and the Distributing expenses. We have been fortunate in our short experience in disposing of our product as fast as made, but this will not always be our happy lot. Under these past circumstances the expense of Freight and Commission might, with fairness to the results, be considered costs along with other expenses, but they are different in their nature, belonging to the commercial department of our business along with such charges as advertising and bad debts. If we, in the next six months, find ourselves with a lot of unsold goods, on which we have paid no freight or commissions, the amount of these charges which we have paid must not be charged into manufacturing, with labor and supplies, but kept in a separate account.

"We shall have a plant selling a part of its product as yarn, and weaving the remainder of its yarn into cloth. We may even be compelled to purchase some yarns. Under these conditions the apportionment of the expense of Repairs, Supplies, Power, Insurance, Taxes, etc., should not be left to guesswork, even though we style the guess an estimate, but should have some basis in accounting of the amount chargeable to each department. This the method we have just followed does not afford."

The manager at once put in operation a series of reports for the purpose of affording detailed information regarding the cost of each operation, which were placed on record, and made a basis for making up the estimates of cost at the end of another six months' period.

In the meantime there had been completed some changes and additions for the purpose of putting a part of the mill on colored work, and a coarse cheviot was made in this portion of the mill, so as to utilize the waste.

Product of the Enterprise Cotton Mill

Six months ending Dec. 29, was as follows:

102,000	lbs.	Cheviot
160,000	"	Print Cloths
250,000	"	Madras
100,000	"	1-25 long chain Warp Yarns
120,000	"	1-28 Skeins
80,000	"	2-28 "
812,000	"	Total

The organization of the cloths was as follows:

	Warp Yarn	Filling Yarn	Sley	Picks	Widths	Yds. Per lb.	% Warp	% Filling	% Sizing on Warp
Cheviot........	8	12	66	45	29	2.15	70	30	6
Print Cloth....	28	36	64	64	28"	7.00	56	44	6
Madras........	25	32	56	60	28	6.00	60	40	6

The weight of the cloth given above is as it comes from the looms. There are several factors tending to modify this weight, as compared with the weight of the yarn originally consumed in the making of the cloth.

The principal of these are, the weight added by sizing, the effects of coloring and bleaching, and the loss in waste.

If the mills were making but one grade of goods, these would be of no special importance. But comparing the weight of woven goods with the weight of yarns, it is worth while to consider whether some allowance should not be made in order to put the yarns sold on a just footing with the cloth woven.

As concerns the sizing, the weight of starch and other compounds used equals about six percent of the weight of yarn dressed. This is equivalent to approximately four percent of the weight of the cloth. And if no other factor entered into the calculation it would be necessary to reduce the weight of warp yarn used in weaving by this six percent, in order to place it on a parity with other yarns. But since spooling, in the operation of warping, beaming, dressing, drawing-in and weaving, there has been a further loss of weight in waste. This loss has been greater on the warp yarns than on the filling, because of the more handling of the chains and the chafing of the warp. This loss is greatest on the yarns which have been sized, and may have amounted to one and one-half percent in weave room sweepings alone; a loss partly of warp and partly of sizing. On the whole, the waste in operations subsequent to spooling, is sufficient to largely offset the gain in sizing, and we make no allowance for the weight added in sizing.

Furthermore, dyeing and bleaching affect the weight of cotton. The madras is largely white with colored stripes. This white yarn or cotton is bleached, which causes a loss in weight.

But there has been an increase of weight in dyeing the colored yarn, varying according to the nature of the dye, and the depth of shade. In this instance we will estimate that one offsets the other, so that no allowance need be made either way for dyeing or bleaching. In the case of the cheviots, there is no bleached stock of consequence used in them, but the colors, both warp and filling, are mostly heavy or dark ones, and it is thought well to make an allowance of two percent from the weight of the cloth, in estimating the amount of gray yarn or cotton used in their manufacture.

The cheviots for purposes of cost estimate will therefore be 100,000 lbs. instead of 102,000 lbs.

The cheviots were a coarse colored fabric, manufactured to utilize card strippings and flyings. The yarn being composed of about seventy percent waste of this character, with some cleanings from picker motes. These were dyed in the loose cotton or waste, and spun thus, into colored yarns. The goods were finished and shipped in bales.

The print cloths were the same organization as before and shipped in rolls.

The madras were a medium grade fabric, with bleached and colored warp yarns. The bleached warp was spun from bleached cotton, but the colored warp was spun in the gray and made into long chain warps, dyed, beamed again, and dressed on a slasher. A portion of the warp yarn for these goods was of printed yarn, and as the mill did not care to purchase a machine for this purpose, the yarn was bought, printed, in long chain warps, amounting to 10,000 pounds. A portion of these goods, also, was woven on drop box looms for the purpose of making check patterns. The filling in all the stripes was bleached, and this with the bleached and colored filling in the checked patterns was spun from bleached or colored cotton. Only a small amount of colored filling was used, as the filling stripes of color were mostly small. The warp in these goods was irregular, some of the patterns having small cords where several warp threads were woven as one.

For the goods described above, and the yarns sold, the following yarns were required:

No. 8 Yarn, Cheviot Warp	70,000 lbs.
" 12 " " Filling	30,000 "

No. 25	" Madras Warp	150,000 lbs.	
" 25	" Warps Sold	100,000 "	
" 25	" Total		250,000 lbs.
" 28	" Print Cloth Warp	89,600 lbs.	
" 28	" 1-28 Skeins	120,000 "	
" 28	" 2-28 Skeins	80,000 "	
" 28	" Total		289,000 "
" 32	Filling for Madras		190,000 "
" 36	" " Print Cloth		70,400 "
			810,000 lbs.

We may divide the cost into three divisions.

1st, The Stock or Material.
2nd, The Labor in Manufacturing.
3rd, The General Charges, Supplies, Power, Etc.

We will take these up in the order named.

The Stock or Material put in process for these yarns and goods was, as previously stated,

1920 Bales of Cotton,	903,614 lbs. costing	$72,289.12
77 " " Strippings,	35,000 " "	1,820.00
No. 25 Printed Yarn	10,000 " "	2,500.00

Passing by for the present the Printed Yarn, we recall that seventy percent of the cheviot, and all of the other output of the mill, are made from the same general quality of cotton. We may therefore separate the stock used into these two classes, and on the assumption that the proportion of waste made has been the same in both classes, proceed to find the percentage of waste, and then work back by means of this to estimate the amount of waste and cotton originally put in process, in each class of stock. For it has not been practicable under the circumstances to keep an accurate weight of it. We then approximate the value of the waste used which was made in the mill, and credit the cost of clean cotton with this amount. The waste used has been from clean uncolored cotton. This value of the waste sold is then credited to each class. This value is either divided according to records of waste made, or on a percentage basis in absence of data.

The details are worked out as follows:

The Stock in process, Dec. 29	94,100 lbs.
" " " " July 30	76,700 "
Excess Stock in Process Dec. 29	17,400 lbs.
Product (Less Yarn Purchased)	800,000 "
	817,400 lbs.

Cotton Put in Process	903,614 lbs.
Waste Purchased and Put in Process	35,000 "
Total Material Put in Process	938,614 lbs.
Less Product Plus Gain in Process	817,400 "
Gross Waste	121,214 lbs.

Gross Waste Equals 14.83% of 817,400 lbs.

Product of Cheviot	100,000 lbs.
In Process Dec. 29, Cheviot Stock	9,000 "
	109,000 lbs.

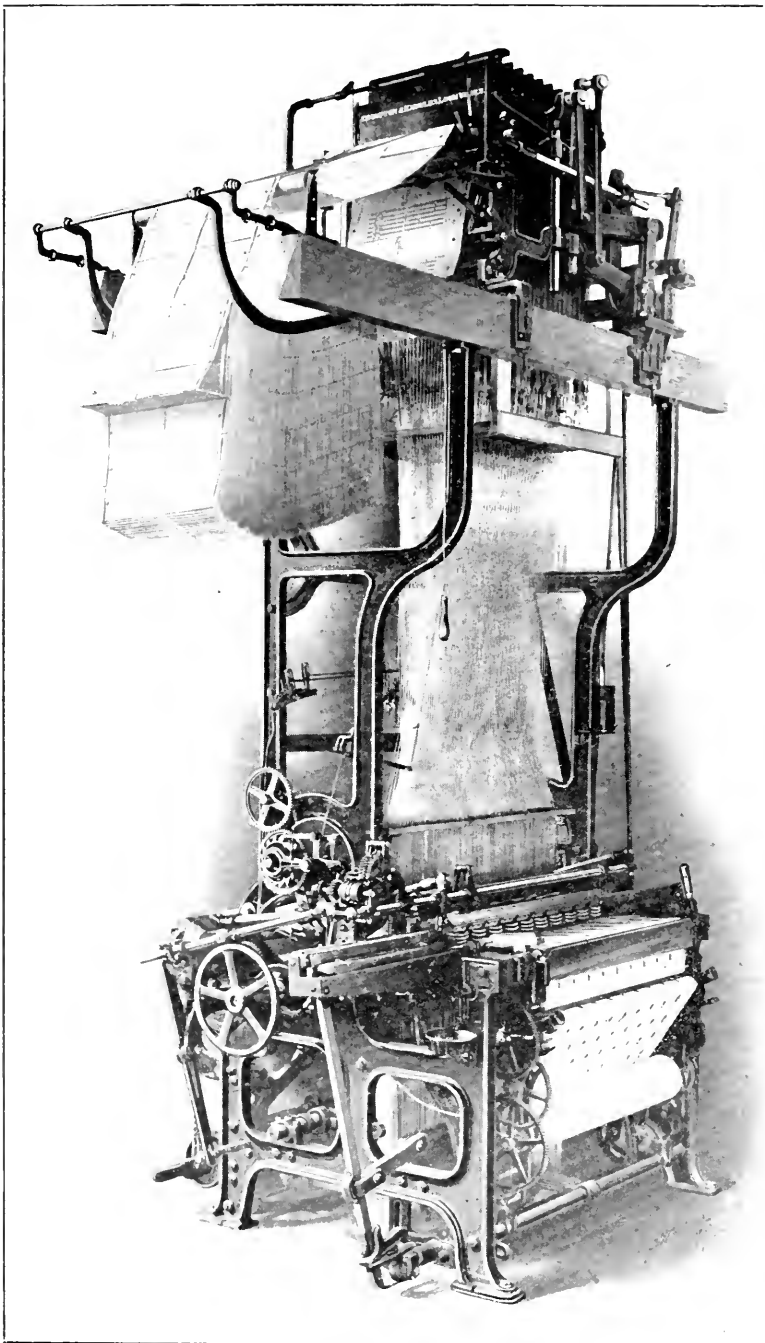
109,000 + 14.83% = 125,164 lbs. estimated amount of stock, made up of good cotton (30%), purchased waste and in the mill (70%) both together making the 125,164 lbs. estimated as started in process for the cheviots.

Total Cheviot Stock	125,164 lbs.
Less Good Cotton (30%)	37,550 "
Waste Used—Purchased, and Made (70%)	87,614 lbs.
Waste Purchased	35,000 "
Waste Made and Used in Cheviots	52,614 lbs.

Stock in Process July 1, all Good Cotton			76,700 lbs.	$ 8,437.00
Cotton Put in Process, for Goods other than Cheviot			866,064 "	69,285.12
			912,464 lbs.	$77,722.12
Cotton Used for Cheviot	37,000 lbs.	$3,004.00		
Waste Purchased	35,000 "	1,820.00		
" Made and Used	52,614 "	2,735.93		
	125,164 lbs.	$7,559.93		
" Made and Used, Cr			52,614 "	2,735.93
			890,150 lbs.	74,986.19
On Hand in Process Dec. 29	9,000 "	543.60	85,100 "	7,488.80
	116,164 lbs.	7,016.33	805,050 lbs.	67,497.39
Waste accounted for and not	16,164 "	323.28	105,050 "	2,101.00
Total net Cost of Stock	100,000 lbs.	$6,693.05	700,000 lbs.	$65,396.39

By these processes we arrive at 6.693 cts. per lb. as cost of material for Cheviot, and (65,396.36 ÷ 700,000) 9.342 cts. for all other product, excepting Madras, to which there is a further charge for 10,000 lbs. of Printed Yarn costing $2,500.00, used only on this work. This is equivalent to 1.00 cts. per pound of all Madras; but as only 8,000 lbs were consumed, 2,000 pounds being in process, the cost for yarn was .800 cts. per pound.

This yarn has been neglected heretofore, because in this instance it is a small amount in proportion, and the waste made from it, is inconsiderable. If large amounts of yarn were purchased in different shapes, it might be necessary to separate the different departments, charging to each its material used and waste made and crediting the output.



KNOWLES SWIVEL LOOM FOR WEAVING A SURFACE FIGURE ON A PLAIN GROUND

Crompton & Knowles Loom Works

THE MANUFACTURING LABOR

The basis for the apportionment of the labor cost, consists of a series of weekly reports from each department, covering the amount of machinery running and the amount of product, and the cost of each operation as computed immediately upon the making up of the pay-roll. These reports are tabulated, and at the end of the six months, or other period, when the costs are made up, their totals are compared with the amount of work ultimately produced by the mill. The costs are based upon the production of the room; but on account of the loss by waste and other causes, the final output of the mill, upon which the cost must be reckoned, is less than the room product. The reported costs are, therefore, less than the actual costs, and are subject to the revision noted above.

Pay-rolls are subject to change, and the total labor cost of each department on the reports, is corrected by the actual amount expended.

This is exemplified in the case of the Card Room as follows: A single weekly report is shown, and the summary of the work for the six months.

ENTERPRISE COTTON MILLS

Cost of Roving for............week ending Oct. 3d, '06.

Hank Roving....................	1.00	1.50	5.20	6.00
Fly Frame Spindles Run..........				
Pounds Roving Made..............	3180	1272	25100	4770
Picking..........................	$ 2.25	.90	18.00	3.37
Carding and Drawing..............	$ 6.00	2.52	59.40	9.45
Slubber..........................	$ 1.50	.90	28.60	7.85
Inter. Frames....................	$ 2.60	1.50	15.16	11.10
Fly Frames.......................			77.48	19.92
General Room Expense.............	$ 1.60	.75	41.20	8.20
Total Wages......................	$13.95	6.57	260.84	59.89
Cost per pound, cents............	.440	.517	.103	.152

SUMMARY FOR THE SIX MONTHS

Hank Roving	1.00	1.50	5.20	6.00
Total pounds made, from reports	80 720	32,800	650,900	109,200
Total pounds yarn and cloth from above	70,000	30,000	600,000	100,000
Add Inventory Dec. 29	6,100	900	58,800	3,300
	76,100	30,900	658,800	103,300
Deduct Inventory June 30			51 700	
	76,100	30,900	601,100	103,300

The sum of the cost from the weekly reports, during the six months is	$350.16	$156.58	$6,680.27	$1,230.26
These make a total of $8,417.27. The corrections and changes in the card-room payroll after leaving the room, have been such as to make the corrected total as shown by the account books $8,263.36 and the necessary correction reduces the costs to	$348.16	$155.68	$6,536.36	$1,223.16

The revised cost of making the roving should be obtained next, and if these total costs are divided by the sum of the goods sold plus the increase of the stock in process the results will give the actual cost per pound.

$ 348.16 ÷ 76100 =	.457c	Cost	per	Pound	of	No.	1.	Hank	Roving
155.68 ÷ 30900 =	.504	"	"	"	"	"	1.50	"	"
6536.30 ÷ 604100 =	1.082	"	"	"	"	"	5.20	"	"
1223.16 ÷ 103300 =	1.184	"	"	"	"	"	6.	"	"

The value of the labor on the roving and yarns in process at the end of the six months is now computed.

6100 lbs.	1.	Hank	Roving @	.457c	= $ 28.38
900 "	1.50	"	"	.504	= 4.53
58800 "	5.20	"	"	1.082	= 636.21
3300 "	6.	"	"	1.184	= 39.07
					$708.19

This, with the value of labor in subsequent operations bestowed on the stock in process, as disclosed by the inventory, is credited to Manufacturing Labor in closing the account books, or retained as the balance of the account, before charging off the remainder into Manufacturing Account.

The further uses of the cost of rovings in the yarn and cloth output of the mill, will be illustrated later.

A table should be prepared showing the stock in process in each department, of the amount of stock of each kind on hand, both at the beginning and end of the period, but is omitted from this illustration.

The summaries of the Labor Costs in each department or operation must be treated in a similar manner. It will not always be the case that the yarn on hand at the end of the period will be greater than at the beginning. They are as often less. By the system outlined above this will adjust itself.

It will be noticed that the pounds of roving made, obtained from the weekly reports, vary about six percent from the roving accounted for by the product of the mill plus the inventory, but in later operations where there is less subsequent waste, this difference should be considerably reduced.

TABLE G.

ENTERPRISE MILLS. SPINNING ROOM REPORT.

Cost per pound of Spinning for week ending September 22.

Number of Yarn	28 Warp	8 Warp	12 Fill	25 Warp	32 Fill	36 Fill	Total
Spindles Run	8,000	418	221	5,600	3,600	2,688	20,320
No. of Pounds Spun	11,200	2,600	900	9,600	4,200	3,000	31,500
Wages							
Spinners	$65.80	$3 60	$2 07	$40 45	$21.60	$18 00	....
Doffers	23.40	2 06	1.87	11.36	7 20	7.20	....
General Room Expense	32 48	2.83	1.80	24.67	13.50	9 60	....
Total Wages	$121.68	$8.43	$5.74	$79.48	$42.30	$34.80	$292 13
Cost per pound, cts	1 086	.321	.638	.828	1.010	1.160	....

TABLE H.

ENTERPRISE MILLS. WEAVING ROOM REPORT.

Cost per pound for weaving, week ending September 22, 1906.

Kind of Goods	Cheviot	Print	Madras Plain Looms	Madras Check Looms	Total
Looms Run	27	150	150	75	402
Pounds Woven	4,000	6,400	7,350	3,333	21,083
Cuts Woven	200	3,100	735	330	....
Wages					
Weavers	$47.90	$175.60	$230.85	$119.54	....
Other Hands	6.10	22.83	31.15	29.92	....
Total Wages	$54.00	$198.43	$262.00	$149.46	$663.89
Cost per pound, cts	1.35	3.10	3.56	4.48	....

Weekly cost reports of the same general discription are made for each department. Samples of these for the spinning and weave rooms are given in Tables G and H.

Passing over for the present the further consideration of Labor Costs, we take up the cost of Repairs, Power, etc., and find the following charges to be divided among the product and the inventoried stock.

LABOR	Repairs Machinery	$1368.20	
"	Boilers and Engine Room	1286.93	
"	Repairs Buildings	60.00	
"	Watch	350.00	
"	Electric Lights	212.50	
"	Moisteners	20.	$ 3,297.63
MATERIALS	Repairs Machinery	$1182.37	
"	" Buildings	120.	
"	Fuel	7000.	
"	Fire Protection	70.	
"	Supplies, Store Room	1576.32	
"	" Special	6895.33	16,844.02
TAXES			5,500.
INSURANCE			900.
SALARIES AND OFFICE EXPENSE			4,000.
EXPENSE, MISCELLANEOUS			500.
YARD			600.
INTEREST			3,600
			$35,241.65

In addition to these there should be a sum set aside or charged off for depreciation of the Machinery and Buildings which will be estimated later.

An analysis of these expenses for the purpose of classification will disclose that they may be fairly grouped in three general divisions.

First: Those which are incurred in maintaining the plant in good repair and condition, protecting it from danger of fire and robbery and providing the necessary supplies for operation, Maintenance, Protection and Supplies.

Second: Expenses incurred in the generation and transmission of Power, and of Steam for other uses than Power.

Third: The cost of administration of the general conduct of the business.

Under the heading Maintenance and Supplies, we collect first the cost of Maintenance in general, dividing between Machinery and Buildings and excluding the particular repairs of which a separate account has been kept. These include, Taxes on the value of Machinery, Insurance on Machinery, Fire Protection and Watchmen in their proportion, and Depreciation.

For the purpose of subdivision of these expenses make a detailed list of machinery in the form shown in Table M, giving in appropriate columns the value of each machine, and of the total value for each operation. By this means we find the grand total value of machinery to be $250,000. A conservative estimate for depreciation may be set at four percent, or $10,000. This completes the items of General Maintenance, which are placed in the box at the head of the columns, and foot up $15,000. This amount is divided upon the machinery in proportion to the value of each operation. The percentage this bears to the total is set in Column 5, and the amount of the corresponding percentages in Column 6. This adds up the same amount as the sum in the box at the top, showing the work to be correct.

We next take the items chargeable to the Maintenance of Buildings, including the furnishings. These items of expense are made up of the due proportion of those which have just now been charged to Machinery, with the addition of Repairs in Material and Labor, an account which is supposed to have been kept. In the distribution of these items, first set down the approximate floor space occupied by each operation, next the estimated or known cost per square foot of construction, adding the accessories, automatic sprinklers, humidifiers, piping, wiring, etc. The cost of building will vary considerably, and some departments will have more or less furnishings than others. The Dye House will have a cost for piping, but no humidifiers, and the store house will have neither one, nor wiring for lights. The floor space is then multiplied by the total cost per square foot, and the products put down in Column 13. By the footing of this column, the total value of construction, etc., is found to be $100,000. To the items charged at the head of the column, we now add one percent for depreciation, making a total of $3,000. The percentage of this amount to each operation is then added in Column 14, and the actual charge, obtained by taking the percentage of $3,000, is set in Column 15. This column is then footed to prove the work correct.

In the Repair Shops, a detailed account has been kept through the six months of the labor and material expended or used for each department and operation. (Total Labor $1,094.56. Total Material $1,074.88.) This cannot include the supervision of the work ($273.64), so that at the end of the period, having ascertained the percentage which the whole bears to the hitherto recorded cost in

TABLE M.

MACHINERY.

Taxes	$ 4,000
Insurance	700
Repairs Fire Protection	50
Watch	250
Depreciation 4%	10,000
	$15,000

BUILDINGS.

Repairs { Material	$ 120
Repairs { Labor	160
Taxes	1,500
Insurance	100
Fire Protection	20
Watch	100
Depreciation 1%	1,000
	$3,000

Operation.	Description.	Price.	Total Cost.	Per Cent.	Distrib.	Sq. Feet Floor Surface.	Construction.	Automatic Sprinkler	Humidifying.	Piping.	Wiring.
1	2	3	4	5	6	7	8	9	10	11	12
Picking	2 Openers with Feeders	$1,000.00									
	3 Intermediates	800.00	$6,800	2.720	408.00	4,000	1.20	.03			.01
	3 Finishers	800.00									
Waste Picking	1 Waste Picker & Feeder		750	.300	45.00	800	1.20	.03			.01
Carding and Drawing	14 Cards	675.00	37,380	11.952	2,242.80	8,200	.70	.03	.03		.01
	96 Del. Drawing	80.00									
Slubbers	6 Slubbers, 312 sp	13.50	4.212	1.685	252.75	1,500	.70	.03	.03		.01
Intermediates	8 Intermediates, 912 sp	9.50	8,714	3.486	522.90	2,500	.70	.03	.03		.01
Fly Frames	24 Fly Frames, 4,032 sp	6.75	27,216	10.886	1,632.96	7,500	.70	.03	.03		.01
Spinning	90 Frames, 21,600 sp	3.50	75,600	30.240	4,536.00	31,000	.70	.03	.04		.01
Spooling	10 Spoolers, 1,200 sp	3.25	3,900	1.560	231.00	2,600	.70	.03	.04		.01
Reeling	15 Reels	200.00	3,000	1.200	180.00	2,000	.70	.03	.04		.01
Warping	10 Warpers	325.00	3,250	1.300	195.00	3,500	.70	.03	.04		.01
Twisting	10 Frames, 1,600 sp	4.25	6,800	2.723	408.00	2,000	.70	.03	.04		.01
Dyeing Stock	1 R. S. Dyeing Machine	1,100.00									
	1 Extractor	350.00	2,750	1.100	165.00	1,500	1.00	.03		.03	.01
	1 Drying Machine	1,200.00									
	1 Fan and Piping	100.00									
	Cotton Bins										
Dyeing Chain	1 Boiling Box	650.00									
	1 Doubler	250.00									
	4 Scotch Tubs	250.00	3,150	1.260	189.00	2,000	1.00	.03		.03	.01
	1 Splitter	250.00									
	1 Set Dry Cans	1,000.00									
Beaming	1 Dry Splitter	150.00	550	.220	33.00	1,500	1.00	.03			.01
	1 Beaming Frames	100.00									
Dressing	2 Slashers	1,200.00									
	1 Size Tub	125.00	2,615	1.046	156.90	3,000	.70	.03		.04	.01
	6 Drawing Frames	15.00									
	Beam Storage										
Weaving	330 Plain Looms	65.00	21,450	8.580	1,287.00	16,000	.70	.03	.04		.01
	75 Drop Box Looms	120.00	9,000	3.600	540.00	4,000	.70	.03	.04		.01
Sewing	1 Sewing Rolling Mach		250	.100	15.00	200	1.05	.03			.01
Brushing	1 Shear & Brushing Mach		750	.300	45.00	200	1.05	.03			
Tentering	1 Sewing Machine	25.00									
	1 Tentering Frame	3,000.00	3,050	1.220	183.00	1,600	1.05	.04		.02	.01
	1 Size Tub	25.00									
Calendering	1 Calender		1,000	.400	60.00	300	1.05	.03		.02	.01
Folding	1 Folder		250	.100	15.00	200	1.05	.03			.01
Winding	1 Winding Machine		80	.032	4.80	100	1.05	.03			.01
Pressing and Packing	Cloth Racks										
	1 Power Press for Cloth		1,000	.400	60.00	3,000	1.05	.03			.01
	1 " " " Yarn		800	.320	48.00	500	1.05	.03			.01
Steam Plant	5 150 H. P. Boilers, &c	1,200.00									
	1 Feed Water Heater	300.00	9,600	3.840	576.00	1,000	1.20	.03		.03	.01
	2 Boiler Feed Pumps	400.00									
	1 Injector	100.00									
Power Plant and Shafting	1 Engine	12,550.00	13,200	5.280	792.00	3,000	1.20	.03		.03	.01
	1 Condenser	650.00									
Light Plant	2 50 K. W. Dynamos	450.00	1,100	.440	66.00	200	1.20	.03			.01
	1 Switchboard	200.00									
Repair Plant	Lathes, &c		1,000	.400	60.00	1,000	1.20	.03		.01	.01
Humidifying	1 Pump, &c		783	.313	46.95	100	1.20	.03			
Cot'n Storage						10,000	10	.03			
Goods and Yarn Storage						5,000	10	.03			
			$250,000	100.000	$15,000.00	123,000					

Total Cost	Per Cent	Distribution	REPAIR SHOPS Labor	REPAIR SHOPS Materials	Storeroom Supplies	Supplies	LIGHT	HUMIDIFYING	STEAM AND POWER H. P.	Per Ct.	Distrib.	TOTAL
			Material 1074.88 Labor Spec. 1094.56 General La. 273.64 General Mat. 107.49 Power 40. Maintenance & Protection of Machinery 60. " Buildings 37.50		Including Oil Belting Pickers Sticks Brooms Travelers Crayons Shuttles Strapping Packing	Roll Covering Card Clothing Bobbins Spools Harness & Reeds Cans Lamps Carbons Starch Bands Wires	P. M. ....$66.00 7.44 R. & S. ....146.68 Labor........212.50 $432.62 Power........385.74 $818.36	P. M. ....$46.95 3.69 R. & S. ....25.30 Power........25.00 Labor........20.00 $123.94	STEAM / POWER Fuel........$7,000.00 / $640.00 Labor........646.73 / 452.62 Repairs........456.00 / 792.00 Main Mach'y 576.00 / 114.57 Main Build. 172.57 $8,851.30 / $2,0[illegible].89			
13	14	15	16	17	18	19	20	21	22	23	24	25
$4,960	4.959	$148.77	$31.02	$25.60	$40.10	$........	$22.73	$	51	7.714	$694.26	$1,370.48
992	.992	29.76	2.40	4.68	3.80	....	5.05	....	3	.429	38.61	129.30
6,311	6.312	189.36	23.00	18.26	60.42	283.16	62.10	11.40	67	9.571	861.39	3,751.89
1,155	1.155	34.65	15.19	16.70	25.60	4.20	12.28	2.25	7	1.000	90.00	453.62
1,925	1.925	57.75	25.30	31.10	60.40	36.50	20.46	3.75	13	1.857	167.13	925.29
5,775	5.774	173.22	42.10	33.20	120.00	15.31	61.38	11.25	31	1.857	437.13	2,256.49
....	....	....	....	....	....	191.68	....	....	....	....	....	....
24,180	24.173	725.19	237.60	181.58	324.00	275.90	253.69	50.08	314	44.857	4,037.13	10,812.85
2,028	2.028	60.84	13.10	7.60	22.00	315.78	20.28	3.90	5	.714	64.26	741.76
1,560	1.560	46.80	2.00	1.50	15.00	....	16.37	3.00	3	.429	38.61	303.28
2,730	2.729	81.87	8.40	28.75	2.50	24.12	28.61	5.25	3	.429	38.61	413.14
1,560	1.560	46.80	16.20	42.00	35.20	65.20	16.37	3.00	30	4.286	385.74	1,018.51
1,605	1.605	48.15	50.20	35.50	47.10	1,809.10	10.27	....	5	.714	64.26	3,054.48
....	....	....	....	....	....	....	....	....	....	....	825.00	....
2,140	2.140	64.20	40.20	20.00	28.70	810.00	13.37	....	5	.714	64.26	1,504.73
....	....	....	....	....	....	....	....	....	....	....	275.00	....
1,560	1.560	46.80	1.10	2.60	4.20	....	12.27	....	1	.143	12.87	112.81
2,280	2.279	68.37	12.00	15.30	107.10	736.23	21.55	....	6	.857	77.13	1,597.58
....	....	....	....	....	....	....	....	....	....	....	400.00	....
12,480	12.476	374.28	343.13	300.10	205.60	133.12	149.40	24.06	82	11.711	1,054.26	3,870.95
3,120	3.119	93.57	110.20	132.05	71.30	33.03	39.23	6.00	19	2.714	244.26	1,269.61
218	.218	6.54	....	....	16.80	....	1.61	....	1	.143	12.87	52.85
216	.216	6.48	3.50	18.40	2.20	....	1.64	....	3	.429	38.61	115.83
1,792	1.792	53.76	25.60	22.00	21.20	450.00	13.09	....	5	.714	64.26	1,240.36
....	....	....	....	....	....	....	....	....	....	....	404.45	....
333	.333	9.99	13.60	2.20	2.20	....	2.45	....	1	.571	51.39	141.83
218	.218	6.54	....	....	.60	5.00	1.64	....	¼	.036	3.24	32.02
109	.109	3.27	....	....	1.00	280.00	.82	....	¼	.036	3.24	293.13
....	....	....				Ch. 180.00	....	....	....	....	....	....
....	....	....				Pr. 112.00	....	....	....	....	....	....
....	....	....	....	....	....	Mad. 806.00	....	....	....	....	....	....
3,270	3.269	98.07	3.50	1.25	3.20	25.10	21.55	....	¼	.036	3.24	1,316.91
545	.545	16.35	....	....	1.20	Yarn 210.00	4.09	....	¼	.036	3.24	282.88
5,080	5.079	152.37	150.00	287.00	60.90	....	....	....	....	....	....	....
3,810	3.809	114.27	160.00	75.00	250.62	....	....	....	....	....	....	....
248	.248	7.44	18.00	2.50	32.18	94.00	....	....	30	4.286	385.74	....
1,250	1.250	37.50	....	....	....	....	....	....	3	.429	40.00	....
123	.123	3.69	11.50	8.60	8.20	....	....	....	2	.285	25.00	....
4,300	4.299	128.97	6.24	4.20	....	....	....	....	....	....	....	139.41
2,150	2.150	64.50	3.12	2.10	....	....	....	....	....	....	....	69.72
$100,026	100.004	$3000.12	$1368.20	$1319.87	$1576.32	$6895.33	$818.36	$123.94	700	100.000	$10,905.19	$37,541.77

detail (25%), the same is added to the cost of repair labor expended on each operation in the mill. In this supervision is included also the labor on the repair department itself. These amounts are then entered in their proper place in the table (Column 16) amounting to $1,368.20.

There is also an unaccounted-for balance of charges ($107.49) for material, but before this is distributed there may be added a charge of $40.00 for power. This is estimated and will be deducted from Power account before distributing, later.

By the portion of the table already constructed, we find the cost of Maintenance of the Repair Plant to be $60.00 for Machinery, and $37.50 for Buildings, etc. These three items, with the unaccounted-for balance of Repair account, are then added to the detailed materials cost, on a percentage basis, in the same manner as the general labor, and the amounts set down in Column 17. These amount to $1319.87, and prove the work correct.

From the Storeroom there have been delivered miscellaneous supplies, oil, brooms, crayons, loom strapping, pickers, picker sticks, shuttles, travelers, packing, etc. An account of these has been kept, and the value delivered to each department entered in Column 18.

In addition to these lighter supplies from the Storeroom, a large amount of money has been spent in paying bills for supplies of a heavier nature, such as card clothing, bobbins, spools, harnesses, roll covering, starch, and the like. In the column in which these are also included some items especially applied to particular classes of costs, may be disposed of, such as packing cases, bands, burlaps, cloth boards, cones, etc., with a notation of the amount. The amount of all the items chargeable to each department or operation, may perhaps be most easily ascertained by an inspection at the end of the period of the bills charged to this account.

In Column 20 are the expenses of Lighting ($818.36) as summarized in the box at the head of the column. The items include Maintenance of Machinery $66.00, and Buildings $7.44, as taken from Columns 6 and 15 of this table. Repairs and Supplies from Columns 16, 17, 18 and 19 amounting to $146.68, and the cost of Power as later ascertained $385.74 and Labor $212.50 from the division of general Labor, already given. This cost is divided among the departments in proportion to the light or current used, omitting the Power and Repair departments, as these cannot be closed and divided up, until after all items have been determined. On the other hand the cost of Lighting cannot be settled until the expense of Repairs and Power has been ascertained. As the costs of these latter are more important than the former, the lighting of Repairs and Power Departments is passed over.

The cost of Humidifying is determined and distributed in a similar way. It will be noticed that this expense applies to but a portion of the mill.

The costs of Power and Steam are next worked up. As a considerable amount of the steam generated at this plant is used for dyeing, drying, warp dressing, and finishing, a separation is made between the Boiler and Engine Installations, and with the cost of running the latter is included the care and maintenance of shafting.

The cost of Steam is made up of Fuel \$7,000.00, Labor \$646.93 (both taken from the records). The Repairs and Supplies as taken from this table amount to \$498.00, and the Maintenance of Machinery \$576.00, and Buildings \$152.37. Of the total \$8,873.30 thus obtained, estimated amounts are apportioned in Column 24, to Dyeing, Dressing and Finishing, to cover the cost of these processes.

The remainder of the cost of Steam is added to the cost of Labor \$640.00, Repairs, etc., \$485.62 and Maintenance of Machinery \$792.00, also Buildings \$114.27, applicable to the Power Plant.

In Column 22 is set down the estimated average power consumed in each operation. The total is 700 horse power. The percentage of each operation is extended in Column 23. The total cost of Power, including the balance of Fuel is then divided according to the percentage of power used and carried out into Column 24. This column, including the amounts already allotted for Steam, will now foot up to the sum of cost of Steam and Power, \$10,905.19.

Excluding Steam, Power, Lights, Repairs, and Humidifying, which have been redistributed, the General Expense of Maintenance, Supplies, Power, etc., are then added across the page, horizontally and enumerated in Column 25.

We have now the means of uniting the Labor Cost with that of Maintenance, Supplies and Power, hereafter abbreviated to M.S.

and P., for the same departments, and dividing the combined amounts among the various kinds of product. This is accomplished in a series of forms such as follow:

Semi-Annual Cost Sheet, Card Room.

Total lbs. carded stock in Yarns and Cloth made.									
No. of Hank or Roving..........	Total.	1.		1.50		5.20		6.00	
Total lbs. carded stock in Yarns and Cloth made.		70,000		30,000		600,000		100,000	
Add Inventory Dec. 29..........		6,100		900		58,800		3.300	
		76,100		30,900		658,800		103,300	
Deduct Inventory June 30..........						54,700			
	814,400	76,100		30,900		604,100		103,300	
		Total.	Per lb.	Total.	Per lb.	Total.	Per lb.	Total.	Per lb.
Labor Costs, corrected..........	$8,263.36	$348.16	......	$155.68	......	$6,536.36	......	$1,223.16	......
Picking, Maintenance, Sup. and Pow..........	1,370.18	128.14	......	52.21	......	1,015.89	......	174.24	......
Waste Picking, Maintenance, Sup. and Pow..	129.30	91.90	.....	37.40	......	....	......	....	......
Carding, Maintenance, Sup. and Pow..........	3,751.89	350.39	......	142.36	......	2,783.24	......	475.90	......
Slubbers, Maintenance, Sup. and Pow..........	453.62	42.39	......	17.21	......	336.48	......	57.00	......
Intermediate, Maintenance, Sup. and Pow..	925.29	....	......	....	......	790.37	......	134.92	......
Fly Frames, maintenance, Sup. and Pow........	2,526.19	....	......	....	......	2,157.60	.....	368.89	......
	$17,420.43	960.98	1.263c	$401.86	1,310c	$13,619.91	2.251c	$2,434.65	2.357c

As a basis of division of cost, at the top of the form are given the pounds of roving contained in the finished product of the mills, and this is then corrected to the amount passed through the card room, by adding the inventory at the end of the period and deducting that at the beginning. The corrected labor costs are then inserted.

The total cost of M.S. and P. of Picking is then entered from Table M, and divided according to the pounds of each hank roving made. The M.S. and P. of Waste Picking is entered and divided among the two rovings containing waste. The M.S. and P. of the various processes of roving frames are then taken separately, and divided according to the spindles occupied on each roving. By this means the cost of 1. hank roving in the department of carding is found to be 1.263 cents per pound.

1 .50 hank roving....1 .310
5 .20 " " ....2 .254
6 " " ....2 .357

By a similar method, the tabular forms for the Spinning Room, Spooling Room, Reeling Room, Warping Room, Twisting Room, Raw Stock Dyeing, Chain Dyeing, Beaming Room, Dressing Room, Weaving Room, Finishing Room and Storage are entered up and figured out.

Semi-Annual Cost Sheet, Spinning Room.

No. of Yarn.		No. 8.	No. 12.	No. 25
Average Spindles run	21,000	500	310	6,133
Lbs. Spinning in Cloth and Yarn	800,000	70,000	30,000	240,300
Add Inventory Dec. 29	21,300	4,900	100	18,500
	821,300	74,900	30,100	258,500
Deduct " June 30....	8,900			
	815,400	74,900	30,100	258,500
Labor Costs, corrected	$ 6,999.90	$214.70 .300c	$195.65 .650c	$2,197.25 .850c
Maintenance, Sup. and Pow......................	10,812.85	257.43 .330	159.61 .530	3,157.63 1.223
	$17,812.75	$472.13 .630c	$355.26 1.180c	$5,354.88 2.073c

No. of Yarn.	No. 28.	No. 32.	No. 36.
Average Spindles run....	8,126	3,400	2,531
Lbs. Spinning in Cloth and Yarn	289,600	100,000	70,400
Add Inventory Dec. 29..................		800	
	289,600	100,800	70,400
Deduct " June 30.................	8,100		800
	281,500	105,000	69,600
Labor Costs, corrected..................	$2,533.50 .900c	$1,058.10 1.050c	$ 800.40 1.150c
Maintenance, Sup. and Pow............	4,184.45 1.487	1,750.52 1.737	1,303.21 1.872
	$6,717.95 2.387c	$2,868.92 2.787c	$2,103.61 3.022c

Semi-Annual Cost Sheet, Spooling Room.

No. of Yarn		8	25	28
Average No. Spindles run		50	600	350
Pounds spooled yarn in cloth and yarn	479,600	70,000	210,000	169,600
Add Inventory Dec. 29	44,500	4,700	25,500	14,300
	524,100	74,700	265,500	183,900
Less Inventory June 30....................	28,500	....	5,000	23,500
	495,600	74,700	260,500	....
Labor cost, corrected	$ 1,775.63	$ 112.05 .15 c	$ 989.90 .380c	$ 673.68 .420c
Maintenance, supplies and power.....	741.76	37.09 .049	415.05 .171	259.62 .162
	$ 2,517.39	$ 149.14 .199c	$1,434.95 .551c	$ 933.30 .582c

Semi-Annual Cost Sheet, Reeling Room.

No. of Yarn			28		$\frac{2}{28}$	
Average reels run			12		3	
Pounds reeled yarn, in yarn sold			120,900		80,000	
Add Inventory Dec. 29			900		800	
			120,000		80,800	
Deduct Inventory June 30			1,000		500	
			119,900		80,300	
Labor Costs, corrected		$ 876.64	$575.52	.480c	$301.12	.375c
Maintenance, Supplies and Power		303.28	242.62	.202	60.66	.075
		$1,179.92	$818.14	.682c	$361.78	.450c

Semi-Annual Cost Sheet, Warping Room.

No. of Yarn		8		25		28	
No. of Machines run		5		5		1.5	
Pounds Warped Yarn in Cloth and Yarn		70,000		240,000		89,600	
Add Inventory Dec. 29		3,700		22,500		10,500	
		73,700		262,500		100,100	
Deduct Inventory June 30						20,000	
		73,700		262,500		80,100	
Labor Costs, corrected	$1,097.24	$92.12	.125c	$708.75	.270c	$296.37	.370c
Maintainance, Supplies and Power	413.14	29.51	.040	295.10	.112	88.53	.110
	$1,510.38	$121.63	.165c	$1,003.85	.382c	$384.90	.480c

Semi-Annual Cost Sheet, Twisting Room.

No. of Yarn			2/28	
No. of Spindles run				
Pounds Twisted Yarn, in yarn sold			80,000	
Add Inventory Dec. 29			800	
			80,800	
Deduct Inventory June 30			500	
			80,300	
Labor Cost, corrected			$ 521.95	.650c
Maintenance, Supplles and Power			1,018.51	1.268
			$1,510.46	1.918c

Semi-Annual Cost Sheet, Raw Stock Dyeing.

Pounds cotton dyed in raw stock in cloth made					298,500
Add Inventory Dec. 29					23,500
					322,000
Labor cost, corrected				$ 644.00	.200c
Maintenance, supplies and power				3,054.18	.948
				$3,698.18	1.148c

Semi-Annual Cost Sheet, Chain Dyeing.

Pounds of dyed stock in cloth made....................		67,000
Add Inventory Dec. 29................................		10,700
		77,700
Labor Cost..	$ 293.10	
Maintenance, Supplies, Power........................	1,504.73	
	$1,797.83	

$1,797.83 ÷ 77.700 = 2.314c per lb. cost.

Semi-Annual Cost Sheet, Beaming.

Pounds of Beamed Yarn in Cloth Made................		75,000
Add Inventory Dec. 29................................		8,700
		83,700
Labor Cost..	$669.60	
Maintenance, Supplies, Power........................	112.84	
	$782.44	

$669.60 ÷ 83,700 = .800 per lb. Cost Labor.
112.84 ÷ 83,700 = .135 " " M., S. and P.

$782.44 ÷ 83,700 = .935c Total Cost per lb.

Semi-Annual Cost Sheet, Dressroom.

No. Slashes run.....................				
Kind of Warp....................	Total.	Cheviot.	Madras.	Print.
Pounds dressed yarn in cloth made....................		70,000	150,000	89,600
Add Inventory Dec. 29........		2,500	17,000	9,000
		72,500	167,000	98,600
Deduct Inventory June 30....				18,000
		72,500	167,000	80,600
Labor cost..........................	$1,685.83	$253.75 .350c	$1,085.50 .650c	$346.58 .430c
Maintenance, Supplies, Power	1,597.58	273.25 .377	948.11 .568	376.22 .460
	$3,283.41	$527.00 .727c	$2,033.61 1.218c	$722.80 .890c

Semi-Annual Cost Sheet, Weave Room.

Kind of Goods....	Total	Cheviot		Print		Madras		Check Madras	
No. of Looms run	....	27		153		150		75	
Pounds of Cloth woven	....	100,000		160,000		170,000		80,000	
Labor Cost, corrected	$15,860.00	$1,380.00	1.380c	$4,880.00	3,050c	$6,120.00	3.600c	$3,180.00	4.350c
M. S. & P. Plain looms	3,870.95	316.71	.318	1,794.69	1.122	1,759.55	1.030	....	
M. S. & P. Check looms	1,269. 64	....		....		....		1,269.64	1.587
	$21,000.59	$1,696.71	1.698c	$6,674.69	4.172c	$7,879.55	4.635c	$4,749.64	5.937c

Semi-Annual Cost Sheet, Finishing Room.

Kind of Goods....	Total.	Yarn.	Cheviot.	Print.	Madras.
No. of Pounds....	810,000	300,000	100,000	160,000	250,000
No. of Yards......			215,000	1,120,000	1,500,000
Labor Cost.	$2,090.00	$600.00	$150.00	$240.00	$1,100.00
Sewing, Main., Sup. and Power	52.85	......	4.00	22.00	26.85
Brushing, Main., Sup. and Power	115.83	......	8.40	46.20	61.23
Tentering, Main., Sup. and Power	1,240.36	......	......	......	1,240.36
Calendering, M'n., Sup. and Power	141.83	......	......	60.48	81.35
Folding, Main., Sup. and Power	32.02	......	.....	13.80	18.22
Winding, Main., Sup. and Power	293.13	......	......	......	293.13
Cloth Pressing, Main., Sup. and Power..........	1,316.91	......	225.11	173.00	918.80
Yarn Pressing, Main., Sup. and Power..........	282.88	282.88	......	......	......
	$5,565.81	$882.88 .294c	$387.51 .388c	$555.48 .347c	$3,739.94 1.496c

Semi-Annual Cost Sheet, Storage.

Kind of Goods Stored...........	Cotton.	Cheviot.	Madras.	Skein Y'rn	Total.
Percentage of Space Used.......	100%	20%	60%	20%	
Pounds Stored..................	......	......	......	......	......
Cotton Warehouse	$139.41	......	......	......	......
Goods "	......	$13.95	$41.83	$13.95	$69.72
Cost per pound Finished Goods.	.018c	.014c	.017c	.005c	

It is unnecessary to follow in detail all the calculations of these forms. Concerning the distribution of M.S. and P. it should be understood that as a rule it is to be divided according to the proportion of machinery run, rather than the pounds produced. For example, in the Spinning Room, one thousand spindles will require about the same floor space, oil, and power whether run on No. 8 yarn or on No. 36 yarn, but the production in pounds will be far different. It is, therefore, contrary to good reasoning, to divide this expense on the basis of so much a pound, but rather should it be on so much a spindle, and the pound cost will take care of itself. The force of this is seen again, in the Weave Room, where the madras is divided into two portions: that woven on plain looms, and that woven on drop box looms—with a decided increase in cost of the latter—and again in the contrast of the cost of the cheviot and print cloth.

The last expression of the Cost is made on the Assembling Sheets, of which we may conveniently make two, one for yarn and one for cloth. As the name implies the departmental costs are here assembled under proper headings to obtain the full gross costs of manufacturing.

Assembling Sheet Yarn.

Number	25 Warp	28 Skein	$\frac{2}{28}$ Skein
Carding	2.254c	2.254c	2.254c
Spinning	2.073	2.387	2.387
Spooling	.551	.582	....
Warping	.382	....	....
Twisting	....	....	1.918
Reeling	....	.682	.450
Finishing	.294	.294	.294
Storage, Yarn	....	.005	.005
Storage, Cotton	.018	.018	.018
	5.572	6.222	7.326
General Expense and Interest	.598	.672	.832
Cotton	9.342	9.342	9.342
	15.512	16.236	17.500
Freight	.252	.330	.336
Commission	1.600	1.680	1.760
Total Cost Yarns	17.364	18.246	19.901

Taking the case first of No. 25 warp yarn; we find this to be made from 5.20 hank roving, and the department cost of carding this, from the Semi-Annual Cost Sheet, is found to be 2.254, which is set down in the proper space. The other sale yarns are also made from the same size roving, and are similarly entered.

From the Spinning Room Cost Sheet we find the cost of spinning No. 25 yarn to be 2.073 cents, now to be entered below the carding.

After the same manner we obtain and enter the costs of Spooling, Warping and Finishing. We omit Twisting and Reeling as having no part in the cost of single warp. We omit also Storage of Yarn as this yarn was shipped promptly upon being packed. The storage of cotton, however, is a part of the cost, and is included.

Following the same steps with all the yarns, we find the sum of the costs, thus far attained, to be

No. 25 Yarn	5.572 cts.
No. 28 Skein Yarn	6.222 "
No. $\frac{2}{28}$ " "	7.326 "

These figures include all the costs of manufacturing proper except the stock, and certain general expenses which are not assignable to any department, nor can they be divided among the products by any system by which it is possible to say: "We know that so much money was expended for Salaries, Postage, or Cleaning up the Yard, and the expense is directly caused by such a kind of goods or yarn, and chargeable to it."

These unassignable expenses as shown by the mills accounts, are

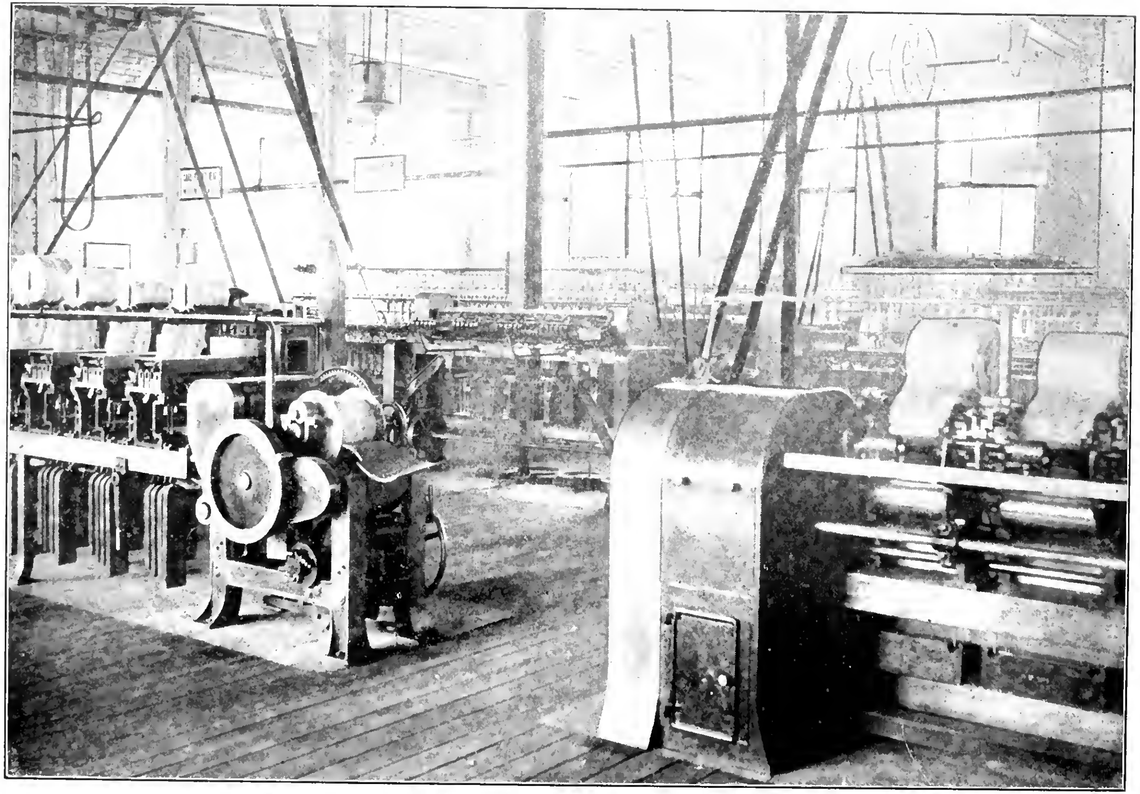
Salaries and Office Expense	$4,000.00
Miscellaneous Expense	500.00
Yards	600.00
Interest	3,600.00
	$8,700.00

This sum is found to be $11\frac{1}{3}\%$ of the amount of other expenses, excluding cotton and yarn purchased, and is divided among the products on this percentage plan. It may fairly be assumed that those departments having a higher labor cost and using more supplies, will call for more supervision, more correspondence and office expense, more general labor and money borrowed. Charges of interest on money used in the purchase and carrying of cotton, may previously be calculated and added to Cotton account, or the cost of interest on funds invested in cotton and finished goods may be added to the Semi-Annual Storage Report, if thought more convenient.

This percentage of general expense should be added before the inclusion of the cost of stock, since the latter bears no relation to it and, varying from season to season, would vary the proportion of expense to each product without good reason.

We have already found the cost of stock used in all yarns sold to be 9.342 cents, and having added this to the previously ascertained cost, the full manufacturing cost, with the exception of the important one of profits, is completed.

As the purpose of all manufacturing is gain, and the utility of cost investigation lies in showing where, and how much of that gain



VIEW IN TEXTILE DEPARTMENT OF CLEMSON COLLEGE SHOWING COMBING, DRAWING AND ROVING MACHINERY has resulted or will result, profits may be considered legitimately an element of cost. It is often easier to determine what it ought to be, than to obtain it under adverse market conditions, and it is occasionally obtainable to a greater degree than is necessary for an average return on capital invested. The return on capital investment, however, is the only basis, when considered as a *cost*. If there is no wide variation in product, such as would be the case if the yarns already considered were the only product, the necessary profit might be reckoned from the production per spindle of each kind of yarn, but in such a combination of departments and processes as arise in a spinning and weaving mill, a better rule is to calculate the gross profit desired, and add the necessary percentage to the costs, again excluding the stock used.

The cost of the stock used should be omitted because it is such a variable element. Depending upon conditions of the crop and markets, it may vary fifty per cent in price, while the margin necessary for fair returns would be unchanged. Of two kinds of goods having a very different cost of stock, the one costing more might, on account of greater production per unit of loom or spindle, require less margin of profit than the other.

The Manufacturing Costs having now all been obtained, the additional expense of marketing and distributing goods must be had. These include Freight, paid on goods shipped, Commissions, for selling, and sometimes Advertising, Traveling Expense, and other items.

In these tables the net Commissions are added as a percentage, varying according to the contract with the selling house, or with trade custom. The estimated amount which will have to be paid for freight is added. It must be borne in mind that these items are based on the actual cost per yard or pound of the product under estimate.

Unlike other factors this cost per pound cannot be taken from the net expense incurred during the periods. It is quite usual for goods to be stored in large quantities, so that the expense of distributing is a very variable one, so far as amount of charges in any length of period is concerned.

Goods which it took most of the time for six or nine months to manufacture, may be stored and then cleared out in one or two months, and all the charges for selling and shipping, concentrated in a short time.

ASSEMBLING SHEET, CLOTH.

	Cheviot			Print Cloth			Madras		
	Warp No. 8 No. 1 h.r. Fill No. 12, 1.50 " Yards, per lb., 2.15			WarpNo.28,No.5.20 h.r Fill No. 36, 5.20 " Yards, per lb. 7.00			WarpNo.25,No.5.20 h.r Fill No. 32, 6.00 " Yards, per lb. 6.00		
	Cost per pound	Per cent used	Cost per pound Cloth	Cost per pound	Per cent used	Cost per pound Cloth	Cost per pound	Per cent used	Cost per pound Cloth
Labor Cost, corrected	....	......	....	....	....	....	....	....	....
Carding warp	1 263	70	.884	2 254	56	1.262	2 251	56 8	1 279
Carding filling........	1 310	30	393	2 254	44	.992	2 359	40 7	.942
Spinning warp	.630	70	441	2 387	56	1 337	2 073	56 8	1 177
Spinning filling......	1 180	30	354	3 022	44	1 330	2 787	40	1.115
Spooling warp	.199	70	159	.582	56	.326	551	56 8	.313
Warping..............	.165	70	106	.481	56	.269	.382	56 8	.217
Beaming..............	....	......	....				935	30	281
Raw Stock Dyeing...	1.148	100	1 148	....	....	....	1 148	70	.794
Chain Dyeing	....	......	....	....	....	....	2.314	26.8	.620
Dressing..............	.727	70	.509	.897	56	.502	1 218	60	.731
Weaving..............	....	......	1 698	....	....	4 172	....	....	4 635
Finishing.............	....	......	.388	....	....	.347	....	....	4 496
Storage, Cotton......	....	......	.018	....	....	.018	....	....	.018
Storage Goods	....	......	014	....	....	....	....	....	.017
Total Mill Expense ..	....	......	6.112	....	....	10.555	....	....	13 635
General Expense and Interest 11⅓ %.....	....	......	693	....	....	1.203	....	....	1.565
	....	......	6.805	....	....	11.758	....	....	15 200
Cotton	....	......	6 693	....	....	9.342	....	....	8 968
Yarn	....	......	....	....	....	....	....	....	800
	....	......	13 498	....	....	21 100	....	....	24 968
Freight	....	......	.560	....	....	.240	....	....	720
Commissions..........	....	......	.850	....	....	.350	....	....	1 500
			14 908	....	....	21.690	....	....	27 188

The above cost of Madras is for 170,000 lbs. woven on plain looms. The 80,000 lbs. woven on drop box looms cost (per Weave Room Cost Sheet) 5 937 cents per pound for weaving instead of 4 635 cents as above. The total cost of manufacturing the check goods was therefore 28.490 cents per pound instead of 24.968 cents.

In the assembling sheet for woven goods, we have a similar work to that on yarns, with additional elements. The Cheviot is made of 70% warp and 30% filling, made from different rovings, and therefore having different card room costs. The warp carding 1.263 cents per lb., and each pound of cloth contained 70% warp. The cost per pound of cloth for carding warp, was therefore, 70% of 1.263 cts., or .884 ct. per lb. The cost per pound of cloth for carding filling is 30% of 1.310 cts., the cost of the filling. For convenience these assembling sheets for cloth are provided with separate columns for each of these three items, and each process is entered up for the extent to which it enters into the make-up of the fabric. There is no division of the cost of weaving and subsequent operations.

In the cost of warp for Madras it will be noted that only 56.8% of the cloth is carded and spun for warp. The filling is 40% of the cloth. The balance, 3.2%, is the yarn purchased which did not pass through the carding and spinning in the Enterprise Mills, and therefore is eliminated from the labor costs of those departments.

Only one half of the warp is beamed, the other half being warped from yarn spun from bleached cotton. One half the warp makes 30% of the cloth.

The yarn purchased was dyed previously, and amounted to 3.2% of the cloth. As already stated 60% of the Madras was warp. One half of this, or 30% of the cloth, less 3.2% purchased, equal to 26.8% of the cloth, was dyed by the long chain system. The balance or 70% was dyed in raw stock.

The addition of General Expense, etc., is also on the same plan, as with the cost of yarn, and also the cost of Stock, excepting that in the Madras the item of the additional cost of the yarn purchased solely for these goods. Deducting the value of the inventory of yarn the amount used was equal to .800 cent per pound.

There were also two kinds of Madras, one woven on plain looms, and one on drop box looms, but alike in all other respects, and having the same cost except for weaving.

Having summed up the Manufacturing Costs, we may add Freight and Commissions. These differ from the Manufacturing Cost items in that they should equal the expense that has been, or will be incurred in the distribution of the goods, whether it has already been paid out or not.

The total costs per pound for cloth, less margin for profit, are:

Cheviot	14.908	cts. per lb.
Print Cloth	21.690	" " "
Madras, plain looms	27.188	" " "
Madras, drop box looms	28.490	" " "

As 170,000 lbs. of Madras were woven on plain looms, and 80,000 lbs. on check looms, but were all sold at the same price, we are interested to find the average price of Madras:

$$(27.188 \text{ cts.} \times 170{,}000) + (28.490 \times 80{,}000) \div 250{,}000 = 27.604 \text{ cts. per lb.}$$

The cost per yard may be obtained from the cost per pound by dividing by the yards per pound, as follows:

Cheviot $14.908 \div (2.15 + 2\% = 2.193) = 6.80$ cts. per yard.
Print Cloth $21.690 \div 7 = 3.10$ cts. per yard.
Madras $27.604 \div 6 = 4.60$ cts. per yard.

These yards per pound are the figures obtained by dividing the pounds from the loom by the finished yards. And 2% is added to the cheviot because 2% has been gained in weight in process through the mill above the original proportion of stock, as previously noted.

The computations have been long, complicated and laborious, and it is well to prove the substantial accuracy of the mathematical work, which may be done as follows:

100,000 lbs.	No.	25 Warp at	15.512 cts. per lb	....	$15,512.00
120,000 "	"	28 Skein "	16.236 " " "	....	19,483 00
80,000 "	"	$\frac{2}{28}$ " "	17.500 " " "	....	14,000 00
100,000 "	"	Cheviot "	13.498 " " "	....	13,498 00
160,000 "	"	Print Cloth	21.100 " " "	....	33,760 00
170,000 "	"	Stripe Madr.	24.968 " " "	....	42,445.60
80,000 "	"	Check Madr.	26.270 " " "	....	21,016 00
					$159,714.60
Additional value Labor, and M. S. & P., inventory of stock in process					1,439 19
Total Cost of Products, as computed					$161,153.79

Total Value, Mfg. Labor, from semi-annual cost sheets	$10,777.25
" " Repairs, Labor, Material, Taxes, etc., see page 28	35,241.65
Depreciation allowed	11,000.00
Cotton, less increased inventory, see page 24	65,396.39
Waste, " " " " " 24	6,693.05
Yarn, " " "	2,000.00
Total Expenses Manufacturing	$161,108.34

The manager of the Enterprise Mills, having devised in outline the method above described, had it carried into effect, at the end of the half year. He discovered, however, that the bookkeeper, though efficient, was not sufficiently informed upon the mill work and processes to carry out the scheme, without his own personal, strict supervision, and that on the other hand the clerical work was far too great for him to do alone.

One afternoon he called the superintendent and showed him the results, and asked him what he thought of them.

"Well!" was the reply, "I reckon they are all right, but it seems to be a mighty lot of work."

"Yes," replied the manager, "it is. But I think in our condition it is worth it. I would not bother with such fine points if we were making only a few yarns, as we began. But I want now, not an *estimate* of what goods have cost, but a *computation*. And while this method is not perfect, and we may yet improve it, no one can say that we have not considered practically all the items of cost in a rational way. Moreover, it has proved an "eye-opener" to me in many ways. We strive to keep down the labor costs, and rightly, and think the card room pay-roll a heavy one, but do you realize that the Depreciation, Maintenance, Supplies and Power cost equally as much. Spinning Room labor cost is considerable, but its Maintenance, Supplies and Power are half as much again. In the light of these facts, how important it is to obtain and maintain the highest efficiency and *production* of our machinery and help.

"We direct our energies to keep down the cost of supplies for the weave room, but their importance dwarfs in comparison with a ten per cent increase in the spinning room production, and, if this new method teaches us something of true values, it will not be in vain."

REVIEW QUESTIONS.

PRACTICAL TEST QUESTIONS.

In the foregoing sections of this Cyclopedia numerous illustrative examples are worked out in detail in order to show the application of the various methods and principles. Accompanying these are examples for practice which will aid the reader in fixing the principles in mind.

In the following pages are given a large number of test questions and problems which afford a valuable means of testing the reader's knowledge of the subjects treated. They will be found excellent practice for those preparing for Civil Service Examinations. In some cases numerical answers are given as a further aid in this work.

REVIEW QUESTIONS

ON THE SUBJECT OF

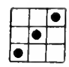
TEXTILE DESIGN.

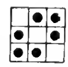
PART I.

*** PROBLEM 1. Make the following designs:**

The complete design is on 24 threads × 12 picks.

12 threads	×	12 picks		No. 1 B.			
3	"	"	12	"	"	2	"
6	"	"	12	"	"	1	"
3	"	"	12	"	"	2	"


1B

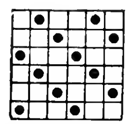

2B

Mark No. 2 B with red, and the risers on the 5th and 6th threads with blue.

PROBLEM 2. Stripe Trousering.

24 threads × 12 picks.

12 threads	×	12 picks		No. 1 B.				
6	"	"	6	"	"	2	"	
6	"	"	6	"	"	1	"	Twill to left; commence with the 1st thread.
6	"	"	6	"	"	1	"	
6	"	"	6	"	"	2	"	


1B LEFT

Mark No. 2 B with red, and the risers on the 6th and 7th threads with blue.

NOTICE These problems are made from warp flush and filling flush weaves. Take particular notice how they join. Make two original stripe designs, using B No. 1 and B No. 2.

PROBLEM 3. Stripe.

48 threads × 12 picks.

12 threads	12 picks		No. 1 B.				
3	"	12	"	"	2	"	
6	"	12	"	"	1	"	
3	"	12	"	"	2	"	
12	"	12	"	"	1	"	
6	"	6	"	"	2	"	
6	"	6	"	"	1	"	twill to left.
6	"	6	"	"	1	"	twill to left.
6	"	6	"	"	2	"	

Mark No. 2 B with red, mark the 6th, 8th, 30th and 32nd threads with blue.

* See page 44

PROBLEM 4. Check Trousering and Coating.

48 threads × 48 picks.

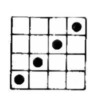
6 threads	36 picks	No. 1 B	
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	twill to left.
6 "	36 "	" 1 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	36 "	" 1 "	
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	36 "	" 1 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	36 "	" 1 "	
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	36 "	" 1 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	
6 "	6 "	" 1 "	" " "
6 "	6 "	" 2 "	

Mark No. 2 B, red. No. 1 B, to left, green.

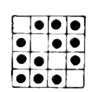
PROBLEM 5. Woolen or Worsted Stripe.

24 threads × 8 picks.

12 threads	8 picks	No. 1 C.
4 "	8 "	" 2 "
4 "	8 "	" 1 "
4 "	8 "	" 2 "



1C



2C

Mark No. 2 C with red, mark the 5th and 6th threads green.

REVIEW QUESTIONS

ON THE SUBJECT OF

TEXTILE DESIGN.

PART II.

---

1. Sketch a black and white color effect, weave $\frac{2}{2}$ Cassimere twill. Warp and filling, 2 black, 2 white, 2 black, 2 white, 4 black, 2 white, 2 black, 4 white.

2. Design a herring-bone stripe, the weaves to make a perfect cut when they come together. Dimensions of stripe, 48 threads per inch. Use Shalloon twill, $\frac{1}{2}$ inch to right, $\frac{1}{4}$ inch to left, $\frac{1}{8}$ right, $\frac{1}{8}$ left.

3. Use the following weaves, Crow, Swansdown, Crowfoot, warp-flush, and Crowfoot filling-flush, and design a cut figure or check, each thread in the warp to have an equal number of risers on the face, and each pick of filling to have an equal number of risers on the face, each check to be 8 × 8.

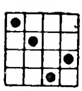


Fig. 1.

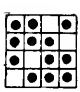


Fig. 2.

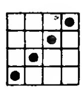


Fig. 3.

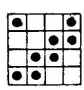


Fig. 4.

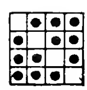


Fig. 5.

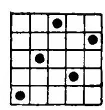


Fig. 6.

4. Design an overplaid for worsted dress goods; use Cassimere twill. Fig. 1 is commonly known as the Crowfoot weave filling-flush. Fig. 2 is the warp-flush Crowfoot weave.

5. What is a warp-flush and what is a filling-flush weave?

6. What are the technical names for weaves in Figs. 3, 4, 5 and 6?

7. What are the chief characteristics of weaves in Figs. 7, 8, 9 and 10?

8. Make a herring-bone stripe on 12 threads and 12 picks.

9. Make a 27-degree twill. Make a 45-degree twill.
Make a 52-degree twill. Make a 63-degree twill.
Make a 70-degree twill all from Fig. 11, first pick.

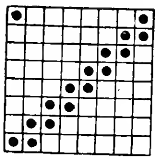


Fig. 7.

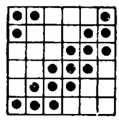


Fig. 8.

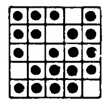


Fig. 9.

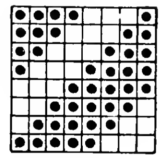


Fig. 10.

10. Write in your own words an explanation of the use of design paper.

11. Make a stripe design, using weaves Figs. 12 and 13. The design to be 24 threads by 12 picks.

12. Make a cut section of the first pick of design of Question 2.

Fig. 11.

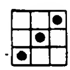


Fig. 12.

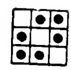


Fig. 13.

13. Weave at Fig. 12; twill this weave to the left, commencing with the third thread. Weave Fig. 13; twill this weave of the right, commencing with the second pick. Each design to be 12 threads by 12 picks.

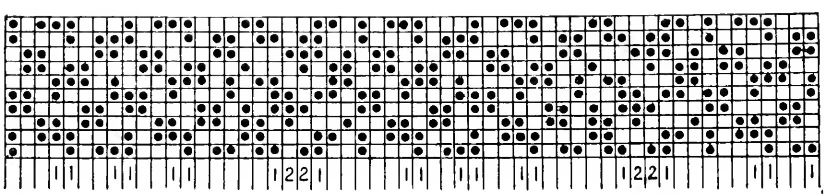


Fig. 14.

14. Design an oblique rib weave on 16 threads and 16 picks.

15. What are the chief characteristics of the regular and irregular rib weaves? Give two examples of each; warp and filling ribs.

REVIEW QUESTIONS

ON THE SUBJECT OF

TEXTILE DESIGN.

PART III.

---

1. Give your opinion on the subject of why cloths are backed, and explain the good features of each system.

2. Explain why it is necessary to bind the back yarn as taught in the lesson on backed cloths.

3. Name and explain the important steps in the construction of a double cloth design.

4. How many threads and picks would be required for each of the following double cloth designs; or in other words, what would be the extent of each design ; all designs to be constructed on the plan of 1 face, 1 back: 5 end sateen for face, 4 end twill for back; 6 end twill for face, 3 end twill for back; 8 end twill for face, 3 end twill for back. 16 end fancy weave which repeats on 16 ends and 12 picks for face, and a 4 end twill for back.

5. Give the extent of the following double cloth designs constructed on the 2 face, 1 back principle: 4 end twill for face and back; 8 end twill for face, 4 end twill for back; 12 end twill for face, 8 end twill for back; fancy weave repeating on 24 ends and 48 picks for face, and 8 end twill for back.

6. Give the extent of the following triple cloth designs constructed on the principle of 1 face, 1 middle, 1 back; 4 end twill for face and middle, 2 end plain weave for back; 6 end twill for face, 4 end twill for middle, and 6 end twill for back; 16 end twill for face, 8 end twill for middle, and 4 end twill for back.

7. Give the several important steps in the production of a triple cloth design.

8. Can the relative position of the binders, or the system of binding used, affect the number of harnesses on which a design may be woven?

9. Explain why the binding should be distributed evenly.

10. Make an original filling backed design and bind the back filling perfectly.

11. Make a filling backed design which if woven with a cotton warp and two wool fillings would hide the cotton; in other words, make a filling flush reversible.

12. Make an original design to show a fancy twill on the face, and backed with filling, on the 2 face, 1 back system. This design to repeat on 18 picks or more.

13. Make an original warp back design, using the 1 face, 1 back system. Bind perfectly, and give the drawing in and chain drafts.

14. Back the design shown at Fig. 171 with warp on the 1 face, 1 back system. Give drawing in and chain drafts.

15. Back the design shown at K, Page 128, with warp using 2 face, 1 back system. Give drawing in and chain drafts.

16. Make an original double cloth design; warp—1 face, 1 back; filling—1 face, 1 back. Give chain and drawing in draft, also a cut section of the first two picks.

17. Make a double cloth design on the 2 face, 1 back system, using Fig. 17, Page 123, for face weave, and the three harness prunella twill for back weave. Bind in the best possible manner.

18. Make a double cloth on 2 face, 1 back system, using Fig. 2, Page 122, for both face and back weave. Bind in $\frac{1}{4}$ twill order. Give drawing in and chain drafts on lowest possible number of harnesses.

19. Make an original triple cloth design. Give chain and drawing in drafts, also a cut section of the first three picks.

20. Make a triple cloth design on 1 face, 1 middle, 1 back system, using Fig. 205, Page 138, for face weave; Fig. 12, Page 125, for middle weave; and Fig. 19, Page 123, for back weave. This design should be perfectly bound.

REVIEW QUESTIONS

ON THE SUBJECT OF

TEXTILE DESIGN.

PART IV.

---

1. Explain the method of making double plain designs, illustrating your explanation with an original design.

2. Name the different methods of making spot designs and give an example of each method.

3. Write about 200 words, discussing the various kinds of pile fabrics, giving at least four original designs.

4. Make a spot design on 32 x 32 squares on the extra warp principle; effect to be two spots arranged in plain order. Give drawing-in draft and harness chain.

5. (*a*) Give a comparison of piqué cloth and other fabrics. (*b*) Make an original piqué design using face and back warps, and face, back, and binder fillings.

6. Why is it necessary to continue a jacquard design until it repeats on even squares?

7. (*a*) How many hooks would have to be cast out of a "*three hundred*" jacquard machine to weave the design shown at Fig. 293? (*b*) How many would be cast out to weave Fig. 294?

8. Give a complete description of the method you would follow in distributing figures in sateen order.

9. Make a diagonal jacquard design similar to Fig. 306, being careful to make the figures and the diagonal repeat.

10. Make an original design showing both warp and filling figures. Give the number of hooks on which it could be woven, and the number of hooks which would be cast out if a "*four hundred*" machine were used.

REVIEW QUESTIONS

ON THE SUBJECT OF

TEXTILE DESIGN.

PART V.

---

1. Give a general classification of cross-woven fabrics. In what respect does each division differ from the others?

2. How many picks are there in one repeat of plain gauze, and what are the positions of the harnesses on each pick?

3. Give twelve threads and eight picks of a plain gauze design, showing chain, harnesses, drawing in draft, and plan of cloth.

4. In what respect does a full gauze differ from a plain gauze?

5. Make a design with alternate stripes of plain gauze and full gauze. Each stripe should be at least eight threads wide.

6. Give the chain and plan of an original leno design similar to Fig. 316.

7. Write about three hundred words on the respective merits of Figs. 321 and 322.

8. Make an original design similar to Fig. 322, but occupying a larger number of threads and picks.

9. Make a design similar to Fig. 325, but limiting it to a smaller number of threads and picks.

10. What is the chief object of crossing the crossing thread under more than one ground thread?

11. Make an original design on the one-thread-crossing-more-than-one principle.

12. Make an original design combining a leno stripe with stripes of plain or twilled cloth.

13. How many methods are there of using color in textile designing?