John Becker

with the collaboration of
Donald B. Wagner

Pattern and Loom

A practical study of the development of weaving techniques in China, Western Asia and Europe

Second edition

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For Kirsten

Contents

Preface

Over 20 years ago we began in our workshop a series of experiments with the intention of reviving older techniques and using them in modern weaving with modern materials. Technical abstracts of some of our results have been used for a number of years at courses in advanced weaving at the School of Arts, Crafts, and Design, Copenhagen. The students have been extremely interested in these techniques and have achieved excellent results.

During the actual weaving problems arose that would not have been apparent in a theoretical study, but which we on many occasions were able to solve. These experiments have progressively been followed up with descriptions and workshop drawings.

Close contact with museums in several countries has convinced us that publication of our results in book form would be useful. Luckily friends among textile scholars with their great experience generously helped me with good advice for this work. My best thanks are due to my old friend, Dr. Agnes Geijer, for many useful discussions on textile subjects, for clear criticism, and for her guidance through the textile world. I am indebted to my late friend, Signe Haugstoga, for invaluable help in trying out in practice part of my technical descriptions and for encouragement in many ways.

For generous help in procuring pictures of ancient textiles and implements I am grateful to the late Dr. Margrethe Hald; to Margareta Nockert, the Historical Museum, Stockholm; Charlotte Paludan, the Museum of Decorative Art, Copenhagen; Gabriel Vial, le Musée Historique des Tissus, Lyon; and to Else Østergaard, the National Museum, Copenhagen.

Some textile books have been of great importance to my own research and I should like to express my gratitude to the authors, to Dr. Geijer and also to the late Vivi Sylwan, Dr. Marta Hoffmann, Dr. Sigrid Müller-Christensen, and to the late Dr. Xia Nai 夏鼐, who was director of the Institute of Archaeology, Academia Sinica.

It is a pleasure to recall innumerable visits to the library of the Museum of Decorative Art and its kind and helpful staff.

I am very grateful to the School of Arts, Crafts, and Design for support and practical help in many ways.

For enthusiastic collaboration in weaving many of the replicas illustrated here I must express special thanks to a number of young apprentices in our workshop over the past 25 years (none named, none forgotten).

Thanks are also due to our photographer, Hans Petersen, who reproduced our woven samples and specific looms in the workshop with the utmost care and a fine result.

For the research and experiments on which this book is based financial support was given by:

Danmarks Nationalbanks Jubilæumsfond af 1968

Konsul Georg Jorck og Hustru Emma Jorck's Fond

Carlsbergs Mindelegat for Brygger J. G. Jacobsen.

At just the right moment when I set out to write this work I met the young Canadian-born sinologist and historian of technology, Donald B. Wagner; without his invaluable contribution this book could never have been written. His knowledge of China and Chinese culture was of the greatest importance to our research. His scholarly mind and scientific experience brought order and system to my heaps of material. 'Dear Don, I can only say thank you for eight years of entirely happy collaboration.'

The book has two objectives:

1) A detailed practical account of the weaving of preserved ancient textiles and a technical classification of the main types. This will be of importance for textile scholars and textile conservators.
2) An inspiration for students and weavers today, who will be able to find new possibilities from practical descriptions of older techniques. This has been tested in practice for several years and given good results, both in our workshop and at the School of Arts, Crafts, and Design.

The main point of the book is the internal development of the weaving technique. The historical background is treated summarily. Ornaments are discussed only where they are dependent on a weaving technique. In order to characterize the varied types of weave simplified designs have generally been drawn from original textiles.

All woven experiments are extensively described with drafts and weaving methods.

Also shown are a few examples of modern textiles woven with the ancient techniques.

Technical terms are mainly in accordance with the vocabularies of Centre International d'Étude des Textiles Anciens (CIETA). These vocabularies are recommended in connection with this book.

John Becker
Holte,
February 1986

John Becker died in July 1986 at the age of 71, while the first edition of this book was in press. After the publication of an edition of a few hundred, the clichés from which it was printed were destroyed; reprints have therefore not been possible. When his widow Kirsten Becker died in 2003 I inherited the copyright to the book, and the original publishers have kindly relinquished their rights, so a new edition is now possible.

In this new edition I have done the typesetting and layout myself, and I hope that readers will find that the sizing and cropping of the illustrations, and their placement in relation to the text, are now more satisfactory than in the original edition. In the text I have corrected a few minor matters, but this is essentially the same text that John Becker and I proofread together in 1986.

Donald B. Wagner
Frederikssund,
January 2008

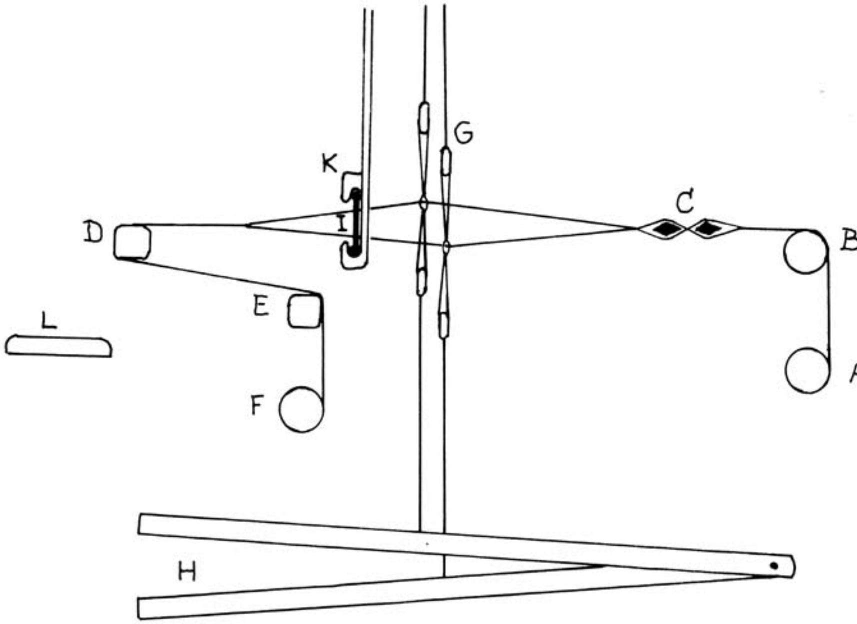


Figure 1 The essential parts of an ordinary shaft loom. Warp is rolled onto the warp beam A and goes up over the back beam B. From there it is stretched to the breast beam D. The woven cloth is rolled onto the cloth beam F. The knee beam E is inserted to give space for the weaver's legs. Two shed rods or cross sticks C keep the warp ends in proper order. Two shafts C with heddles are hung with cords over pulleys in the upper part of the loom. One shaft is lifted and the other depressed by one of the treadles H. This causes the shed I to be opened for the weft to be thrown in. The beater K with the reed is used to beat in the weft. L is the weaver's seat.

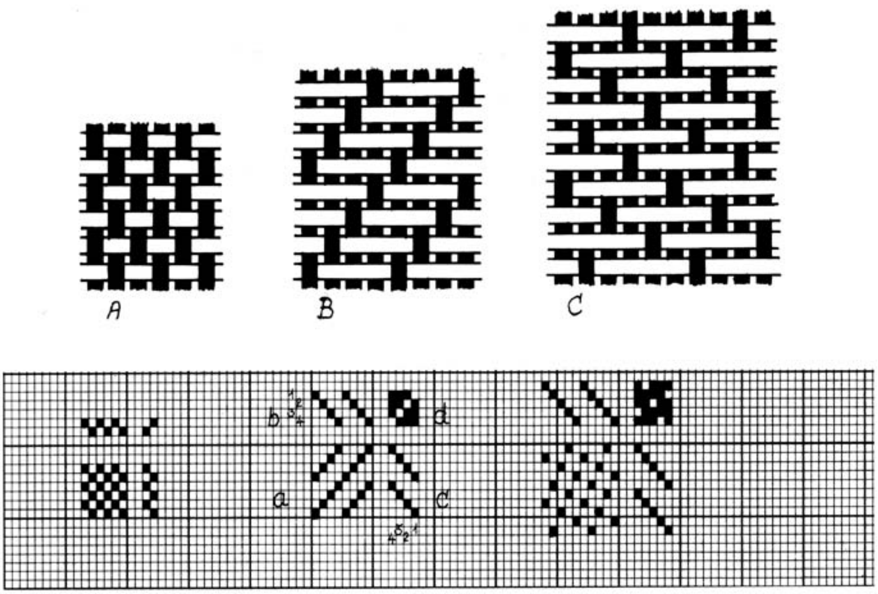


Figure 2 Three basic weaves: tabby, twill, and satin. Uppermost individual threads are drawn to show the weaves more clearly. Below they are drawn on ruled paper such as a weaver makes his drafts supplied with entering treadling, and tie-up.

Introduction

A certain knowledge of hand-weaving is presupposed here. A good basic textbook is Ulla Cyrus-Zetterström's *Manual of Swedish handweaving* (1977).

Before we start to describe our weaving experiments it will be useful to describe briefly our method for making drafts for a hand loom and also to give a very simplified introduction to the theory of weaving.

Figure 1 shows the essential parts of a hand loom. The *warp,* the longitudinal threads, is rolled onto a *warp beam,* A, and the warp ends are *entered* through heddles placed on *shafts*, G. The shafts are connected to *treadles*, H, so that the warp ends can be lifted or depressed to form a *shed,* I, through which the *weft is* thrown in with a *shuttle* at right angles to the warp.

The warp ends are furthermore *sleyed* through a *reed* which regulates the spacing of warp ends and which is also used to *beat in* the weft by means of the *beater*, K.

The crossing of warp and weft is called the *binding;* this has a *weave unit* which contains every differently working thread and is repeated in both directions.

There are three *basic weaves* or binding systems from which other weaves are derived. See Figure 2:

- **A Tabby**: the wefts go alternately over and under one warp end, so that the weave unit is 2 × 2. Variations are obtained by doubling warp ends or weft or both.
- **B Twill**: wefts go over two or more warp ends, and binding points are moved stepwise from one end to the next on successive wefts and form diagonal lines. Innumerable variations are possible by means of entering in *straight repeat* or in *point repeat;* the treadling can be varied similarly. The smallest weave unit is 3 × 3. Larger numbers of course give still richer variations.
- **C Satin**, which is characterized by binding points being spread evenly out to give the best smooth surface. The lowest number for a weave unit is 5 in both warp and weft. Satin weave is extensively described in Chapter *9.*

Uppermost in Figure 2 individual threads are drawn to illustrate the basic weaves more clearly; warp ends are black, wefts are white.

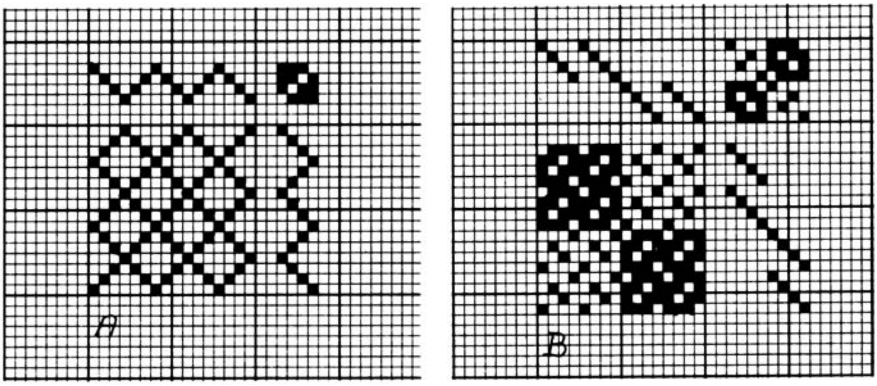


Figure 3 Two drafts:
A) a lozenge pattern with twill 1/3, entering and treadling in point repeat.
B) a two-block pattern woven with a broken twill 1/3.

The basic weaves are shown beneath as drafts such as a weaver uses on a shaft loom. Ruled paper with heavier lines after eight squares is generally used for drafts. As an example see the draft Figure 2 B for twill 1/3:

a At lower left is the detailed binding; vertical columns of squares mean warp ends and horizontal rows mean weft. A filled square means one warp end lifted over one weft, while an empty square means one weft over one warp end.

b The *entering* of warp ends into heddles on shafts is shown above the binding; for each differently working warp end a shaft is needed. This example is called straight entering.

c The treadles and the order in which they are used is shown at the right. For each differently working weft a treadle is needed. The *treadling* is here in straight repeat.

d The *tie-up,* shown at the upper right, for a shaft loom with countermarch. Filled squares mean depression shafts and are connected to the upper side lams. Empty squares mean lifting shafts and are connected to the lower lams. Cords from upper as well as lower lams are connected to treadles according to the tie-up.

Two examples of drafts are shown in Figure 3. A is a twill 1/3 entered with *point repeat* and the treadles are also used in this way. The diagonal lines form a lozenge pattern. B shows the method to make a simple two-block pattern with a broken twill 1/3 as the basic weave.

Shaft loom with countermarch

This type of loom is commonly used by modern handweavers. It is therefore useful to show briefly the principle of a *countermarch loom;* see Figure 4. Upon the upper part of the loom the *countermarch frame* A is fastened; this holds the *top lams* B, two for each shaft, pivoting on two metal rods. The outer ends are connected to the upper shaft rod C. The inner ends are connected to the *countermarch cord* which goes vertically behind its shaft through the warp to the *lower side lam* E. When a lower side lam is connected to a treadle, see treadle 4, this lifts the shaft when pressed down. The knot in the lower side lam F corresponds to an empty square in the tie-up. The lower shaft rod is connected to the *upper side lam* D. When this is supplied with a knotted cord G, corresponding to a filled square in the tie-up, the shaft is lowered when the treadle is pressed down.

Key to signatures

To make drafts for the complicated weaves described in this book we had to work out a more comprehensive list of signatures for differently working warps and wefts. These are shown in Figure 5. Of course varied symbols printed with black could have done duty but we think that a few bright colours are of great advantage for the interpretation of a complicated draft.

In our detailed bindings colours indicate in every individual square which thread is visible in warp as well as in weft, including white (empty) squares which always mean weft 1.

The current weft is indicated at the left of the detailed binding.

Several types of heddle are needed, as different methods for tying up. Both are indicated by symbols.

According to our experience the appended key to signatures is sufficient for any instances in the weaves discussed.

In a few cases we had to depart from our colour code and use the colours to designate the actual colours of the silk; this is remarked upon in every single case.

For our experiments with patterned weaves a simplified design derived from an original textile was generally made. To illustrate the weaving technique a section of the pattern is shown in detailed binding. In order to avoid repeated descriptions of drawlooms etc. we constructed what we

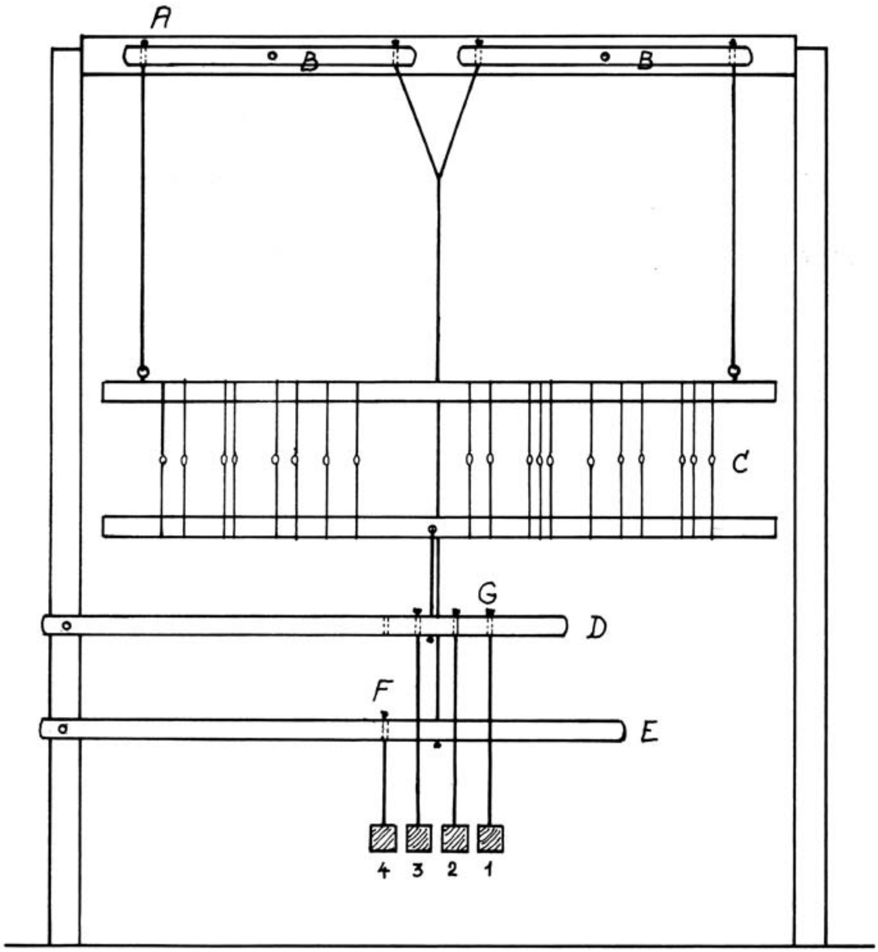
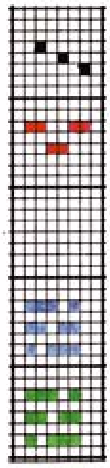


Figure 4 The principle of a countermarch loom.

call a lifting plan shown above the drafts. A red square means a lifted harness cord and thus one or more lifted main-warp ends. At the left the current wefts are suggested. Horizontal black lines indicate each weft unit or passée. The smallest number of wefts or passes that form one step in the outline of a pattern is called a *découpure* and is generally denoted by braces at the right.

Figure 5 Key to signatures



binding warp

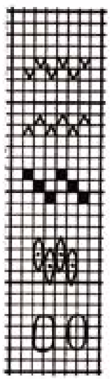
main warp red

weft 1 white

weft 2 blue

weft 3 green

Heddles



lifting heddles (B)

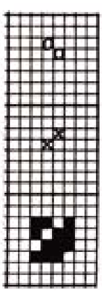
depression heddles (C)

eye heddles (E)

long-eyed heddles (F)

mails, leashes (G)

Tie-up



lifting shaft

depression shaft

shaft loom (countermarch):
black squares: depression shaft
empty squares: lifting shaft

PART I

Patterned Weaves of Han China

206 BC – AD 220

Patterned weaves of Han China

Archaeological material

Ancient Chinese textiles have been found in archaeological excavations in numerous places in and outside of China:

1. Sites of Han military garrisons along the western stretch of the Great Wall. The most important are at Edsen-gol and Lop-nor in Inner Mongolia (Sylwan 1949).
2. Sites along the Silk Road, the ancient caravan route between China and the Roman Empire. At the eastern end of the Silk Road, Chinese archaeologists have discovered large quantities of textile material (*Sichou* 1973; Xia 1963; in English, Hsia 1962, 1972a, 1972b); at the western end, some Han textiles have been found at the site of Palmyra, in the Syrian desert (Pfister 1934).
3. Tombs of nomadic peoples excavated in Siberia (Loubo-Lesničenko 1961).
4. Richly furnished tombs in China proper. The richest of these finds is at Mawangdui, in Changsha, Hunan, dated shortly after 168 BC (*Mawangdui* 1972, 1973, 1980; in English, Hall 1974, Riegel 1975). Hsio-yen Shih (1977) has compiled a complete list of textile finds from 1957 to 1974; see also Hsia 1980 and Wagner 1980.
5. Dunhuang (Tunhuang, Touen-Houang), at the western end of the Gansu Corridor. This was a military outpost in the Han, and later an important commercial city. The textile finds from Dunhuang are considerably later than the Han, but many continue the Han techniques, and Riboud and Vial's (1970) analyses have been of great help in the study of the Han textiles.

Most of these finds are far out on the periphery of Han China; it seems likely that they were not produced locally, but imported from China proper. There is no way to determine where in China they were produced.

The written sources on ancient Chinese textiles were exhaustively collected and discussed by Ren Dachun in the 18th century, in a book called *Shi zeng* 釋繒. A modern study of the same material is Sun Yutang 1963, and Xia Nai (1972, pp. 17–20) has some additional discussion. We have not studied the written sources carefully, but they do not appear to offer much help beside the wealth of archaeological material at our disposal.

In an area the size of China it is obvious that there must have been considerable regional variation in weaving techniques. Neither written sources nor archaeological finds, however, give much help in investigating these variations. The Han textile finds in China proper show so little variation in technique that they probably come from a few specialized workshops. Trade within China, especially in luxury goods, was highly developed in the Han; material from before the Han is extremely sparse, and nothing can be said about its regional variation.

These silks are the products of professional workshops, not of home craftmanship. This is especially clear in the case of trade goods found along the Silk Road, and some military uniforms found at Edsen-gol and Noin-Ula; but all of the patterned silks show such a command of the art that they must also be considered professional products. Probably the greater part of the textiles used in this period was produced locally by common people, but since we lack any material remains of these ordinary textiles, we can have nothing to say about them.

Patterned silks from Han China were not generally known to Western scholars before the 1920's (Simmons 1956), and it is no wonder that a drawloom was at first considered to have been necessary for the production of such silks. We have no difficulty agreeing with Burnham (1965) that a true drawloom was not used in weaving these pieces. For instance for the polychrome silks a drawloom would have required independent leashes for each of thousands of warp ends. Once the setting up had been accomplished, the drawloom could have been used for very high pattern repeats in warp direction; but the repeats in extant Han patterned silks are never more than a few centimetres high. The argument *for* the use of a drawloom in the Han is a postulate, often repeated but never seriously argued, that the Han figured weaves could not have been woven without it (e.g. Willets 1965, p. 138). Our practical experiments show that this postulate is incorrect; we have been able to weave all of the Han weaves with much simpler equipment.

Figure 6 Rubbing of a Han tomb-relief found in Tongshan County, Jiangsu (Xia 1972, p. 21).

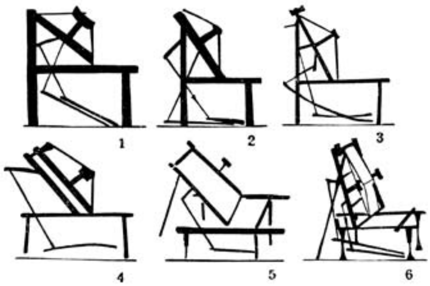


Figure 7 Schematic representations of looms depicted on six different Han tomb-reliefs (Xia 1972, p. 20; originally in Song & Li 1962, p. 29). Provenances: 1. Teng County, Shandong. 2. Teng County, Shandong. 3. Jiaxiang County, Shandong. 4. Feicheng County, Shandong. 5. Pei County, Jiangsu. 6. Tongshan County, Jiangsu.

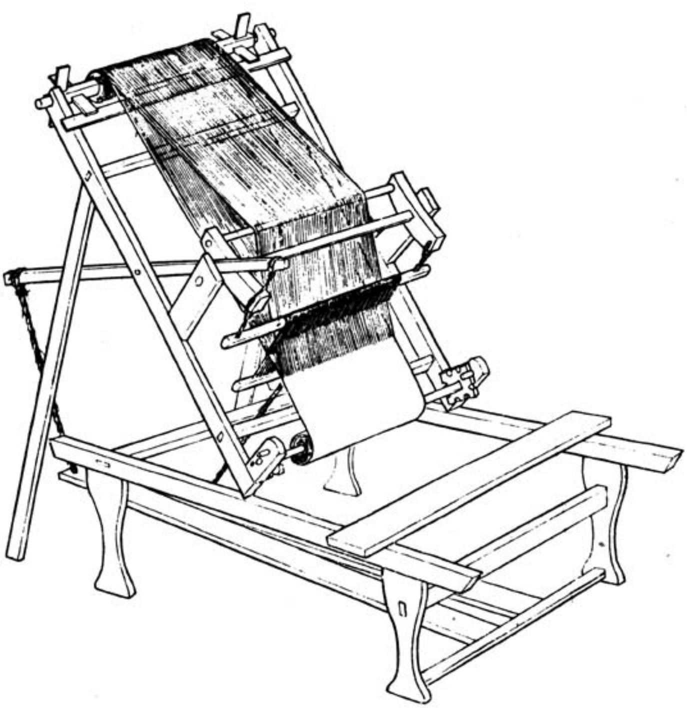


Figure 8 Reconstruction of a Han loom, based on the Han tomb-reliefs shown in Figure 7 (Xia 1972, p. 23).

Table I Modern Chinese terms for ancient weaves

Han qi	汉绮	tabby patterned with warp floats
jialuo	假罗	open tabby ('mock leno')
jin	锦	polychrome compound warp-faced tabby or twill
juan	绢	plain tabby
luo	罗	gauze
luosha	罗纱	gauze
qi	绮	tabby patterned with twill
qirong jin	起绒锦	*jin* patterned with pile warp
qiwen juan	畦纹绢	warp rep
rongquan jin	绒圈锦	*jin* patterned with pile warp
sha	纱	open tabby
wenluo	纹罗	patterned gauze
xiewen	斜纹	twill
zhou	绉	crepe

The Han loom

One type of loom used in the Han is depicted on numerous Han tomb-reliefs. One of these is shown in Figure 6, and schematic diagrams from six different reliefs are shown in Figure 7. Reconstructions of this loom have been attempted by Ōta Eizo (1951), Song Boyin and Li Zhongyi (1962), and Xia Nai (1972, pp. 20–24). Of these the last is definitely to be preferred. Xia's reconstruction is shown in Figure 8. It has a solid frame, two beams, a slanting warp, one shed rod and one heddle shaft, two treadles, and no reed. The heddle shaft is probably too advanced: a shaft with open loops to lift the warp ends from the lower shed face for the counter shed would certainly have been sufficient; compare the loom illustrated in a Chinese watercolour drawing from the 18th century, shown here in Figure 268, Chapter 12. This latter loom is 'body-tensioned': the warp is straightened when the weaver leans back. One treadle is sufficient to lift the heddle

Table II Alternate transcriptions for the terms in Table I.

PY	OLDER FORM	SIMPLIFIED FORM	WG	EFEO	BK	JAPANESE
Han qi	漢綺	汉绮	*Han ch'i*	*Han k'i*	*Han k'i*	*Kan ki*
jialuo	假羅	假罗	*chia-lo*	*kia-lo*	*kia-lo*	*kara*
jin	錦	锦	*chin*	*kin*	*kin*	*kin, nishiki*
juan	絹	绢	*chüan*	*kiuan*	*küan*	*ken, kinu*
luo	羅	罗	*lo*	*lo*	*lo*	*ra*
luosha	羅紗	罗纱	*lo-sha*	*lo-sha*	*lo-sha*	*rasha*
qi	綺	绮	*ch'i*	*k'i*	*k'i*	*ki*
qirong jin	起絨錦	起绒锦	*ch'i-jung chin*	*k'i-jung kin*	*k'i-jung kin*	*kijūkin*
qiwen juan	畦紋絹	畦纹绢	*ch'i-wen chüan*	*k'i-wen kiuan*	*k'i-wen küan*	*keimon ken*
rongquan jin	絨圈錦	绒圈锦	*jung-ch'üan chin*	*jong-k'iuan kin*	*jung-k'üan kin*	*jūken kin*
sha	紗	纱	*sha*	*cha*	*sha*	*sha*
wenluo	紋羅	纹罗	*wen-lo*	*wen-lo*	*wen-lo*	*monra*
xiewen	斜紋	斜纹	*hsieh-wen*	*sie-wen*	*sie-wen*	*shamon*
zhou	縐	绉	*chou*	*tcheou*	*chou*	*shu*

PY: *Pinyin*, the official transcription system for all foreign-language publications of the People's Republic of China.

Chinese characters: the 'older form' is that used before the script reform of the 1950's and 60's. The 'simplified form' is the form adopted in that script reform. Modern Chinese archaeological literature uses of course the simplified forms. The older forms will be seen in older Chinese publications, Chinese-language publications from Hong Kong and Taiwan, and Japanese publications.

WG: *Wade-Giles*, the commonest transcription system in English-language publications.

EFEO: *Système de l'Ecole française d'Extrême-Orient*, the commonest transcription system in French-language publications.

BK: *Bernhard Karlgren's system*, used by many Swedish sinologists, including Vivi Sylwan, when writing in English.

Japanese: the Japanese pronunciations of the Chinese terms, in the Hepburn transcription. These are sometimes used by Japanese scholars writing in English.

shaft, while the natural shed opens up when the weaver leans back and straightens the warp.

These looms used a natural shed and a countershed, and it is therefore most likely that they were used only for weaving tabby. Xia points out that a more complicated loom must have been used for the patterned weaves.

We suggest that professional weavers whose business was fine figured silks for the wealthy used a much larger loom. It probably had a horizontal warp, two shafts with two treadles, and a long extension to give space for pattern heddle-rods. In our experiments we used an ordinary modern handloom with two shafts and two treadles.

Chinese textile terminology

Confusion seems to prevail among Western textile researchers concerning the terminology for ancient Chinese weaves. We list in Table 1 below the most important terms used by Chinese archaeologists for the various ancient weaves, and give brief definitions. This list includes all the terms used for weaves in *Sichou* 1973, plus a few more, and is probably accurate and nearly complete for all modern Chinese works dealing with textiles through the Tang period.

The misleading terms 'damask' and 'Han damask' have long vexed textile scholars. We suggest that the Chinese terms, '*qi*' and 'Han *qi*' be used for these weaves.

Another problem is the term 'mock leno', sometimes used incorrectly to refer to a very open tabby weave, which might be said to resemble leno. The term 'mock leno' actually refers to a very different weave (see e.g. D. Burnham 1980, p. 90), and we do not know of a single example of this weave from pre-modern China. Unfortunately this mistaken usage has influenced Chinese workers: the term *jialuo*, a direct translation of 'mock leno', is sometimes used for these open tabbies. The correct Chinese term seems to be *sha.*

We use the Pinyin transcription for Chinese: this system was adopted in China in the 1950's, and is used consistently in Chinese schoolbooks and dictionaries. In 1979 it also became the standard to be used in all foreign-language publications in China. We strongly urge that all researchers dealing with Chinese textiles use this transcription system. Table II gives equivalents in various other transcription systems for the terms listed in Table I. Also listed in Table II are the Japanese pronunciations of these terms, following the Hepburn transcription for Japanese.

The patterned weaves

We have grouped the patterned weaves from the Han into three main types. Though a great number of new excavations have been made in the People's Republic of China during recent years, and a large number of fine silk textiles have appeared, no hitherto unknown technique has been found so our three categories are still valid:

Chapter 1: The monochrome weaves patterned in one colour.
Two different types seem to stand out:
- a) The ground weave is tabby and the figures are warp-faced twill 3/1. This type is called in Chinese *qi*.
- b) the tabby ground is patterned with warp floats 3/1 on every other warp end. This type is called in Chinese 'Han *qi*' (a translation of the former English term 'Han damask').

Chapter 2: The gauze weaves: plain gauze, *luo* or *luosha,* different variations, and samples of all-over patterned gauzes, *wenluo.*
Chapter 3: The polychrome weaves: warp-faced compound tabby with warps of two or more colours, *jin.* The silks patterned with pile warp loops also belong to this group, *qirong jin* or *rongquan jin.*

Chapter 1
The monochrome patterned weaves

For our first cautious experiments with ancient Chinese weaving techniques Vivi Sylwan's work *Investigation of silk from Edsen-Gol and Lop-Nor* (1949) became a very useful foundation for further experiments. Her analyses are clear and expertly described.

The 2–2 method. As a first attempt to find a weaving method for tabby patterned with twill 3/1 a fragment was drawn on ruled paper, the pattern unit repeated several times. It soon appeared that some common unit or norm was used to form the patterns. The ground weave is always tabby, and the patterns are warp twill 3/1 or a derivation from this. No Han silk entirely woven with twill has been found, while tabby was commonly used; apparently weavers in the Han had no more than two shafts at their disposal.

An area of ruled paper was marked with tabby (hatched), see Figure 11 A. Then a diamond form was filled out with twill 3/1. It was now evident that two different actions were necessary to form a pattern shed, one action to lift for tabby using two shafts, another at the same time to lift warp ends in groups to form the twill pattern. From experiments with various examples from Sylwan's book we found it useable to lift alternate groups of two warp ends and to keep the same groups lifted for two wefts. This is shown by black crosses in the draft, Figure 11 A.

Later on we got the book *Tissus de Touen-Houang* (Riboud and Vial 1970) where a similar method is suggested for some lozenge-patterned silks. This gave a stronger confidence in the probability of our experiments.

It is an interesting fact that Lyon silk weavers in the 19th century used the term *montage chinois* to refer to a monture with two warp ends in each of the leashes in a drawloom (Riboud and Vial 1970, p. xxxix). This technique has an obvious resemblance to our '2–2 method'; but we have been unable to trace the connection further, despite the kind help of M. Vial.

The outline in Figure 9 shows the function of the pattern rod in the 2–2 system. The tabby shafts are A and B; note that warp ends are entered

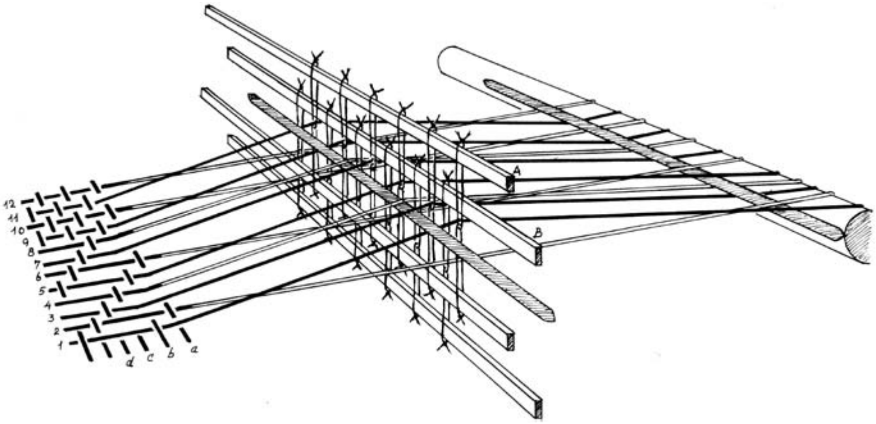


Figure 9 Sketch showing the lift for one pattern shed with the 2–2 system.

above the clasp of the heddles, so that the shafts lift but do not pull down. Warp ends entered into A are shown black; into B, white. A pattern rod (hatched) is counted into the warp under warp ends 3–4 and 7–8. Shaft A is lifted and the pattern rod locks up warp ends 4 and 8 from the lower shed face; thus the lift consists of the lift of the shaft plus the ends which run over the pattern rod. Weft a was woven in this shed; weft b used the same pattern lift but here shaft B was lifted.

The row of pattern counted up is transferred to another rod behind the tabby shafts and pushed toward the warp beam to give space for the next rods. In this way pattern rows are preserved for use in the reversed order. The rod shown near the warp beam was used for wefts c and d. The four warp ends 9–12 at the upper left have no pattern lifted, and plain tabby appears.

In Figure 10 is shown a close-up of the same position as is shown in Figure 9. Note the pattern rod near the tabby shafts.

If the 2–2 square is moved one or three threads either way in proportion to the tabby binding the twill direction changes. Four drafts in Figure 11 show the effect on twill direction:

A) Here the 2–2 system is followed exactly: warp ends are always lifted in groups of two, and each pattern rod is used for two consecutive wefts. This means the twill direction is the same throughout the pattern; in this case it is the Z-direction.

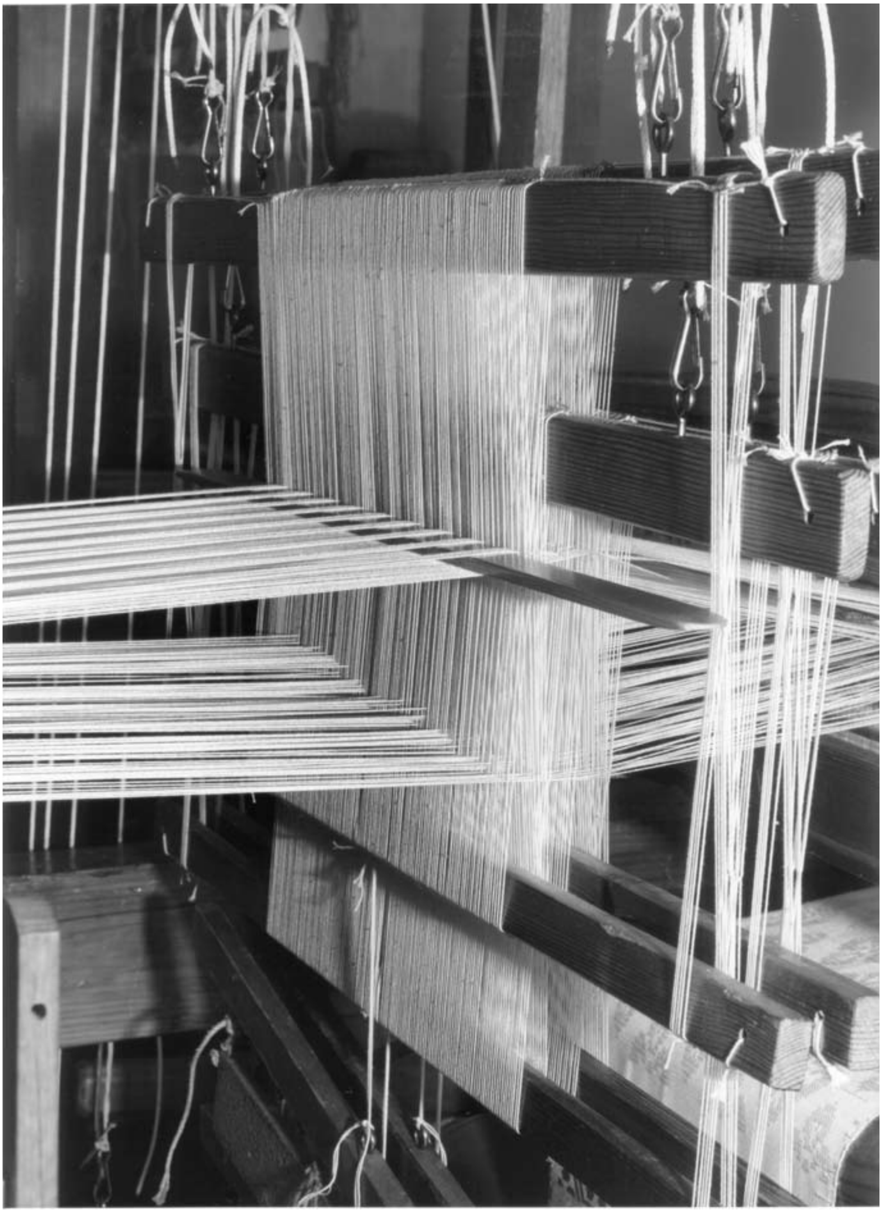


Figure 10 The close-up shows the shed for one weft; note the pattern rod near the tabby shafts. This is the same position as shown in Figure 9.

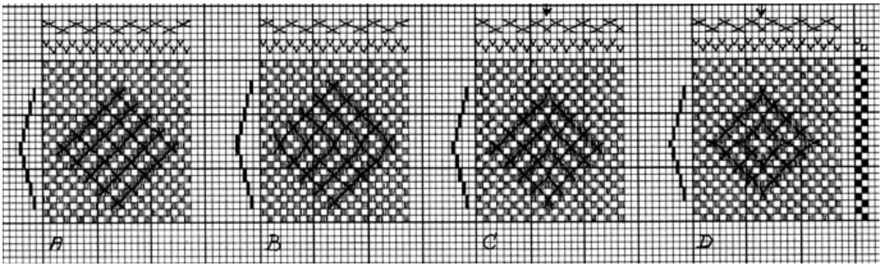


Figure 11 Four drafts illustrate the different possibilities for changing twill direction according to a lozenge figure.

B) Here one of the pattern rods is used for three consecutive wefts. This causes a shift from Z-direction to S-direction along a horizontal line.

C) At the vertical line indicated by the arrow a single warp end is lifted by the pattern rods instead of the usual two. The twill direction changes from Z to S along this line.

D) Here one of the pattern rods is used for only one weft instead of two, *and* the pattern rods lift only one warp end along the line indicated by the arrow. The twill direction follows the contours of the lozenge.

Our detailed drafts for monochrome weaves show the tabby binding *and* the twill patterns; hatched squares mean lifted warp ends. Black crosses show the 2–2 squares lifted for twill pattern. Two shafts with lifting heddles are shown above the detailed draft, see for example Figure 16 A; two treadles denoted by black squares are tied up (o means lift) to lift alternate shafts for tabby. How Chinese weavers in the Han plucked up the 2–2 groups for pattern can only be conjectured. We suggest the placing of two 'dividing rods' B supplied with loops permanently in the warp, shown by crosses above the tabby shafts.

In our experiments we 'cheated' slightly by using four shafts and four treadles, entered and tied up as at C in Figure 16. The two treadles indicated by black squares are used to weave tabby, just as with the tie-up shown at A; the two treadles indicated by vertical lines at the right serve to divide the warp into groups of two, which simplifies the plucking in of the pattern rods. But this method can only function when the 2–2 system is followed exactly.

It must be emphasized that we do not believe the Han loom had more than two shafts and two treadles. Our use of four shafts and four treadles here serves only to speed up the tedious process of plucking in the pattern rods.

The loom set up for weaving with this method is shown in Figure 18.

Our woven experiments

Four experiments with weaving ancient Chinese monochrome patterned silks by the 2–2 method are described. Three are Han silks, while the first (Figures 12 to 14) is from the Yin period, about a thousand years earlier.

In the Han material which we have studied, most samples appear to follow the 2–2 system exactly as described above. That is, the pattern is formed by the superimposition of 2 × 2 squares of warp lifts on a tabby background.

It can be seen in Figures 16 and 17 below that the twill direction is S throughout the pattern. This means that it follows the contour of the lozenge on two sides and opposes it on two sides, producing an asymmetric effect in an otherwise symmetric pattern. In the Yin piece the twill direction follows the contours of the pattern. This effect is achieved by allowing slight variations in the 2–2 system, as described in connection with Figure 11.

Perhaps we can interpret this circumstance as follows. Weavers of the Yin period undoubtedly had more primitive tools and gave more time and care to counting up these details; furthermore they presumably produced shorter lengths of silk. On the other hand the weavers of the Han had to produce larger quantities on their certainly better-equipped looms. It is far more efficient to have the pattern lifts in groups of two all over the warp; patterns can be changed and with the use of pattern heddle rods much more can be produced.

For our second experiment with the 2–2 method we used a slightly simplified version of a silk from tomb no. 1 at Mawangdui, Changsha,

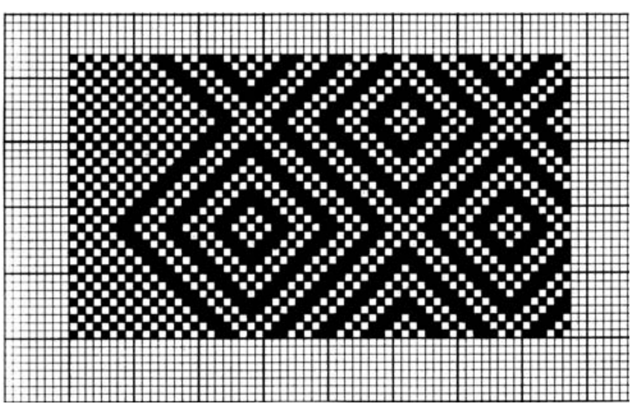


Figure 12 Draft of a monochrome patterned silk of the Yin period (16th-11th century BC), from an imprint in the patina of a bronze axe in the collection of the Museum of Far Eastern Antiquities, Stockholm (inv. no. K. 11090:36).

Warp: 14–16 ends per cm.

Weft: 10–12 per cm.

Redrawn from Sylwan 1937, fig. 2.

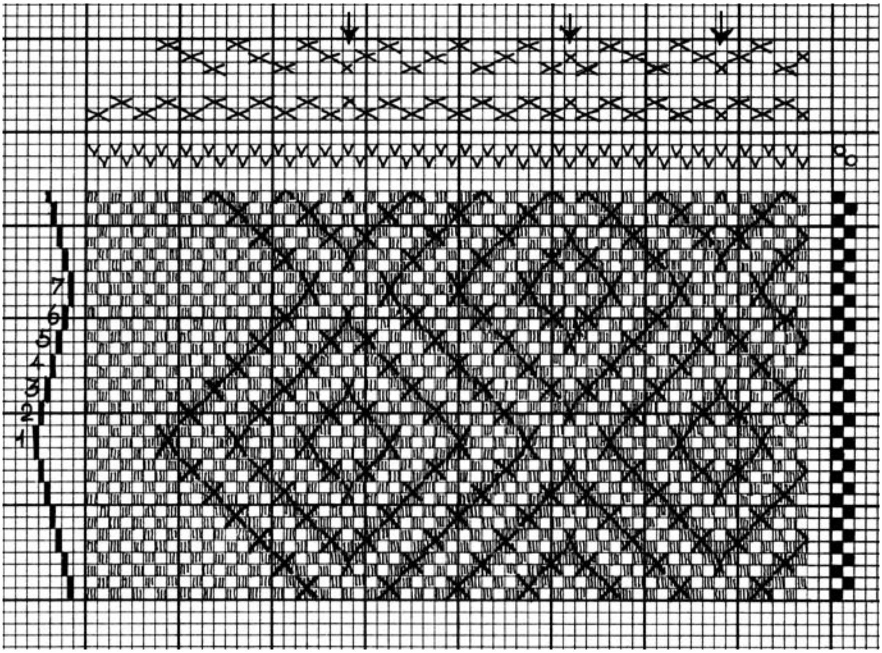


Figure 13 Draft for the silk of Figure 12, woven by the 2–2 method. As in our other drafts for monochrome patterning black crosses show the Pattern lifts. As a general rule in the 2–2 system, each pattern rod lifts groups of two warp ends, and each is used for two consecutive wefts. Here there are two exceptions to this rule: (1) at the point marked by arrows at the top, the pattern rods lift single warp ends instead of groups of two; (2) pattern rods 1 and 7 are each used for three consecutive wefts. These exceptions serve to make the twill direction follow the lines of the pattern. The placement of permanent dividing rods in the warp aids in the task of plucking in the pattern rods. Two possible configurations of dividing rods are shown by crosses at the top.

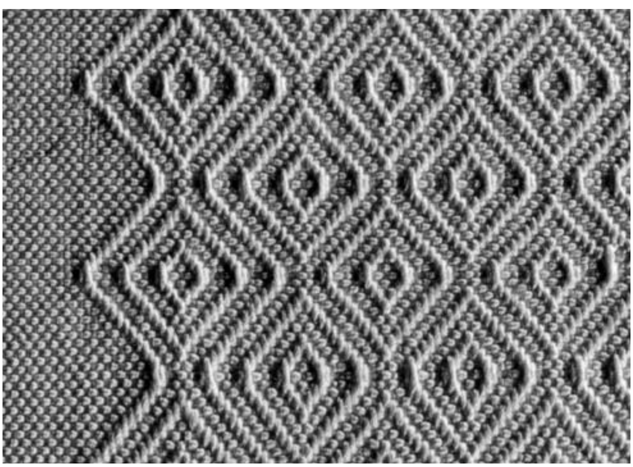


Figure 14 Our reconstruction of the Yin-period silk, woven with the 2–2 system according to the draft of Figure 13.

Warp and weft: spun silk Nm 10.

Warp: 16 ends per cm.

Weft: 12 per cm.

These are nearly the same thread-counts as in the original.

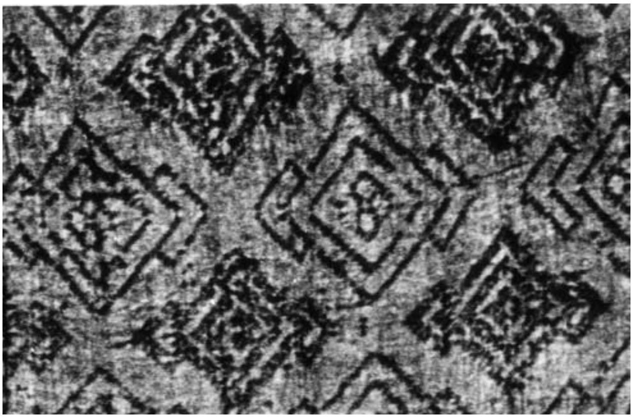


Figure 15 A Han monochrome patterned silk from tomb no. 1 at Mawangdui, Changsha, Hunan, dated shortly after 168 BC (*Mawangdui* 1973, pl. 140; 1980, pp. 23–28; *Chūka* 1973, collateral pl. 34).

Hunan, shown in Figure 15. It can be seen in our draft for this experiment, Figure 16, that this example follows the 2–2 system exactly. As mentioned above the twill direction S goes throughout the pattern, following the lozenge contours on two sides and opposing them on two sides. It can be seen that the more efficient way of making patterns with the exact 2–2 lift

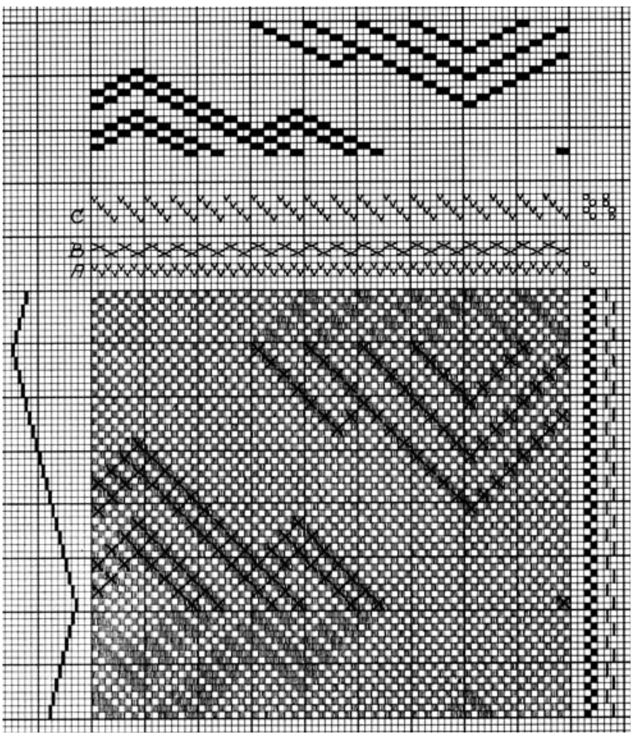


Figure 16 The draft for our simplified version of a sample from Mawandui tomb no. 1. Two lifting shafts for tabby are shown at A, and at B is suggested two dividing rods. Our easier method using four shafts and treadles is marked C. Twenty rods are needed for this pattern, shown at the top by black squares. The order of lifting is suggested at the left of the detailed draft. Black crosses in the draft are shown for only one-half of the pattern unit.

Figure 17 Monochrome patterned silk woven according to the draft of Figure 16. Note the effect of twill direction, following the contour on two sides and opposiing it on two sides.

Warp: spun silk Nm 10, 16 ends per cm.

Weft: spun silk Nm 10, 12 wefts per cm.

does not detract from the effect of the pattern but in many cases enhances it. This can also be seen in later all-over patterned lozenge silks from the Tang period.

Our woven replica is shown in Figure 17, and in Figure 18 our loom at work with this silk is shown.

Figure 18 The loom during the weaving of the silk shown in Figure 17 by the 2–2 method. Compare this photograph with the outline in Figure 9. Four shafts are used here rather than two; but they are always lifted in pairs so that their function is the same as that of two tabby shafts. One pattern rod is near the shafts; the shed lift consists of the tabby lift plus those warp ends which go over the pattern rod. It was necessary to lengthen the loom so that twenty rods could be stored at some distance from the tabby shafts, where they have no effect on the shed.

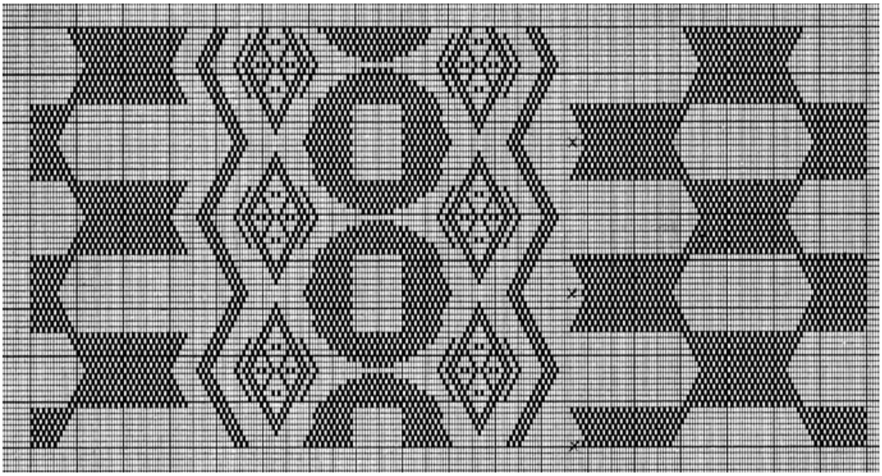


Figure 19 Design of a monochrome patterned silk from Loulan, drawn from an illustration in Sylwan 1949, pl. 13 c. Each square indicates two warp ends and two wefts. White areas: tabby; checkered areas: pattern of floating warp ends. Thread counts in the original: warp 56–60 ends per cm, weft 26 per cm. Repeated irregularities in the design, one marked with crosses, indicate that some mechanism was used to repeat the pattern units. We believe that pattern heddle rods were used for this purpose.

Transversally symmetric patterns

Another feature of the silk shown in Figure 17 is that it is 'transversally symmetric', that is half of the pattern unit is followed by its mirror image. This is characteristic of nearly all the Han monochrome pattterns.

In weaving transversally symmetric patterns the work of counting in the pattern rods can be reduced by one-half. After a rod has been counted in and two wefts have been woven, the lift of the pattern rod is transferred to another rod, out of the way behind the shafts. Then the pattern rod is removed, the next is counted in, and so forth. When half of the pattern unit has been woven, its mirror image can be woven by drawing the stored-up rods forward one by one. This time the rods must be pulled out until the last rod has been woven. It is useful to keep this last rod in the warp when the new half-unit is to be counted in. Figure 18 shows the loom with one pattern rod in place near the shafts and several others stored up behind the shafts.

This method is used in connection with the traditional Swedish *opphämta* weaving technique, as described by Agnes Geijer (1979, pp. 91–95). We do not know whether it was ever used in China, but we have shown

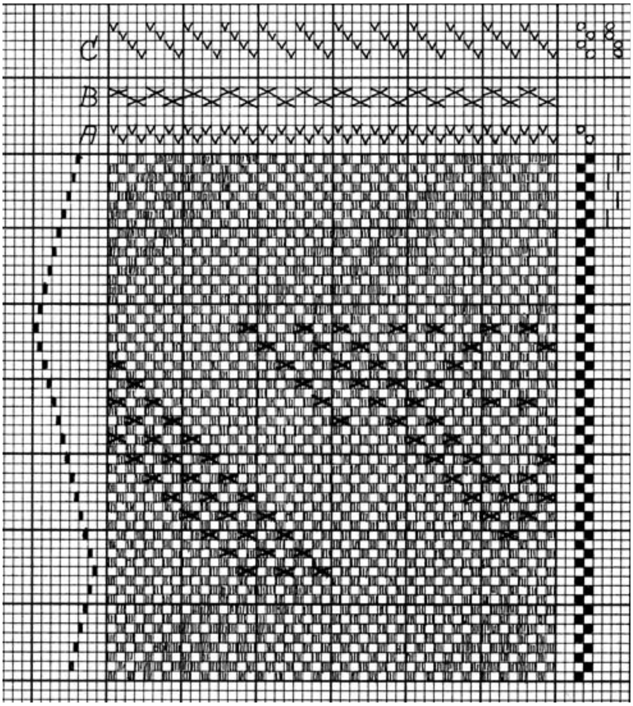


Figure 20 Detail of the pattern drafted for weaving by the 2–2 method. This type of monochrome patterned weave is known as 'Han *qi*' (sometimes, incorrectly, 'Han damask'. Pattern floats occur only in every other warp end. Note the black crosses in the detailed draft for one-half of the pattern unit.

The only modification of the 2–2 system necessary to weave the Han *qi* is that each pattern rod is kept in place for only a single weft; then the rod is pushed away and a plain tabby weft is woven.

that it *could* have been used. It is a very simple technique, involving no serious practical problems, which reduces by one-half the work of counting in pattern lifts. It might have been used before the development of more elaborate systems for permanently storing repeats.

For our third experiment we used a design drawn from an illustration in Sylwan 1949, pl. 13 c; see Figure 19. Repeated irregularities (one is marked by crosses) suggest that some mechanical aid was used to repeat pattern lifts. Probably 'pattern heddle rods' were used for this purpose. This example used the pattern technique known as 'Han *qi*' (sometimes, incorrectly, Han damask). It differs from the usual monochrome patterning in that floats occur only in every other warp end. The draft in Figure 20 shows how this pattern can be woven by a simple variation of the 2–2 system: each pattern rod is used for only a single weft, and each pattern weft is followed by a tabby weft with the other shaft lifted. Of course it is not strictly necessary to lift warp ends in groups of two; single lifts would suffice. But this does not give any saving of effort, and lifting in groups of two feels more natural to the weaver.

Figure 21 Our reconstruction of the silk woven according to the method of Figure 20.
Warp: red spun silk Nm 10, 18 ends per cm.
Weft: red spun silk Nm 10, 9 wefts per cm.

The Han *qi* technique has no dominant twill direction and here there is no conflict between the twill direction and the direction of lines in the pattern.

Our woven replica is shown in Figure 21.

Riboud (1973, p. 38) suggests that Han *qi* should be the earliest of the Han monochrome patterned silks; it is suggested that, because only half the warp ends are involved in the patterning, less work should be involved. In our experience we found that this is not the case. The same number of pattern rods is required, and the work involved in plucking them in is about the same. Another argument against Riboud's view is the patterns themselves: in the Han *qi* the patterns tend to be freer and to be drawn with greater ease, and this suggests a more developed technique.

Pattern heddle rods

Repeated errors throughout the length of some samples indicate, as mentioned above, that some more elaborate technique for repeating pattern lifts was used. Following Burnham (1965), we believe that 'pattern heddle rods' were used. Instead of storing the pattern rods within the warp, loops of string are placed around the groups of threads counted up for a row of

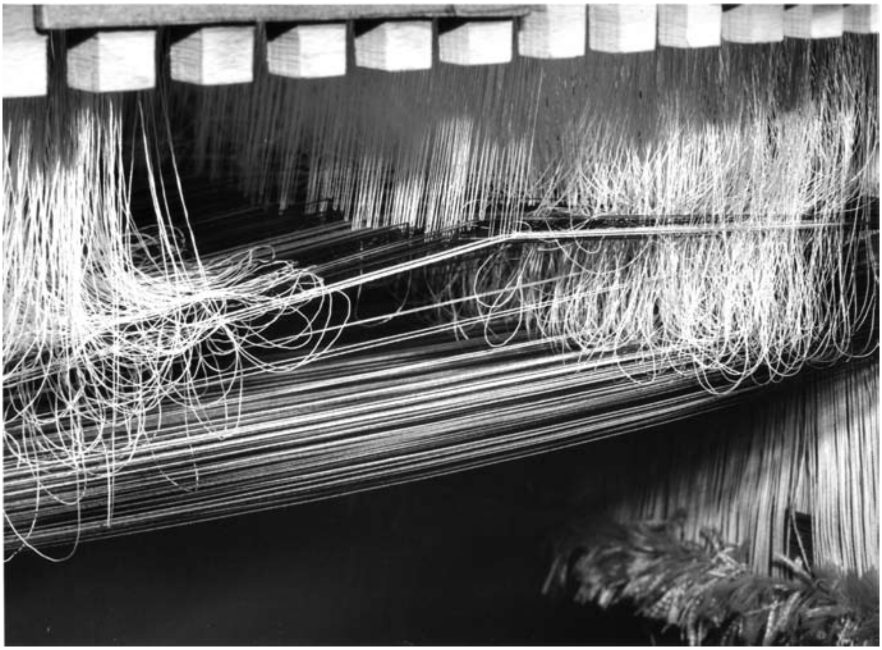


Figure 22 Here one pattern heddle rod is lifted and it is evident that the shed needs to be cleared up by means of a flat stick before it is of any use to the weaver. On this problem see also Chapter 3 on polychrome weaves.

pattern and fastened onto a rod. Then the pattern row can be lifted and function through other pattern rows ahead of it. Though this idea is conceptually simple there are practical problems in its execution. In the very tight warps which are normal in Han weaving the loops have a tendency to become entangled. Therefore it is necessary to put in a smooth flat stick under the lifted heddle rod to clear up the threads and to open the shed sufficiently; see Figure 22.

Pattern heddle rods of a similar sort have been used in traditional weaving in many parts of the world. Examples from Bulgaria and Hungary are described by Endrei (1959 and 1966); see also Geijer (1979, p. 92) on this method.

In our experiments we have developed a technique for setting up and using heddle rods in a dense silk warp. Figure 23 is a diagram of our loom seen from the back. We added two brackets to hold the pattern heddle rods in place and keep them in order.

The process of setting up the pattern heddle rods is as follows. By means of a flat pointed stick a pattern row is counted up ahead of the

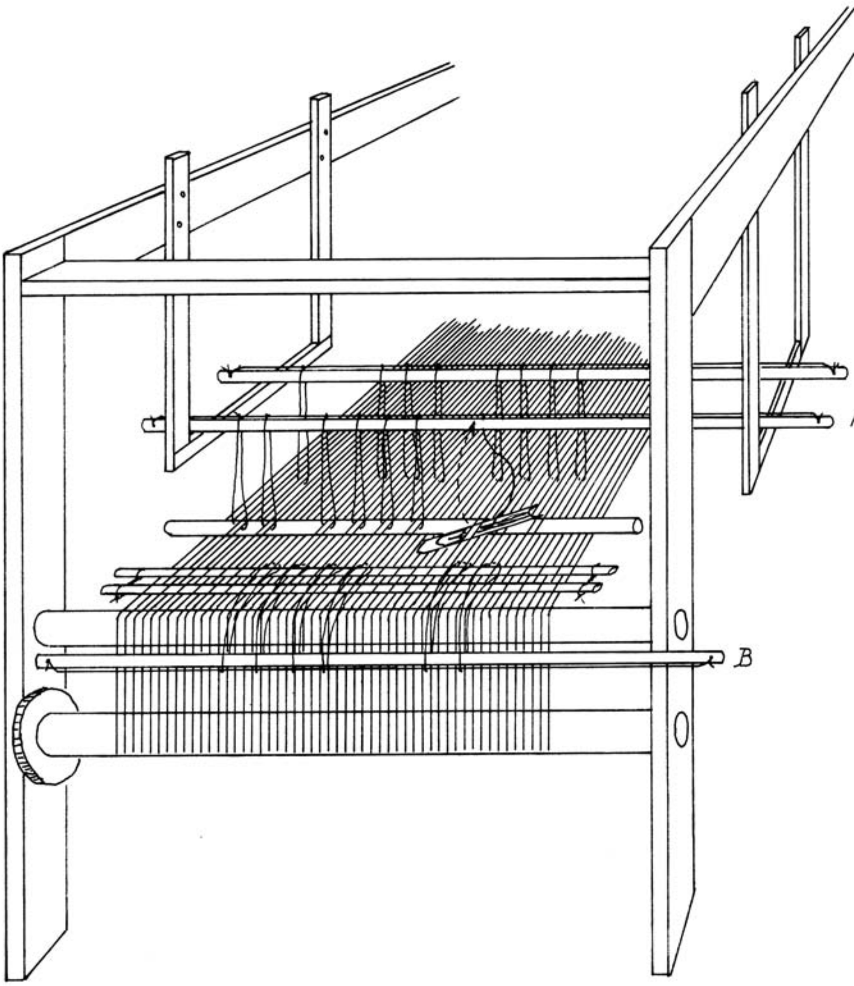


Figure 23 Sketch showing the setting up of pattern heddle rods.

shafts, taken through the shafts onto a thick round stick, and also woven to control the pattern. The shed rods secure the exact order of the warp ends – this is very important.

A strong cord is stretched along the upper side of the pattern heddle rod. Rod A is shown placed on the brackets, ca. 25 cm above the warp. The instrument used to knot the loops is a mending needle for fishing nets; the material for the loops, a thin twisted silk, is wound onto the needle. The first end of this thread is knotted securely to the cord over the rod, just above the first group of warp ends to be lifted, at the left. The

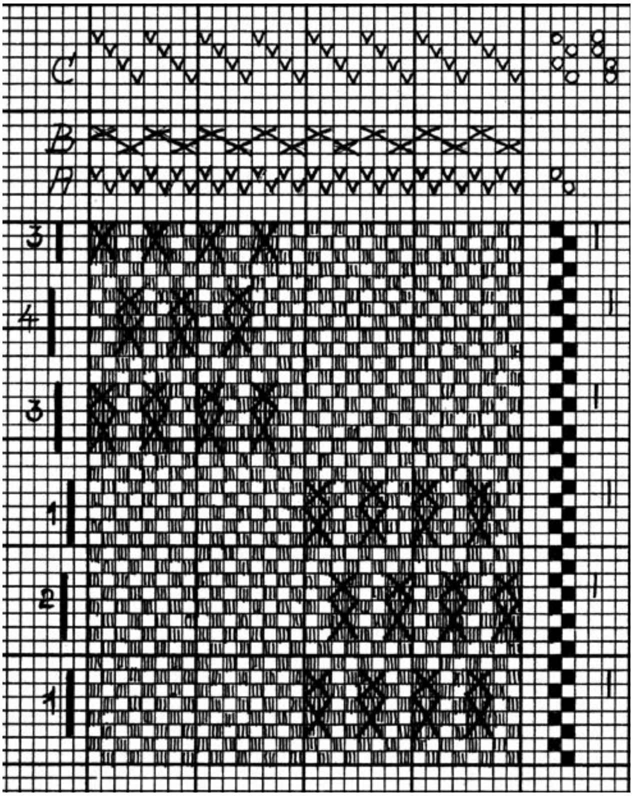


Figure 24 Draft for the silk with squares of waving effect. (Sylwan 1949, pl. 11 c, Hedin Coll. 03.36.266). The order of lifting pattern heddle rods is shown at the left. Thread counts in the original silk: warp 44 ends per cm and 34 wefts per cm.

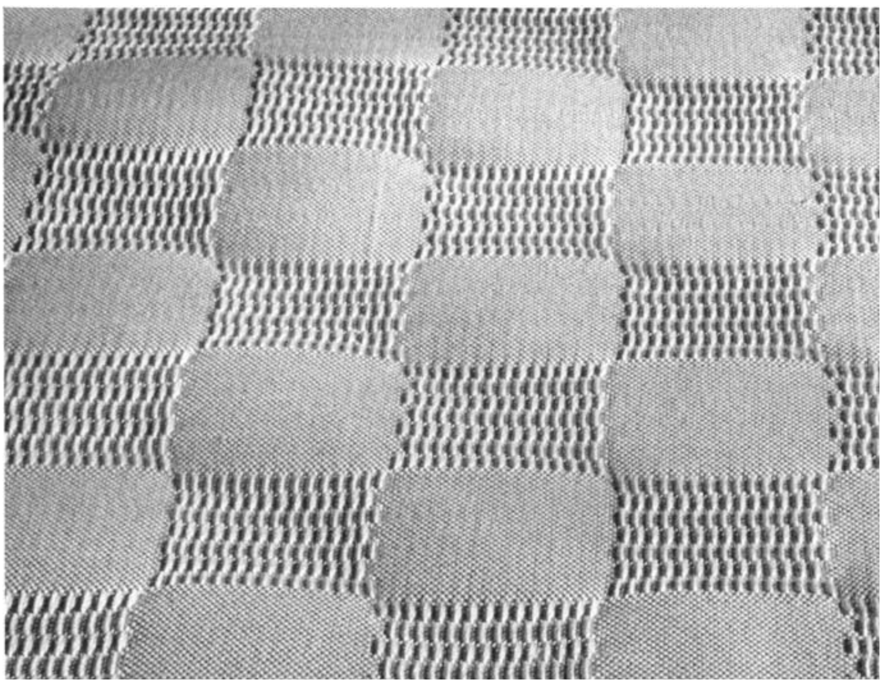
needle is brought behind the rod, then below one or two threads appearing above the round rod within the warp, then up in front of rod A (see the dotted line and arrow in Figure 23) and here knotted carefully to the cord. When space appears between groups of pattern the thread must be wound around the cord and knotted again before it continues the next loop. It is very important that loops be pulled evenly and knotted securely. When a row is finished the last loop is knotted especially securely before the knotting thread is cut and the round rod is taken out of the warp.

We found it useful when a pattern heddle rod was finished to let it down backward over the beam (see B in Figure 23) to give space for the next rod to be knotted. It is necessary for the control of the correct order of warp ends to take the cross-shed through each finished pattern heddle rod by means of a third cross-stick. Afterwards the cross-sticks are easily moved to their normal place again near the warp beam.

When all the rods needed for the pattern unit are ready they are taken up in the correct order onto the supporting brackets. Each of the brackets is beforehand supplied with a row of thin nails to hold the thin flat rods on edge and also to keep them in order. When rather thin rods are used, and the loom is of sufficient length, it is possible to work with a considerable number of rods. In some of the Han silks as many as 60–70 pattern heddle rods would have been necessary.

The fourth example represents an interesting variation of the 2–2 system; it is described by Sylwan (1949, p. 106, pl. 11 c). This sea-green silk was found by Sven Hedin on his first expedition to the Lop Desert, 1899–1901. The thread counts are: warp 44 per cm, weft 34 per cm. The checkered pattern consists of squares of tabby alternating with squares of a waving effect. This effect is obtained when lifted groups of two warp ends are kept lifted not for two wefts, as usual with the 2–2 system, but for five wefts, so that one warp end goes over seven wefts and another over only five wefts. Two wefts of plain tabby are woven between pattern lifts; see the draft in Figure 24. The longer warp floats slide over the shorter

Figure 25 Our woven replica. Note the waving effect in alternate squares.
Warp: spun silk Nm 10, 16 ends per cm.
Weft: spun silk Nm 10, 14 wefts per cm.

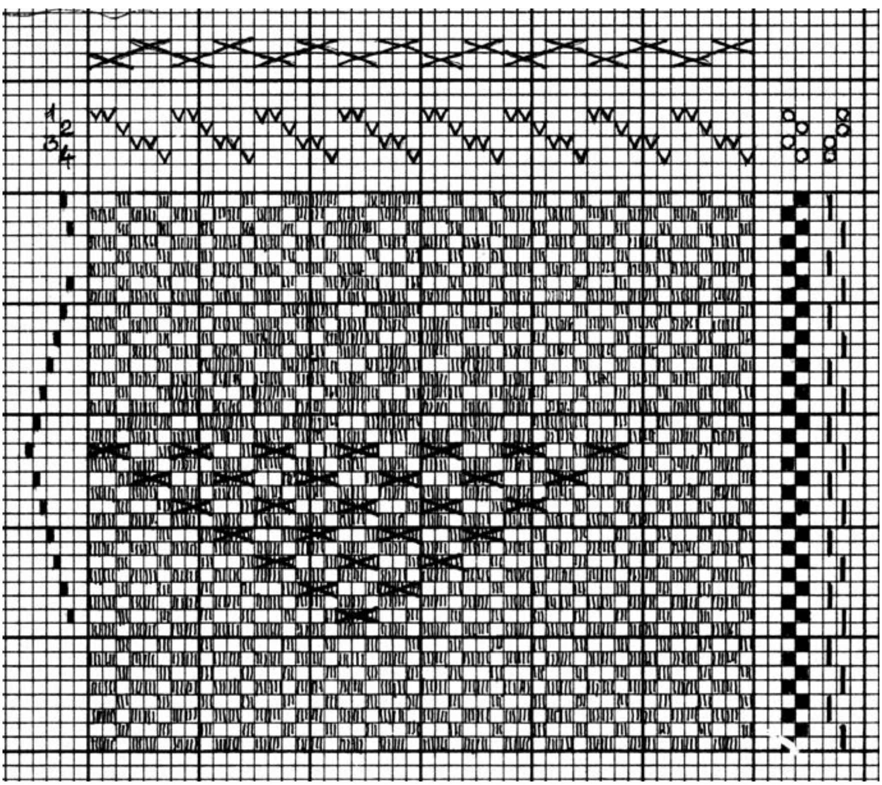


ones in alternate direction with each row; this gives the waving effect, as in our woven replica in Figure 25.

This pattern does not show any transversal symmetry and needs only four pattern rods, two for each row of squares, see the draft in Figure 24. It would be intolerable to count up every other row; therefore it is reasonable to suppose that pattern heddle rods were used for this silk.

One purpose of our experiments with ancient weaving techniques is to inspire modern weavers to use the ancient techniques in materials and designs appropriate to their own time. An example of a modern use of ancient techniques is shown in Figures 26–27, a linen altar-cloth designed and woven in our workshop. We used the Han *qi* technique; the material is linen thread 16/2 lea. In order to give a more pronounced structure to the figures the floating warp ends were doubled as shown in Figure 26.

Figure 26 The draft for an altar cloth woven with linen thread. Note the double warp ends entered into tabby shafts 1 and 3. In the detailed draft black crosses show the lifted groups for one pattern unit.



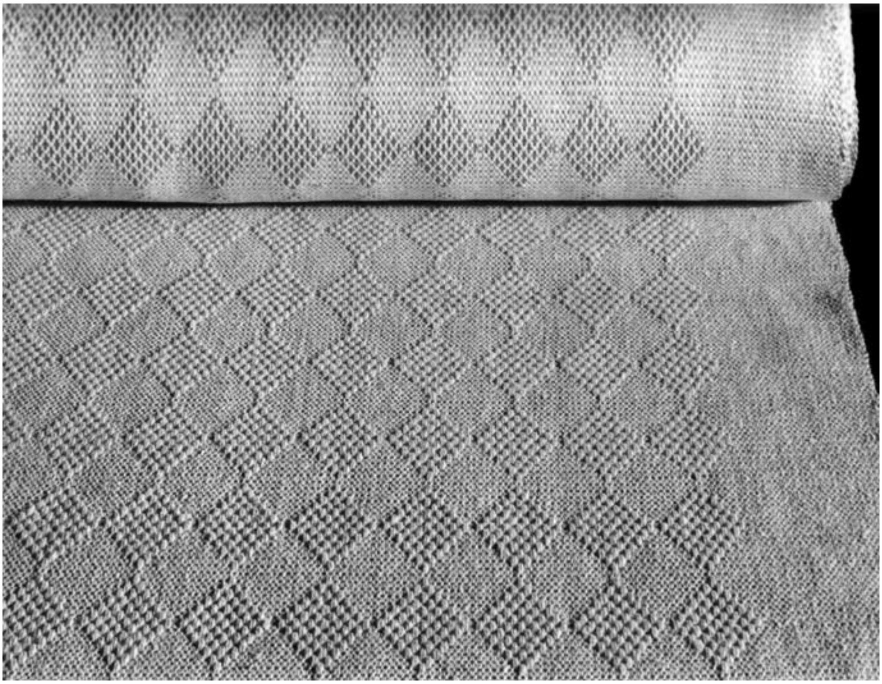


Figure 27 A linen altar-cloth woven in our workshop.
Warp: linen thread 16/2 lea, 16 ends per cm.
Weft: linen thread 16/2 lea, 7 ends per cm. Weaving this cloth by the 2–2 method required seven pattern rods used in transversally symmetric order.

Only one end is entered into tabby shafts 2 and 4 and two ends are entered into shafts 1 and 3. The alternating single and double threads are of a specific effect to the tabby ground and the patterned parts appear with a faint relief as can be seen in the photograph Figure 27.

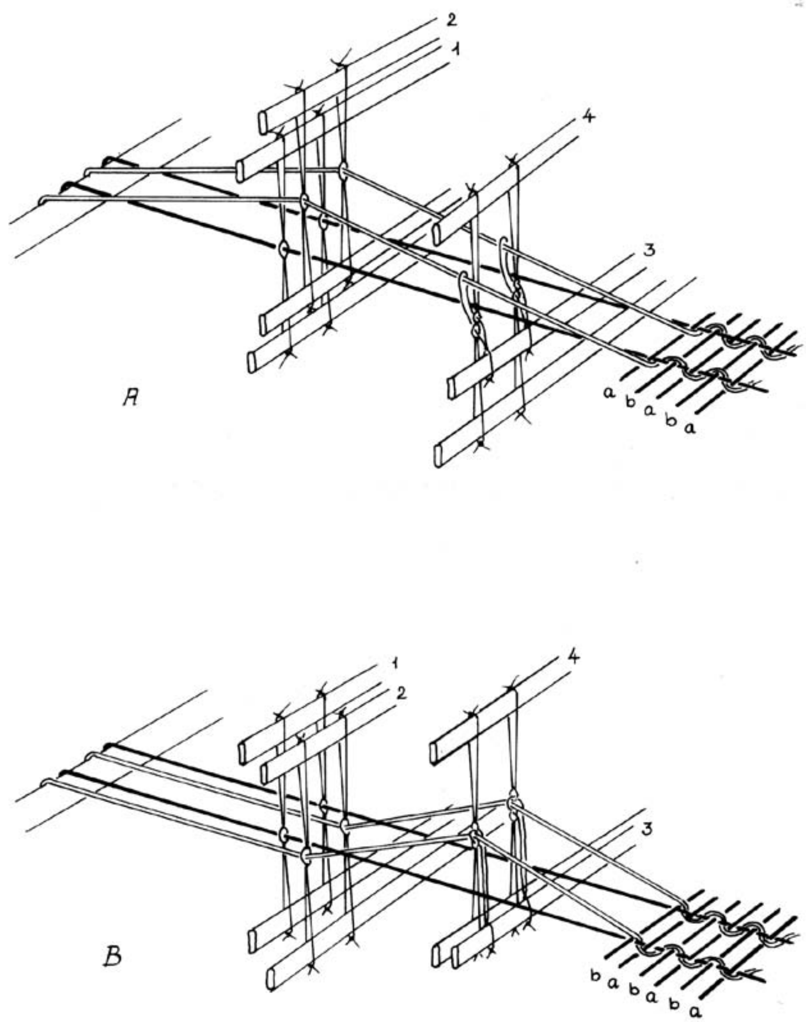


Figure 28 A. The 'open shed'. The white doup ends are lifted by shaft 2 in their natural order to the left of the corresponding fixed ends. Simultaneously the half-shaft 3 with the doups is lifted in order not to obstruct the shed.

B. The 'crossing shed'. Shafts 1 and 2 stay down; only the real doup shaft 4 is lifted, bringing the doup ends up to the right (opposite) side of the corresponding fixed ends.

Chapter 2
Gauze weaves

Plain gauze in our time

Before we start to discuss our experiments with the gauze weaves of the Han it will be useful to describe briefly what plain gauze is and how it has been woven by handweavers in recent centuries. The plain gauze or cross weave is the basis for all varieties of gauze. The purpose of this sort of weave is to produce a lightweight open material sufficiently bound that the threads cannot slide apart. In contrast to other weaves the warp ends do not lie parallel but cross each other. The warp ends are divided into two types, *fixed ends* and *doup ends,* according to their function: a fixed end is always below the weft, while a doup end is lifted over the weft alternately to the left and to the right of its neighbouring fiixed end. Two adjacent warp ends are always crossed between wefts, and this gives the necessary solidity to the open weave.

In Figure 28 A and B is shown a slightly simplified version of how the so-called doup heddle or simply *doup* (in French *lisse anglaise*) is used. For clarity fixed ends are drawn black and doup ends white. Nearest the warp beam are placed the two ordinary heddle shafts, 1 and 2; about 18 cm in front of these is placed the *doup shaft,* 4. This consists of one shaft provided with two-eyed heddles and a half-shaft, 3, on which loops, passing through the double eyes, are fastened. These loops can slide easily up and down.

The fixed end (black) is entered into shaft 1 and taken past the doup heddle on its left. The doup end (white) is entered into shaft 2; then the loop on half-shaft 3 is pulled upwards under the fixed end, and the doup end is entered into the loop. In Figure 28 A is shown what we call the *open shed,* because no cross takes place here. Shaft 2 is lifted by means of its treadle and so is also the half-shaft 3 to give an easy 'lift' to the loops; weft a is thrown in. Figure 28 B illustrates the *crossing shed;* shafts 1 and 2 stay down and only the doup shaft 4 is lifted by its treadle. The half-shaft 3 is spring-loaded in order to keep the loops, together with the doup ends, tightly locked to the double-eyed heddles during this cross lift; this causes a very strong pressure on the warp. The doup ends are now lifted to the right of their fixed ends and weft b is thrown in.

Doup heddles in the form shown here are a modern invention. In earlier gauze weaving simple loops were used, as will be seen below in the description of our experiments.

This short description of the principles of gauze weaving is only meant to show the essential points and to introduce the terminology used. This should be useful as we deal in the following with gauze in its earlier forms.

Gauze weave in the Han, **luo**

Xia Nai (1972, pp. 17–18) describes three different gauze weaves used in Han China and proposes reconstructions of how they were made. Certainly the first type, plain silk-gauze, was widely used thanks to its many useful properties. Xia Nai mentions a Zhou-period jade knife in the Palace Museum, Beijing, with imprints of cloth with this weave (Xia 1972, pp. 15, 17). Among the printed silks from Mawangdui Tomb No. 1 (168 BC) some are executed on plain gauze.

Pseudomorphs of what appears to be gauze have been found on a bronze vessel from a Shang-period (16th–11th century BC) site at Taixicun, Gaocheng County, Hebei (Gao Hanyu 1979, pp. 47–48; Tang Yunming 1979; Wang Ruoyu 1979). An embroidered gauze garment was recently found in a tomb dated ca. 300 BC in Jiangling County, Hubei. It has 46 warps and 42 wefts per cm; every fourth weft is crossed, while the rest are plain-woven (Chen Yuejun & Zhang Xuqiu 1982, p. 10; cf. *BR* 1982.12: 28–29). Peng Hao (1982, p. 5) states that this structure is the same as that of artifact no. 340-17 from Tomb no. 1 at Mawangdui.

Aurel Stein's finds from Qianfodong include painted banners and hangings made from 'fine silk-gauze' (O'Neale 1945, p. 405).

Xia shows the simplest way to weave this plain gauze, Figure 29. Odd-numbered warp ends are the fixed ends while even-numbered ends are

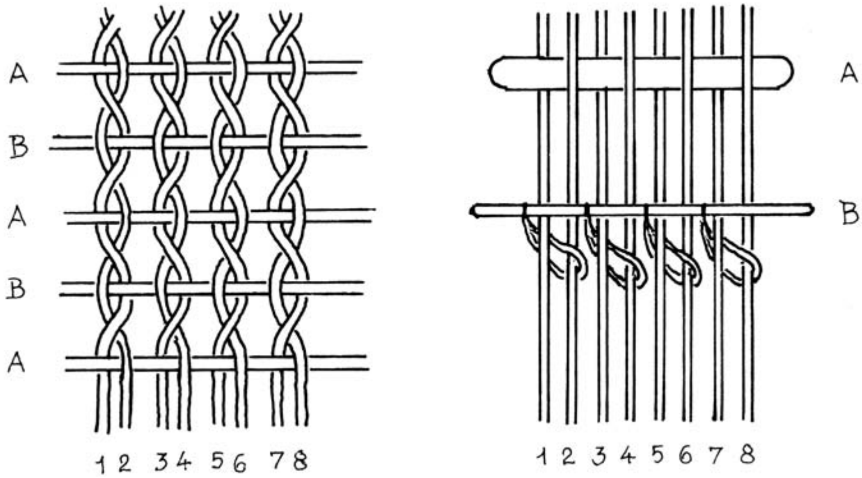


Figure 29 Plain gauze as shown by Xia Nai (1972). Odd-numbered warp ends are the fixed ends, while even-numbered ends are the doup ends. The broad shed stick A is used for lifting the open sheds A; shaft B with the doup heddles lifts for crossing sheds B.

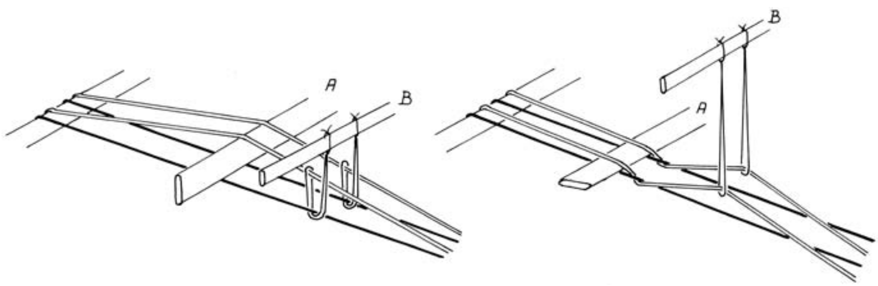
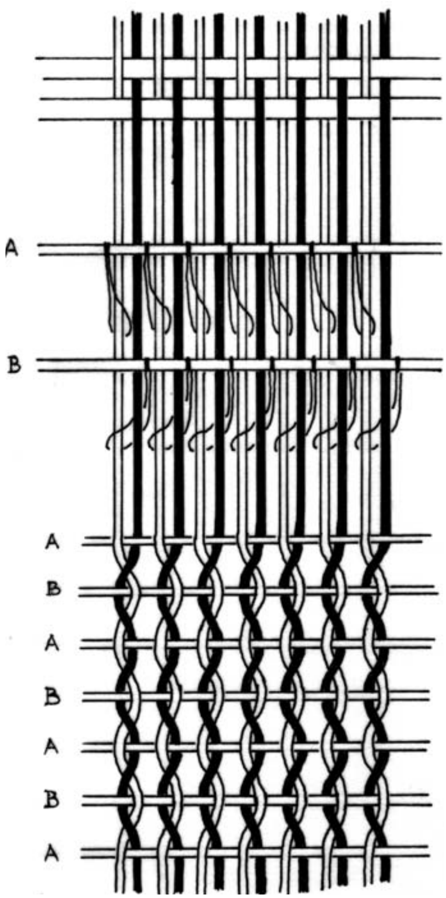


Figure 30 Xia Nai's method outlined in detail. At the left the broad shed stick A is raised on edge to give the open shed. The doup heddles on shaft B must be of sufficient length to go below the fixed ends and to follow its doup ends up to the upper shed face. At the right is shown the crossing shed. Doup shaft B is lifted and the doup ends go below its fixed ends and up at the left side of the fixed ends.

the doup ends entered into the doup shaft B as shown in the drawing. Wefts A are made with rod A pulled forward and turned on edge; this is the open shed, in which no cross impedes the opening and warp ends are used in their natural sequence; the loose doup heddles follow their threads to a sufficient height so that they do not interfere with the shed, Figure 30. Wefts B, in the cross sheds, are made with the doup shaft B lifted, so that the doup ends come up to the left of their corresponding fixed ends.

Certainly plain gauze can be made in this way with one heddle shaft and one shed rod. However we have earlier (Chapter 1) presumed that by this time the Chinese loom had two shafts and two treadles; therefore we have used two shafts and two treadles for plain gauze in our experiments, see Figure 31. Shaft A lifts the doup ends (white) in their original sequence (the open shed), and the doup heddles follow their threads up. Doup shaft B lifts the doup ends to the right of the corresponding fixed ends (black). It is useful in a gauze weave to place the fixed ends slightly higher than the doup ends, so that these slip more easily under the fixed ends; that is why the nearer shed rod is placed below the fixed ends.

It must be supposed that the first gauze weaves or the experiments for this sort of weave were made by manually crossing the warp ends onto a rod without the use of special heddles. Such manual methods were used



← **Figure 31** Our use of two heddle shafts for plain gauze. Shaft A lifts the doup ends in their natural order for the open shed; doup shaft B lifts for the crossing shed.

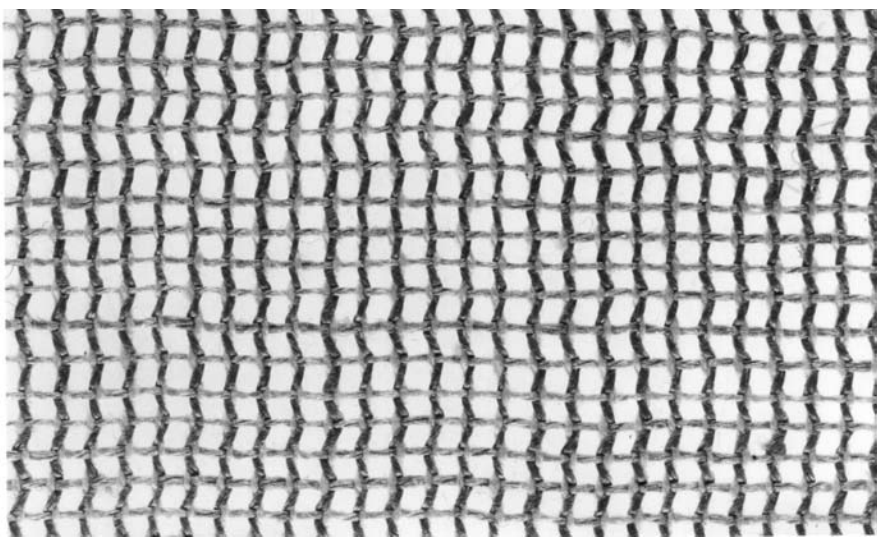
→ **Figure 32** A woven sample of a plain gauze in a coarse quality.

Warp: doup ends cotton 20/2, fixed ends linen 16/2 lea. Total: 7 pairs of ends per 2 cm.

Weft: linen 16/2 lea, 4 wefts per cm.

in folk-art from many countries; more on this later on. In weaving fine silk-gauzes with as many as 70–100 ends per cm such methods would be extremely troublesome and time-consuming, and some sort of doup heddles must have come into use very soon. We should also remember that Chinese silk weavers were professional craftsmen. They surely had to deliver a certain amount of material every day and had no time for finger-twisting. If we look again at shaft A (Figure 31) as one tabby shaft not much imagination would be needed for a weaver to make the experiment of putting heddles on shaft B under the neighbouring threads and entering the threads from A into these heddles. Later on he would find that these heddles ought to be rather longer than usual because they not only have to lift their threads but also, when shaft A is lifted, they have to follow their threads below the neighbouring fixed end and furthermore so far upwards as not to prevent a usable shed, Figure 30 once more. Threads can in this way be crossed to the left or to the right depending only on the way they are entered. It is possible to make alternating pairs of threads cross in opposite directions. In each case a pair of warp ends will appear tightly twisted together. In Figure 32 is shown a sample of plain gauze woven with very coarse yarns.

The obvious material for heddles when weaving with fine materials is a fine twisted silk thread. For our trials we knotted heddles of hard-twisted silk and found them rather easy to work with. They have the advantage that, being of the same material as the warp, they receive the same static-



electric charge. The slight electric repulsion involved significantly reduces problems of tangling.

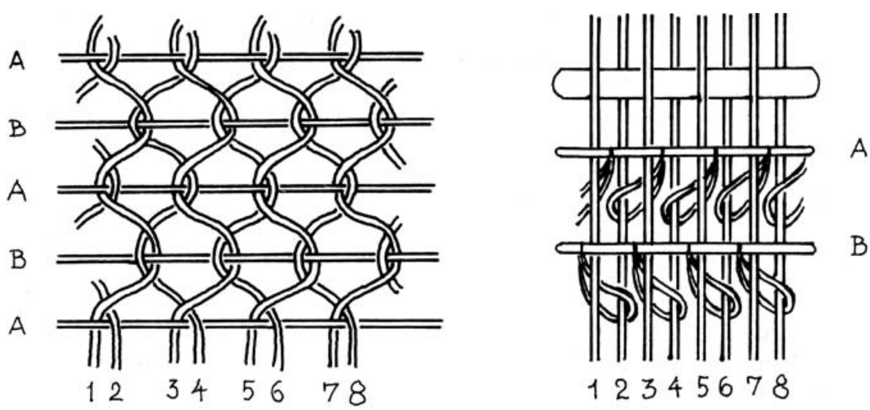
Modern automatic looms for gauze weave have a special release beam for the doup warp. Nahlik (1961, pp. 11–15) shows two beams, presumably for this purpose. In most handweaving, and especially when a fine silk with its high elasticity is used, such arrangements are unnecessary.

The tighter weave with small apertures

The second gauze weave considered by Xia is reproduced in Figure 33. This is not just a plain gauze: each doup end crosses two fixed ends. We wove this weave with a fine silk warp and at first also used the same fine silk for the weft. The warp ends are then extremely apt to slide together. In our next trial we used a much thicker, rather loosely twisted silk for the weft and beat it in as hard as possible. Then we got a useable material, shown in Figure 34. A group of warp ends is here pushed aside to make it easier to see the weave.

For our experiment we used the method shown by Xia Nai in Figure 33. Two shafts are equipped with doup heddles; shaft B pulls each of its threads to the left of its neighbouring fixed end, while the other shaft A pulls the same threads to the right. By this means each doup end crosses two fixed ends after each weft, and the result is a fine-meshed material with small apertures. Here there is no open shed; both are cross sheds.

Figure 33 The tighter weave as shown by Xia Nai (1972). Two doup shafts are needed; shaft B lifts the doup ends to the left of the fixed ends, and shaft A lifts the same ends to the right of neighbouring fixed ends. Thus each doup end passes two fixed ends between wefts.



Certainly textiles woven entirely with this weave have been used. Sasaki (1960, p. 16) shows a sample from a Japanese tomb dated 1632. John Murphy (1850, pp. 166–174, pl. 7) shows this same weave under the heading of 'net weave' or 'whip net' used for some sort of netting. Chinese weavers presumably produced this type of fabric, which when extended in weft direction formed net-like structures nearly as shown in Xia's drawing, Figure 33.

The modern Chinese word for gauze, *luo* 羅, appears to have been used with this meaning well before the Han. But it was also used to mean 'a net for catching birds,' and indeed the character consists of the elements 'net' 网, 'bird' 隹 , and 'silk' 糸 (Karlgren 1957, item 6a).

Though we have not found archaeological evidence from the Han of this weave used throughout a textile we do have many examples which use combinations of this weave with, for example, tabby, as in our next sample. Also this same weave is used for the tighter figures in patterned gauze.

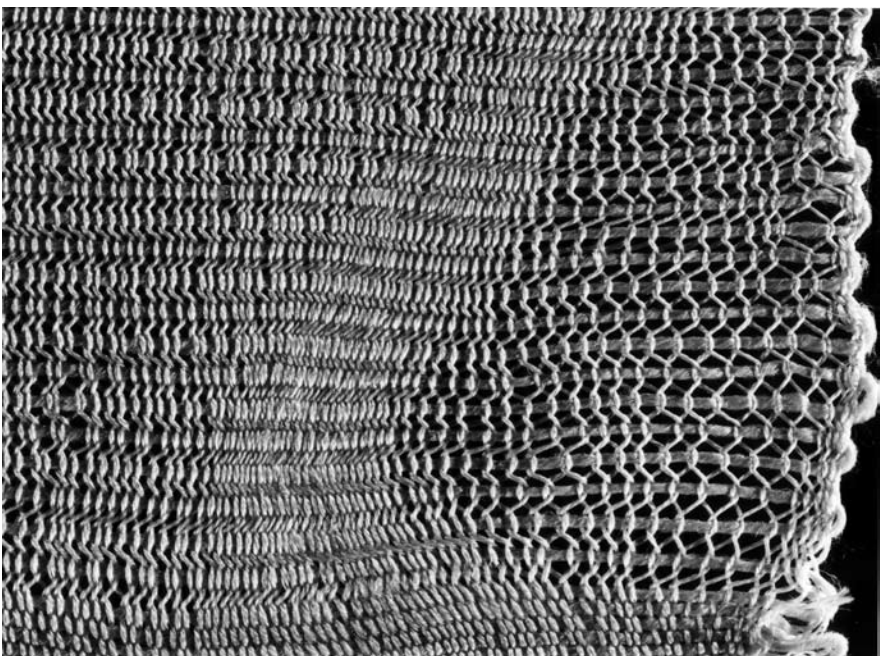
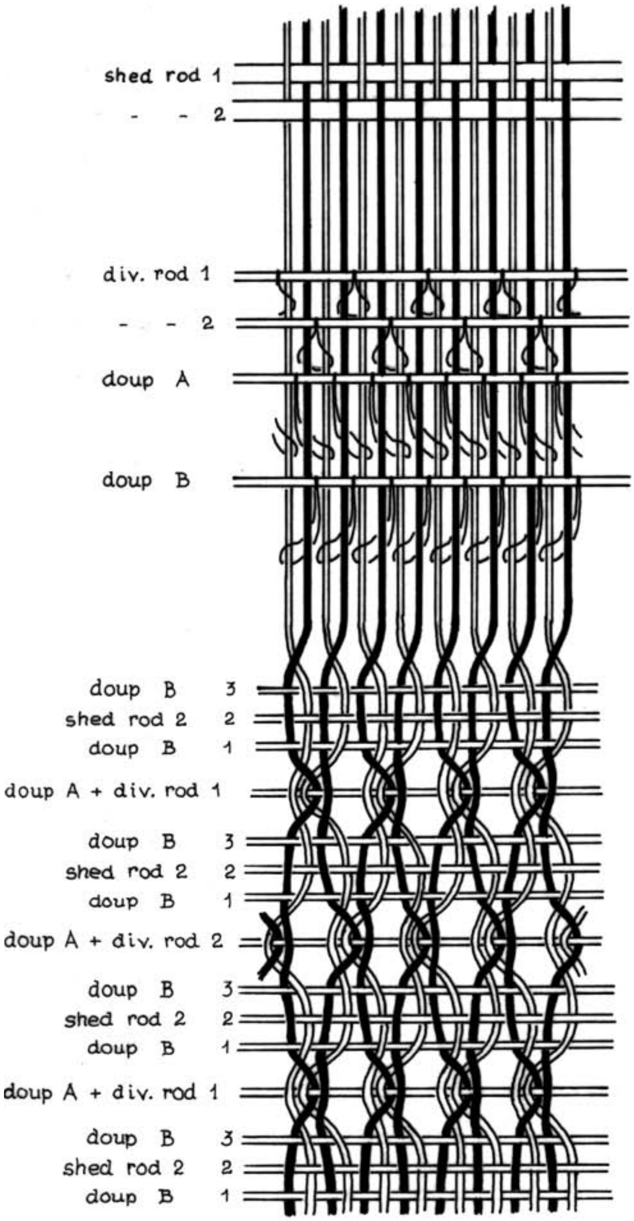


Figure 34 A sample of silk woven with the tighter weave. At the right the warp ends are pushed aside in order to show the gauze weave more clearly.

Warp: organzine Nm 36.

Weft: spun silk Nm 10.



← **Figure 35** Systematic diagram of the variegated gauze shown by Sylwan (1949, pl. 12 B). Note the dividing rods 1 and 2 behind two doup shafts A and B. Doup shaft B lifts for tabby wefts 1 and 3; for tabby weft 2 shed rod 2 is raised on edge. Doup shaft A alternately together with dividing rod 1 or 2 brings out the larger apertures between tabby wefts.

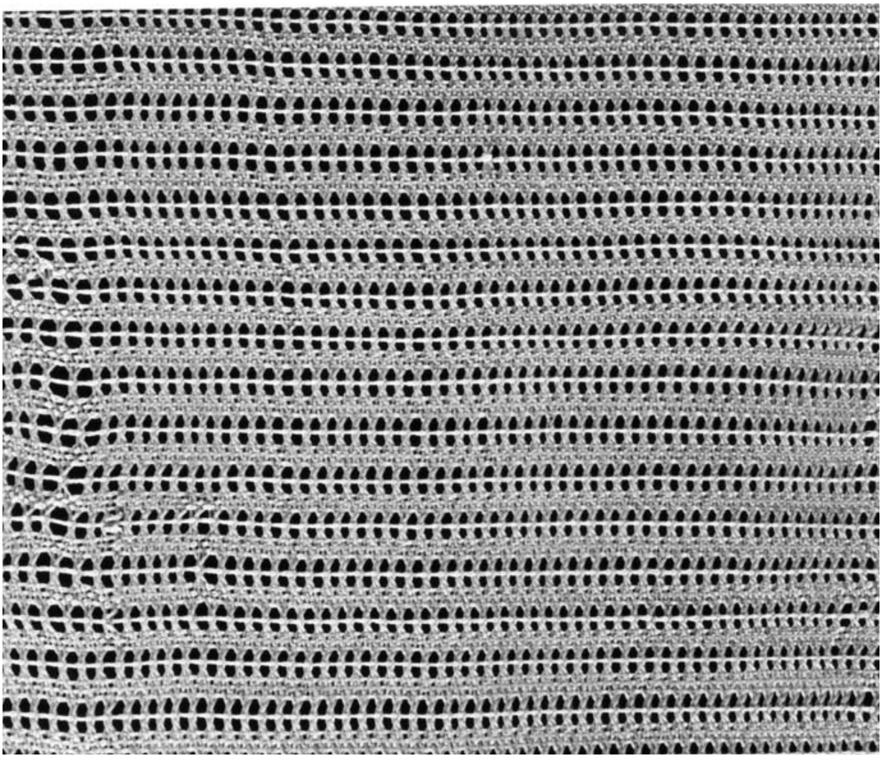


Figure 36 Woven sample of the gauze described in Figure 35.
Warp: organzine Nm 36, ca. 25 ends per cm.
Weft: organzine Nm 36, ca. 12 wefts per cm.

Vivi Sylwan's sample

Vivi Sylwan (1949, pl. 12 B) has a silk gauze from Edsen-Gol. In this weave three tabby wefts alternate with a gauze weft, bringing groups of four threads together, alternately displaced between the tabby wefts. For this silk, Figure 35, we used the two doup shafts and behind them added two dividing rods lifting groups of two (one doup end and one fixed end) as in the 2–2 system for monochrome patterning. For the three apparent tabby wefts we used for weft 1 doup shaft B turning to the right, for weft 2 the nearer shed rod 2 lifting all fixed ends, and for weft 3 again doup shaft B. The warp ends never appear in their natural sequence following the shed rods. For grouping into four with the cross weft, doup shaft A is lifted together with one of the dividing rods alternately to bring out the displacement of groups of four. It is essential here to keep in mind that fixed ends must stay below the weft and doup ends must go over the weft when a true gauze is woven. When doup shaft A is lifted and dividing rod 1 is also lifted, every other fixed end is lifted too. The raising of a fixed end causes the cross to slip out, so that no crossing takes place. The connection to the next group of four disappears and gives instead a larger aperture as is shown in Figure 35. This is the only trick needed to make patterns in gauze weave. For this example we have needed only two dividing rods for every other weft between the 'tabby rows'. It is quite insignificant that also the doup ends are lifted; they will be lifted in any case by the doup shafts. A piece of this weave is shown in Figure 36.

Patterned gauze, **wenluo**

A considerable number of all-over patterned gauzes are preserved from the Han. Usually they are decorated with some lozenge-like figures drawn with fine thin lines alternating with rather thick and strong outlines; this gives an effect of lighter and darker colours though only one colour is used. Presumably they were woven with silk thread in its natural colour (not perfectly degummed), and dyed after weaving. Some exquisite examples are preserved from Mawangdui tomb no. 1, e.g. pl. 122, reproduced here in Figure 37, a richly patterned gauze preserved in its full width, 49.5 cm. This illustration is so clearly printed that it was possible to count ca. 48–50 different pattern rows in one-half of the symmetric pattern unit. An irregularity in the sharp-pointed angles of one thin lozenge is also discernible, and this irregularity is repeated throughout the length of the material. This indicates that pattern rods equipped with loops were in use by 168 BC at the latest.

Xia has considered a third gauze weave, the weave used for the ground in patterned gauzes. His arrangement for doup shafts to pull one doup end below three fixed ends is possible but certainly would be rather complicated and impractical. In fact this weave can be produced by using his much simpler doup arrangement shown in Figure 33.

Part of a patterned gauze is diagrammed in Figure 38 to show the movements of warp ends. The narrow part to the right of the middle is the same sort of weave as shown by Xia (Figure 33). This weave forms the lines and tighter parts of the design. The open ground to the left and right is also woven alternately with doup shafts A and B, but when doup shaft A is lifted every other fixed end is lifted simultaneously.

For counting in pattern rods the two dividing rods 1 and 2 are used in the same way as in monochrome patterning; dividing rods are used only while the counting-in of a pattern is done. In Figure 38 four pattern rods (a–b–c–d) are shown, corresponding to the lower part of the drawing. When no fixed end is lifted the tighter effect will appear.

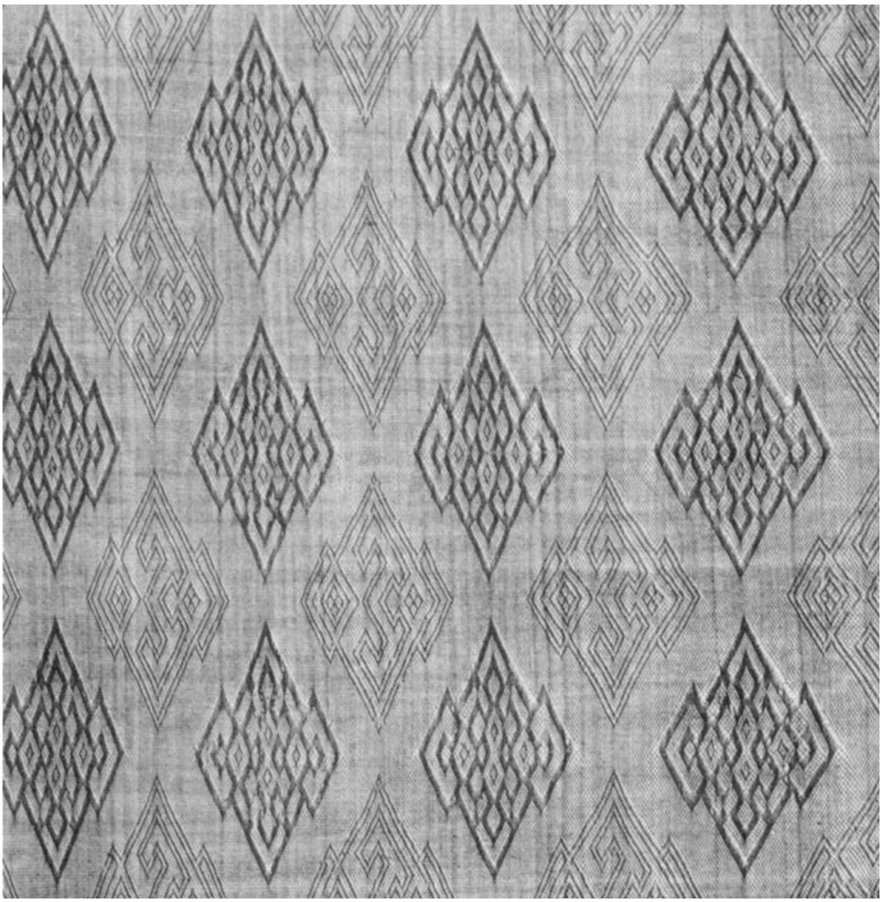
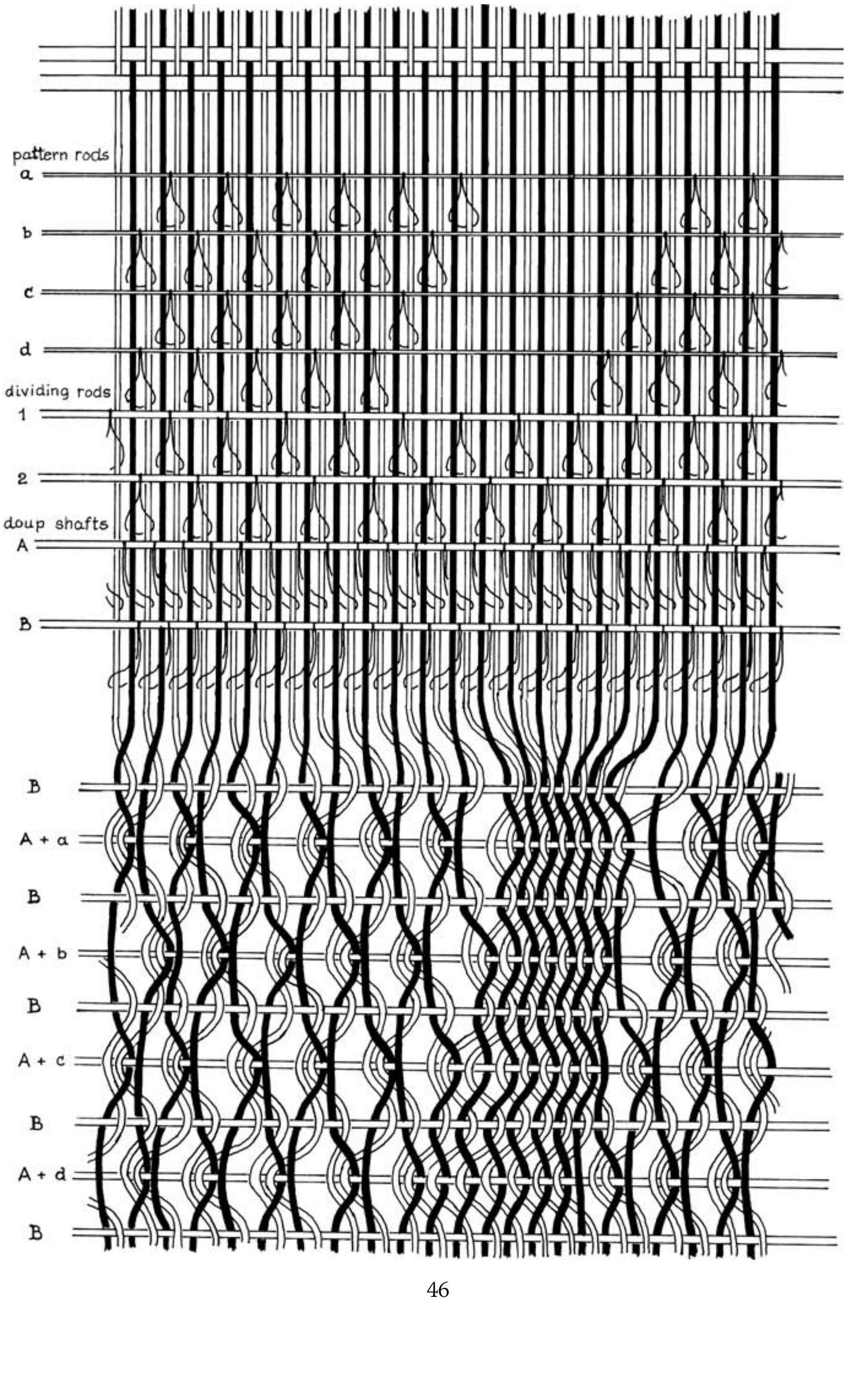


Figure 37 An example of a patterned gauze from tomb no. 1 at Mawangdui (artifact no. 340-21, reproduced here from *Mawangdui* 1973, pl. 122, p. 53). The full piece is 49.5×56 cm; weight 8.7 g.

Warp: 64 per cm.

Weft: 40 per cm. The part of the whole shown here is ca. 15 cm wide.


pattern rods
a
b
c
d
dividing rods
1
2
doup shafts
A
B
B
A + a
B
A + b
B
A + c
B
A + d
B

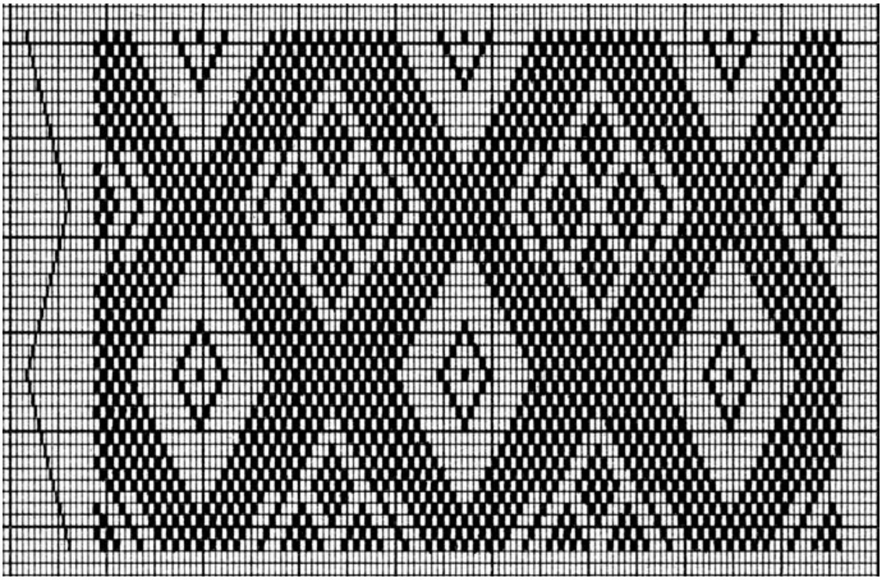


Figure 39 Our simplified design for a patterned gauze. One black point means a group of two threads lifted; i.e. each vertical column means two warp ends and each horizontal row means two wefts.

For our experiment we made a simplified design comprising only fifteen pattern rods in one-half of the pattern unit, Figure 39. One black point in the figure means a group of two threads lifted in the same way as shown in the chapter on the monochrome silks. Between pattern wefts one weft is thrown in with doup shaft B lifted.

For our first experiment with patterned gauze we lifted only the fixed ends. This too functioned reasonably, but we consider pattern lifts in groups of two to be most probable considering the general use of the 2–2 method, and it is our impression that pattern rods with groups of two more easily give a useable shed.

In this weave it is impossible to make use of a reed; the warp ends can nowhere be parted. We used a sharp-edged smooth rod (a sword beater) to beat together the wefts; because of the twisted warp ends it must be beaten very hard – even though the material looks so light and open. As

← **Figure 38** The diagram for part of a patterned gauze. Two doup shafts A and B lift the doup ends respectively to the left and to the right of the fixed ends. Two dividing rods 1 and 2 are used to count in the pattern. Only four pattern rods, a–d, are shown. Each of the loops on the pattern rods contains a doup end and a fixed end. Where alternate fixed ends are lifted no crossing takes place and the larger apertures appear. Where fixed ends are not lifted the tighter gauze weave appears and forms the outlines of the lozenges.

← **Figure 40** Doup shaft B is lifted and the little flat shuttle is placed in the shed.

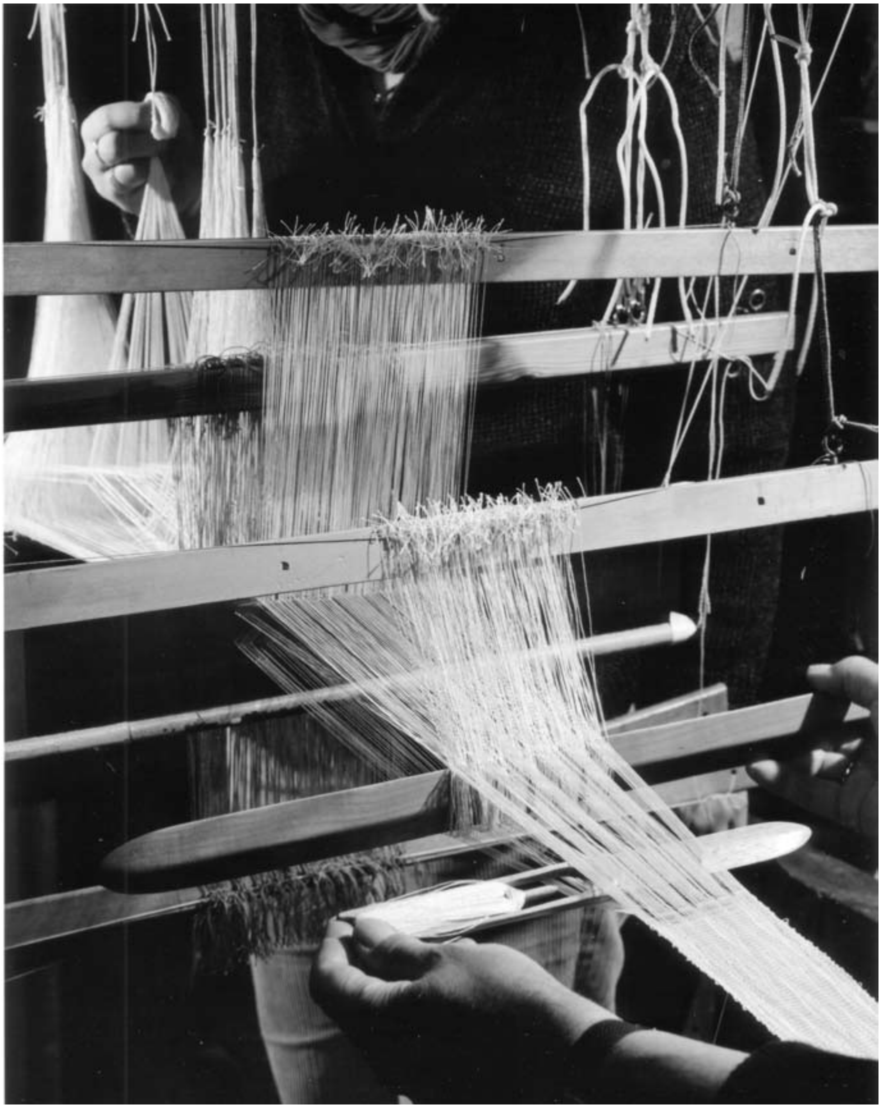
→ **Figure 41** A pattern shed is opened. The loops for pattern are lifted by an assistant and doup shaft A is lifted at the same time. The heavy sword beater is used to open the shed behind doup shaft B. The shuttle is ready to go through the pattern shed; then the sword beater is used in this shed to beat in the weft.

is shown in the photographs, Figures 40 and 41, we placed a reed behind the doup shafts as a means of keeping the threads in order. In Figure 40 the doup shaft B is lifted and the small flat shuttle is in the shed. Figure 41 shows a pattern shed. An assistant lifts the pattern loops for one row, doup shaft A is lifted, the sword beater is put in behind the doup shaft to help clear up the shed, and the weft is thrown in.

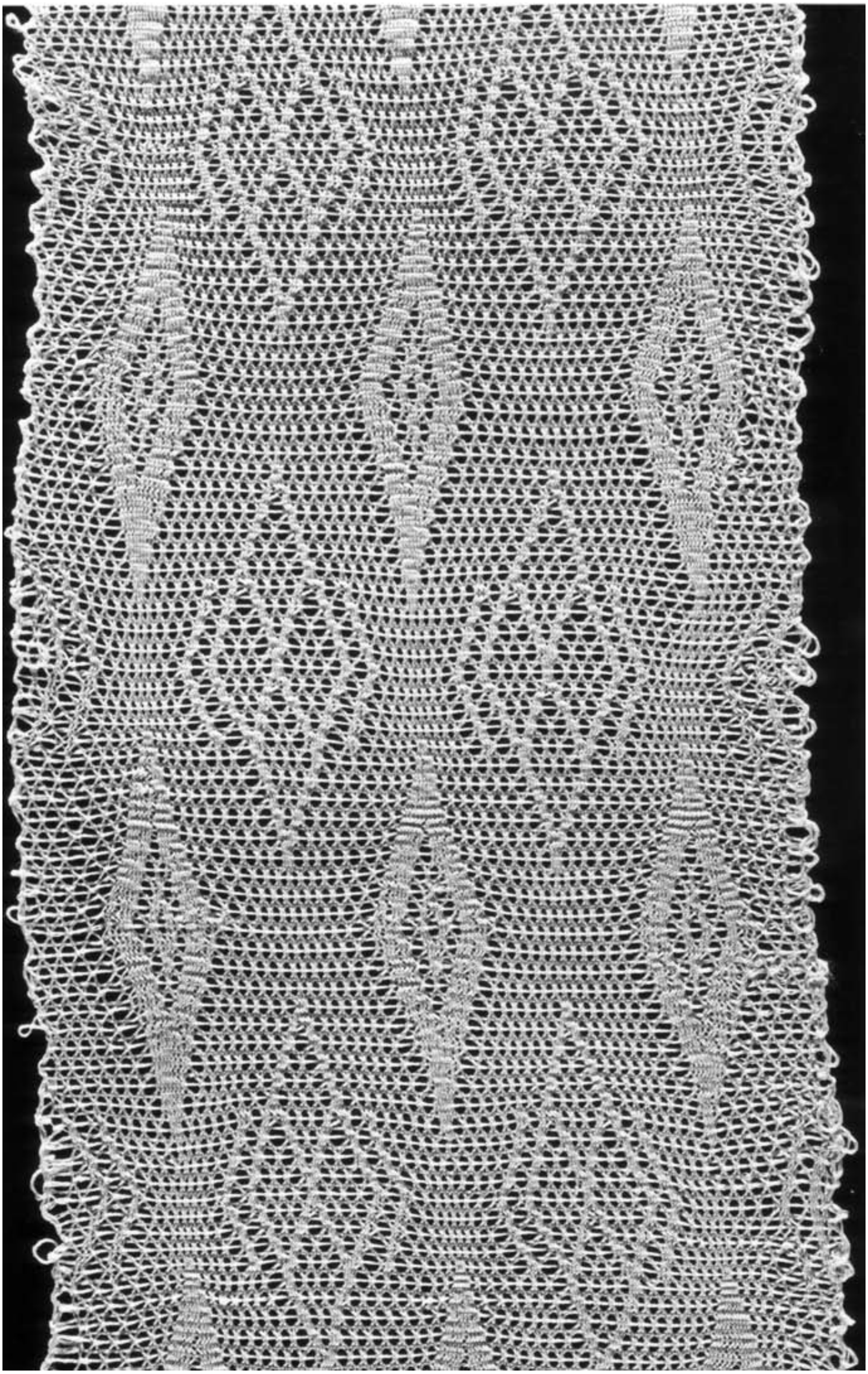
Finally a piece of woven silk-gauze is shown in Figure 42. The material used is organzine Nm 36 (36 m in one gram). In our sample there are only 24 ends per cm, while the Han gauzes go up to 70–100 ends per cm. Still we are convinced that it would be possible with some practice to weave these fine silks with an arrangement like ours.

Gauze weaves from other parts of the world

Perhaps it would be of interest to see a little of gauze weave from other parts of the world. Among ancient Peruvian textiles, which include nearly every sort of weave, gauze weave is widely represented. Raoul d'Harcourt (1962, p. 50), in his extensive work on these textiles, shows many examples



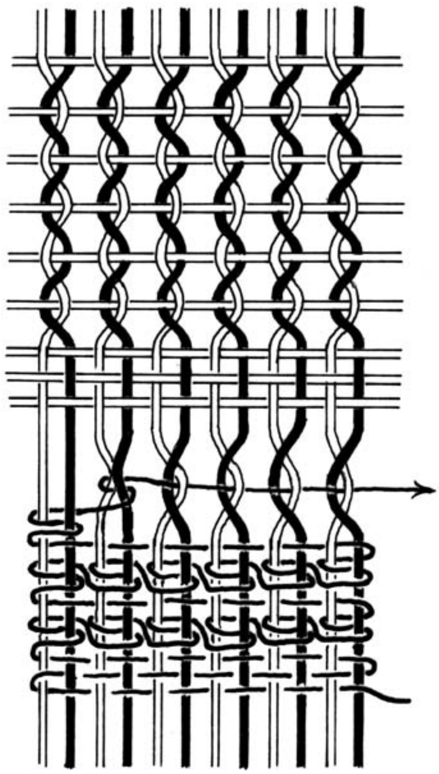
of extremely varied gauze weaves. The Peruvian method of twisting a weft round groups of warp ends is clearly shown. In Figure 43 we have tried as well as possible to illustrate the method for plain gauze. The twisting looks very complicated in the drawing, but in reality it is rather easy when it has been practised a little and the twisting is done entirely by instinct. When a row is finished the weft thread is pulled straight as indicated by the arrow; thus the twist is transferred to the warp ends. The lower part



← **Figure 42** Our woven sample of a patterned gauze. The width is ca. 11 cm.

Warp: organzine Nm 36, ca. 25 ends per cm.

Weft: organzine Nm 36, ca. 8 wefts per cm.

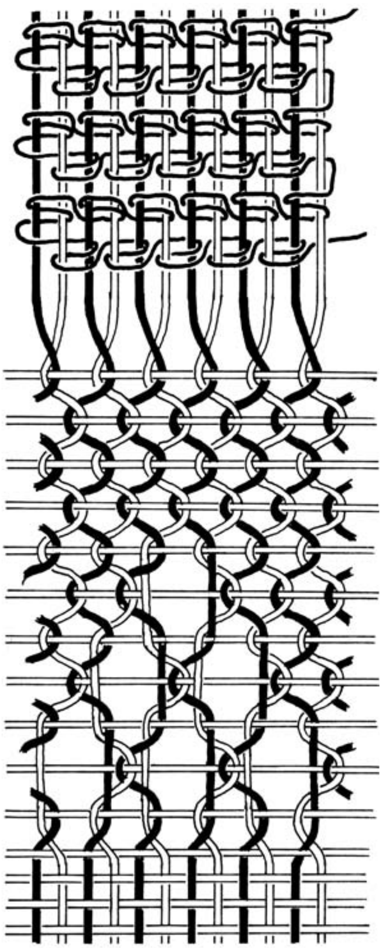


→ **Figure 43** The Peruvian method for weaving plain gauze. Every other weft is twisted round groups of warp ends. The twisted weft is pulled straight before the tabby weft is woven.

of the drawing is a fantasy. Each twisted weft is of course pulled straight before the tabby weft is thrown in.

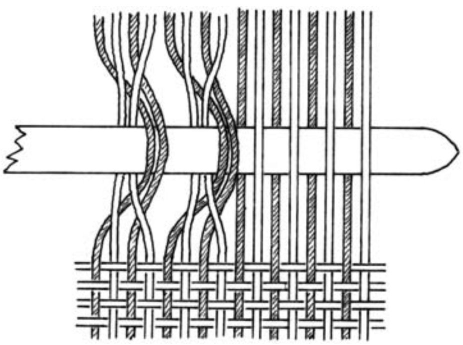
For patterned gauze the Peruvians used two wefts working differently, without any tabby in between. In Figure 44 part of a patterned gauze is shown. The lower part is here also a fantasy whose only purpose is to illustrate the different movements of the twisting wefts a and b. This way of twisting gives nearly the same weave as the Chinese tighter type (Figure 33): one end passes two other ends between wefts, but in the Peruvian weaves the end on its way past two others goes under the first one and over the next. Thus we cannot here discern a doup end from a fixed end, both being alternately above and below the weft. For patterns with larger apertures the twisting of a pair of warp ends is left out, as is shown in the simplest form uppermost in Figure 44. A large variety of methods of patterning have been used, as shown in d'Harcourt's book.

Presumably the simple body-tension loom used by Peruvian weavers would be of advantage for this sort of weave. It would be easy when lean-



← **Figure 44** Patterned gauze and the tighter type of gauze shown according to the Peruvian method. The lower part of the drawing is a fantasy. Of course each twisted weft is pulled straight before the next is done. It is only meant to show the different movements of the twisting wefts.

↓ **Figure 45** The Finnish method for twisting warp ends. A broad shed stick is taken into one tabby shed and groups of warp ends are lifted by hand from the lower shed face past groups of the upper shed face.



ing a little backwards to keep the warp straight while the twisting is done. Afterwards, when the weft thread is to be pulled straight, it would be easy to lean a little forward to slacken the warp and thus transfer the twist to the warp ends.

The weavers of Peru used their hand-spun cotton and the number of ends per cm is only from six to ten, counted from illustrations of archaeological material. This can in no way be compared with Chinese professional weaving. Unfortunately we do not know anything of folk-art from the Han. The extant material is always of the most exclusive sort preserved in richly furnished tombs. What was possibly made by common people has disappeared.

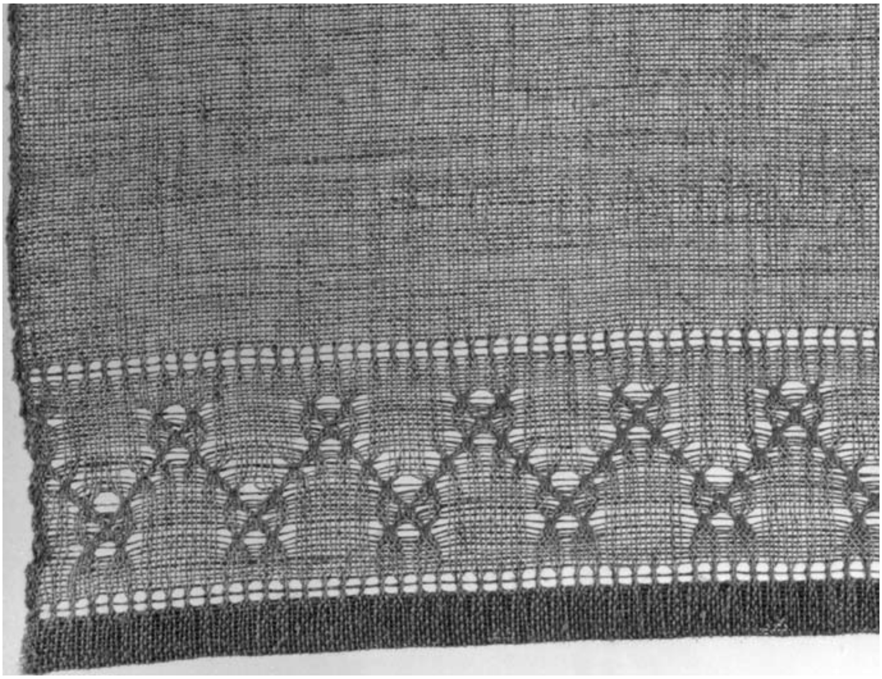


Figure 46 Finnish table-mat, 30×42 cm.
Warp: unbleached linen 20 lea, 10 ends per cm.
Weft: unbleached linen 20 lea, 10 wefts per cm.

Various types of gauze have been woven nearly everywhere in South America and Mexico. O'Neale (1945, pp. 74–75, pl. 19) shows the same method for plain gauze in modern Guatemala as is shown by Xia Nai from the Han (Figure 29).

Among Eastern European textiles from recent centuries are preserved fine examples of linen tabby decorated by means of twisted warp ends. Geijer (1979, pl. 9 a) shows a fine textile of this type from about the year 1500. In Finland this sort of weave has been used widely, here known as Karelian Lace. In a way this sort of weave cannot be grouped with true gauze weave. The twisting is always done in connection with areas of plain tabby as a decoration such as borders or small ornaments.

The Finnish method is shown in Figure 45. A tabby shed is opened and groups of two threads are lifted onto a shed stick from the lower shed face as is shown in the drawing. Patterns are made by twisting other pairs of threads or by doubling the number of twisted threads. Where only tabby is needed the shed stick is pushed on to the next twisting point. When the entire width is finished the stick is turned on edge and a weft is thrown in. The next weft is tabby. As far as we have been able to see the tighter type of twist similar to that from China and Peru is never found in the Finnish type. This method of decorating tabby-woven textiles is still used and gives a fine effect in materials for curtains, shawls, etc. A modern Finnish table-mat is shown in Figure 46.

These different sorts of gauze weave are not shown here to prove any connection between Han China, Peru, and Eastern Europe. It is meant only to show in some detail the similarities as well as differences in the twisting of threads; for example the groups of four ends in the ground of Han patterned gauze have three threads above wefts and one below. In Peru the groups of four have two threads above and two below the wefts.

Generally among scholars such accomplishments as this thread-twisting would be supposed to have wandered from one country to another. In this case we are not inclined to believe in diffusion of techniques. The resulting textile products from these three regions are so widely different; and for the Eastern European type we should absolutely presume that it arose spontaneously. When a weaver had worked hard and diligently for weeks on a very long warp of linen tabby, then one day, when there was only a short piece of warp left, the tabby would perhaps not be perfectly even. Then there was a possibility of 'playing' with the rest of the warp instead of simply discarding the good material. We are convinced that many interesting 'inventions' have been made on such occasions. In the National Museum of Denmark is preserved a number of small table cloths with a border and fringe at only one end. These cloths were used at one end of the long table, when a guest arrived for a meal. These decorative borders on Danish 'table-end cloths' are not done just by twisting of threads; many other equally interesting inventions are used. Such inventions have perhaps appeared in just the same way in many other places; some are still in use under different headings: 'Danish Medallions', 'Spanish Lace', and so on.

Chapter 3

The polychrome silks, jin

Archaeological material from the Han

The polychrome silks, *jin*, technically termed 'warp-faced compound tabby', with warp in two or more colours, are undoubtedly the finest achievement of Chinese weavers in the Han. Fortunately a large number have been preserved to our day. From Aurel Stein's excavations in Loulan and Dunhuang a large number is preserved in the National Museum, New Delhi. The excavations are described by Aurel Stein in *Serindia* (1921) and *Innermost Asia* (1928). A number of the silks have been described by his assistant F. H. Andrews (1920).

Loubo-Lesničenko (1961) has described the extensive collection in the State Hermitage Museum, Leningrad, mostly derived from P. K. Kozlov's expeditions to Noin-Ula. Also among the finds from Sven Hedin and Folke Bergman's expeditions to Loulan and Lop-nor, some polychrome silks are preserved and described by Sylwan (1948).

In later years a large number of finely preserved polychrome silks have been discovered in archaeological excavations in the People's Republic of China. These later finds are described and dated in Chinese archaeological journals; the exceptionally important Mawangdui Tomb No. 1, Changsha, Hunan, is extensively described and the artifacts exquisitely illustrated in the two volume work *(Mawangdui* 1973) on this richly furnished tomb dated ca. 168 BC Another Chinese work, *Sichou zhi lu* ('The Silk Road', 1972), gives very clearly printed illustrations of silks from different periods found along the ancient caravan route from China to the Roman Orient. Among these are many polychrome silks from the Han. A surprise among the textiles from the Mawangdui Tomb No. 1 was a comparatively large number of polychromes with pile warp patterns: fifteen samples, of which twelve were used as borders on garments *(Chūka* 1973).

Only the best trained weavers were able to weave these silks; the yarn had to be dyed before weaving, thus needing greater care than the monochrome silks, which could be made with the undegummed silk material. Presumably the polychrome silks were always very expensive; they were of a refined decorative effect and as such certainly valued as works of art. Perhaps also the tight and rather solid quality helped to preserve them.

Characteristics of patterns

In the study of the large number of Han polychrome silks, *jin*, now at our disposal certain technical characteristics of the Chinese treatment of patterns become apparent.

The very wide pattern units extend over the entire width of the cloth. In those cases in which Han textile samples have been found with both selvedges intact, most have a width of about 50 cm. This fits well with some scattered references in Han written sources which indicate that the size of bolts of cloth was standardized by law at 2 *chi*, 2 *cun* in width and 4 *zhang in* length. (1 *zhang* = 10 *chi* = 100 *cun*; 1 *chi* = ca. 23 cm). The relevant historical sources have been collected and discussed by Sun Yutang (1963, p. 160).

The height of pattern units varies, but it is always comparatively low, seldom exceeding a few centimetres.

The treatment of the design and colours is reminiscent of a sensitive painting. Willets (1965) describes lacquer and silks in the same chapter precisely because of this similarity in handling the motif. These finely designed and intricately woven silks have no very great effect when seen from a distance, compared with later silks from Persia and Byzantium which were of a far more grandiose effect. The polychrome Han silks were meant to be seen more closely, and frequently they were used as trimmings on garments.

Essentials of the warp-faced compound weaves, **jin**

The essential feature of this warp-faced compound tabby, *jin*, is the predominating warp in two or more colours; one colour appears on the face when needed while the other or others are kept to the reverse side. When only two colours are used the weave is completely reversible, the only difference between the face and the reverse being that the colours are interchanged.

The basic weave is tabby; one thread of each colour is entered into each heddle on the two tabby shafts. The weft is invisible, and only one weft is used with two functions: a binding weft in tabby alternates with a pattern weft which divides the colours in the required order. The visible warp threads normally go over three wefts and under one. At a horizontal boundary between colours every other thread goes over only two wefts; this caused by the tabby weft (see drafts). This is explained in detail in the section below on our practical experiments.

Samples with two or three colours are most common. Some silks with more than three colours have been made by changing warp colours in stripes in such a way that only two or three colours occur in the same place. Polychromes with as many as six colours in the same place are known, as in the famous silk with birds and trees among rocks preserved in the State Hermitage Museum, Leningrad (MR 1330 from Noin-Ula). This silk is unique, a tour de force, rather outside the typical polychrome silks, and it will not be dealt with here.

There need not be any difficulty when weaving with three or four colours for one thread on the face side to hide the other threads on the reverse side. A slightly twisted silk is the ideal material with its capacity to be pressed tightly together on one side, and when given space on the face side to expand and give a clean unbroken surface.

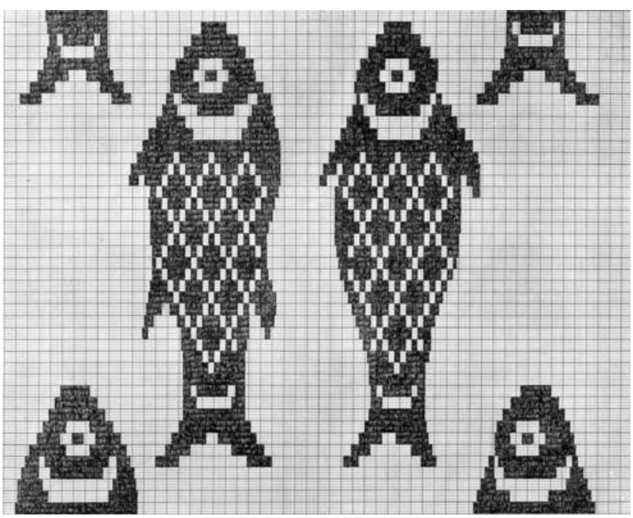


Figure 47 Part of our design for the first experiment. 6 × 4 ruled paper is used in order to obtain the true proportion in the figures. One small rectangle means one visible warp end and one weft. Four horizontal rows are always identical: tabby weft 1 – pattern weft 2 – tabby weft 3 – identical pattern weft 4, see draft Figure 48.

Our first experiment

We have experimented with the polychrome silks for many years. It will be useful here to describe each stage of our experiments, including the embarrassing mistakes, in order to show how we arrived at our final results.

Our first trial was based on Burnham's extensive article (1965). A simplified sketch was made after the blue-yellow silk reproduced by Loubo-Lesničenko (1961). Part of the design is shown in Figure 47. In order to obtain the true proportion in our figures we used for the design a 6×4 ruled paper so that six warp lines have the same measure as four weft lines; only visible warp ends are noted in the design. Our trial has eighteen visible warp ends and twelve wefts per cm, so that 6×4 paper gives the true proportion 18×12. One small rectangle in our design means one visible warp end and one weft. It must, however, be kept in mind that the visible end has its counterpart or 'working partner' momentarily invisible on the reverse side.

At the left in the draft (Figure 48) is shown a detail of a pattern drawn in blue and red. In this chapter on polychrome silks the colours in the drafts denote differently coloured yarns and do not have the technical significance usual in our drafts (see Figure 5). Red denotes the yellow in our silk. Here again one small square means one visible warp end and one weft. Above the detailed binding are shown two tabby shafts, marked A. Into each heddle is entered one end of each colour; this we have presumed to have been the Chinese method. Instead of two shafts we found it more practical in our loom to use four shafts, marked B. Following Burnham (1965) we took the colours in this order: 1–2–1–2, and we entered the blue warp ends on shafts 2 and 4, the red ones on shafts 1 and 3. In this way it is easy to lift shafts 1–2 and 3–4 alternately by means of two treadles (black) for the tabby wefts. At the right we placed two more treadles, 1 and 2. No. 2 lifts all red threads and no. 1 all blue threads; these treadles are used only in counting up patterns. In the detailed draft it can be seen that each odd-numbered weft is a tabby weft with treadles 3 and 4. Even-numbered wefts are pattern wefts. Burnham's article also told us that two pattern wefts following each other were identical, 2 = 4, 6 = 8 etc. Thus the binding unit in the weft was four: tabby weft 1 – pattern weft 2 –tabby weft 3 – identical pattern weft 4. Therefore four wefts are always drawn identically in our design; see Figure 47.

It will be noted in the detailed drafts that visible warp ends on the face side normally go over three wefts and under one. At horizontal

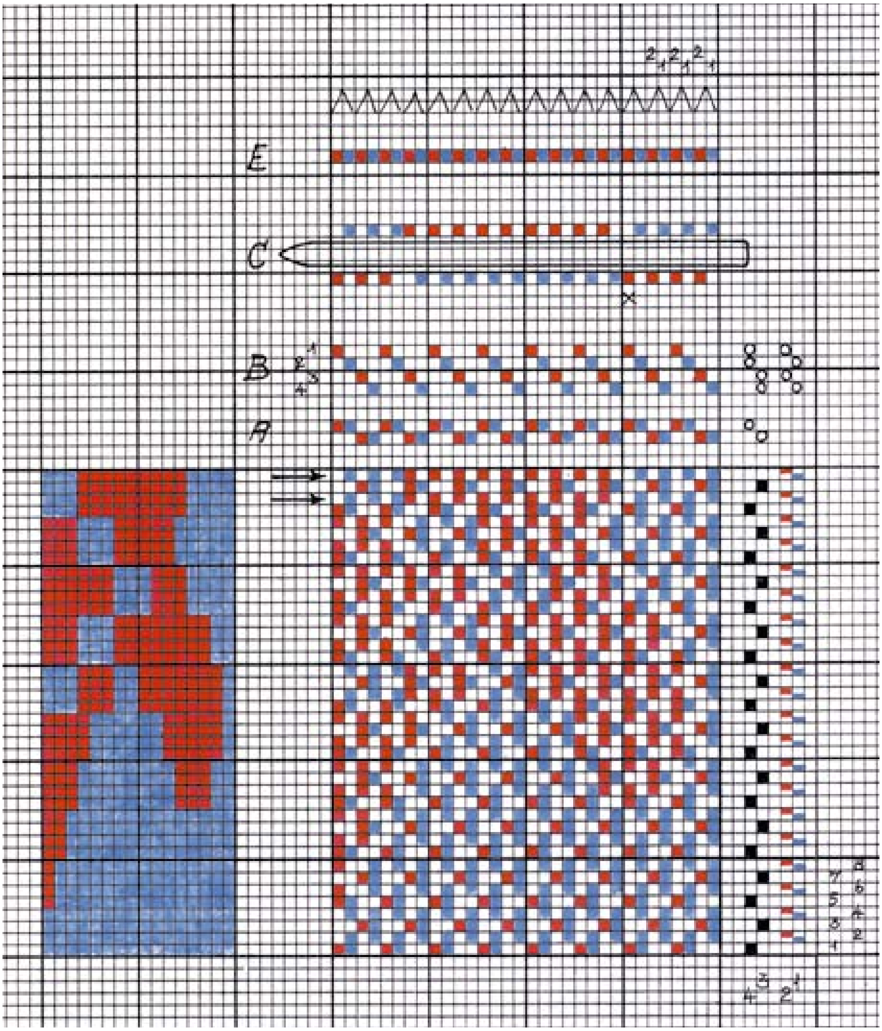


Figure 48 The draft for our first sample of a warp-faced compound tabby. In the detail of the pattern on the left one little square means one visible warp end and one weft as in the design Figure 47. The order of colours is shown at E. At C is demonstrated the pick-up for one row of pattern marked by arrows at the left of the draft. Our way of entering the warp into four shafts is shown at B.

colour-boundaries every other end of each colour goes *over* only two wefts, the other ends under only two wefts. The tabby weave causes this minor irregularity. It can be more clearly seen in the draft, Figure 51, pattern weft no. 8. In our coarse replicas it is clearly seen along horizontal lines.

Figure 49 Part of the first length of polychrome silk, *jin*.
Warp: organzine Nm 12.5, blue and gold.
Weft: organzine Nm 12.5, 12 wefts per cm.
Reed: 9 dents per cm, four threads in each dent. 36 threads per cm – 18 visible.

Counting up a pattern

We used a pointed flat stick for counting up patterns and found it most practical to start at the right side. At C in the draft is shown the stick counted up for pattern rows marked by arrows. Uppermost at E is shown the order of the coloured warp ends; blue 1 and red 2 are the 'working partners', shown by inverted V's over the colours. To count up the stick as shown at C we started at the right side and lifted all blue ends by treadle 1; took up onto the stick four blue ends according to the design; then changed the treadles to lift red ends. Here we must note that the first red thread we meet is the counterpart of the last blue (marked by a cross) and must stay down. Then nine red ends are taken onto the stick and treadles changed again to blue. Here there is no problem; the first blue end has its red counterpart placed next in the order. If the working partners are divided there will be no counterpart ready on the reverse side when it is needed in the vertical row next time; the pattern will little by little appear misshapen.

When a complete pattern row is counted up in this way in front of the tabby shafts it is taken through the shafts by means of another flat stick. A tabby weft is thrown in, the pattern stick is raised on edge, pattern weft 2 is thrown in, a tabby weft is made with treadle 3, and finally the identical pattern weft 4 is thrown in. A tabby weft on treadle 4 is again thrown in and a new pattern row can be counted up.

In this first experiment we did not think of any device for storing patterns for repeated use. Our design has 65 different rows. Even though it was tedious and time-consuming, we succeeded in weaving a good length of this silk, Figure 49. During this troublesome procedure we realised that something could be done to preserve patterns so that one did not need to count up every unit anew.

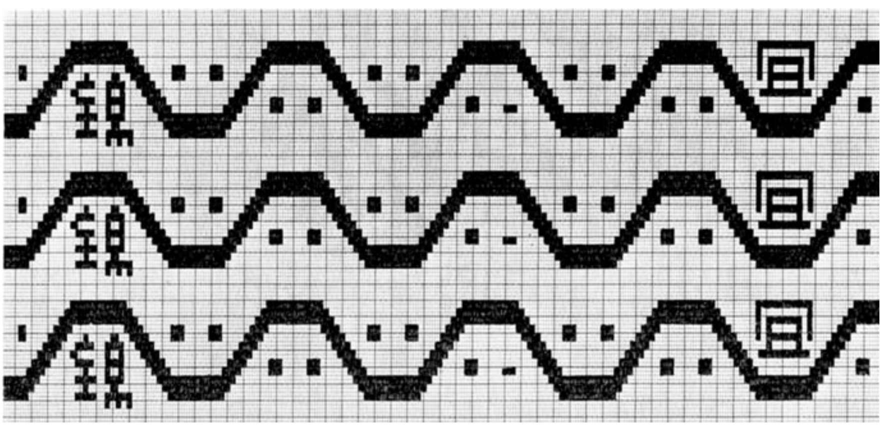


Figure 50 Our design for the second example, drawn from a reproduction of a silk in the National Museum, New Delhi, LC vii.02, reproduced by Willets (1965, p. 130, fig. 24). Two of six different characters are shown here. One little rectangle now means two visible warp ends of the same colour and two wefts, one tabby weft and one pattern weft

Besides his very extensive and exact analyses of four polychrome silks, perhaps the most important point in Burnham's article (1965) is his strong argument against the use of a drawloom, which has been the traditional assumption among scholars for many years. Burnham writes: 'The setting up of a full draw system where every one of some 5,000 or more ends was controlled individually when the repeat only required from ten to forty lashes seems unsound, and it is more likely that some sort of pattern-rod loom was used'.

The standard width of these silks was ca. 50 cm. A typical thread count for a three-coloured silk was ca. 150 per cm, i.e. 7,500 in the entire width.

Burnham mentions very briefly a silk from the National Museum, New Delhi, L. C. vii.02, reproduced by Willets (1965, p. 130, fig. 24) where some faults are repeated throughout the length. This circumstance indicates the use of some sort of mechanical repetition of the pattern unit.

Second example

Our next experiment was based on the silk from New Delhi, mentioned above, with waving ornaments and different Chinese characters placed transversally.

For greater clarity the design, Figure 50, is reduced in such a way that here one small rectangle means two visible warp ends and two wefts; again it is to be kept in mind that each visible thread has an invisible counterpart on the reverse side.

The order of colours

Meanwhile we had learnt from Donald King (1968), together with technical notes by Gabriel Vial (1968) and Harold Burnham's additional notes (1971), that colours in the polychrome warps were arranged not 1–2–1–2 but 1–2–2–1, so that two ends of the same colour come next to each other. This simplifies to some extent the counting up of patterns; more details on this will be shown later in our experiments.

We altered the order of colours accordingly as shown at E, Figure 51, and entered our warp ends anew in such a way that red ends were lifted by shafts 1 and 4, blue ends by shafts 2 and 3; compare shafts B in the draft Figure 51 with shafts B in Figure 48. The working partners for one

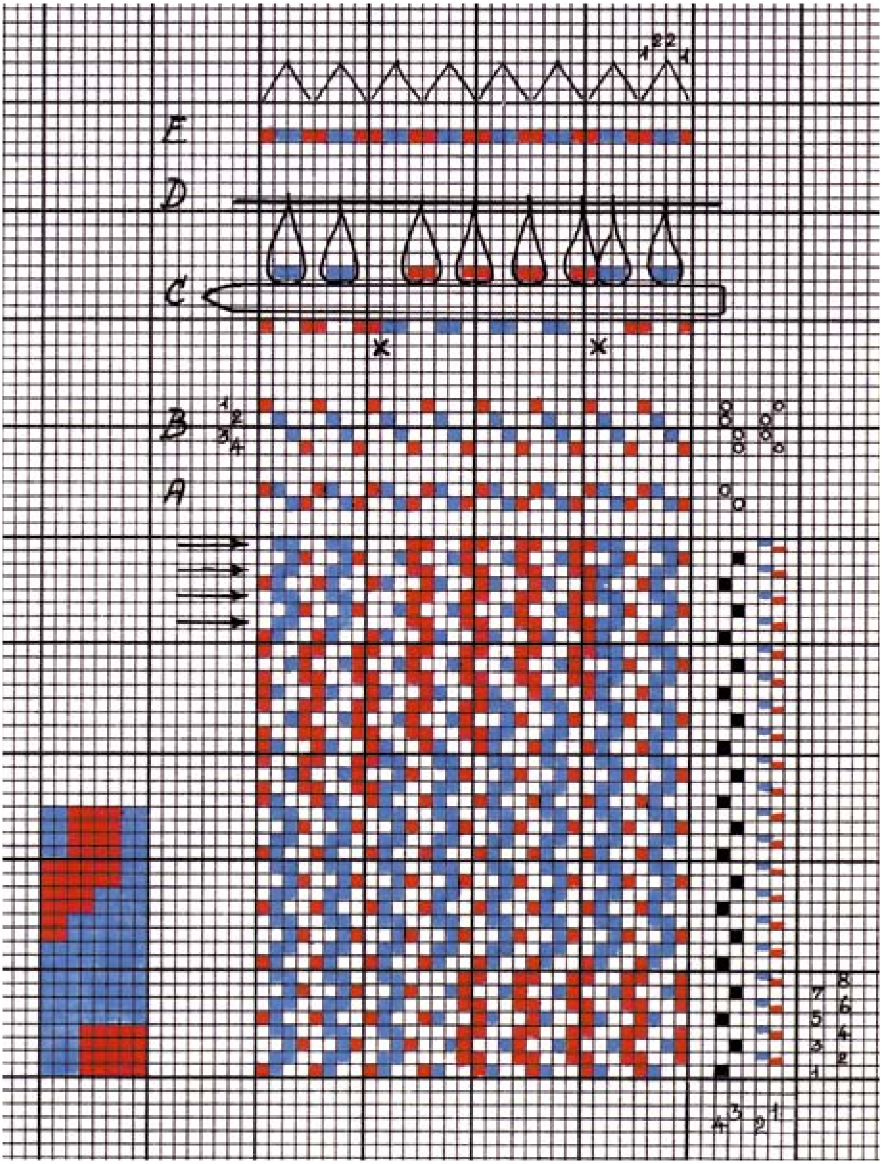


Figure 51 Part of the design with waving lines shown in detailed draft. Note that the order of colours at E is now 1–2–2–1. At C is shown the lifting of colours in groups of two throughout; the irregularities are noted by crosses and are also visible in the draft below.

↑ **Figure 52** Our second example of a warp-faced compound tabby, *jin*.
Warp: organzine Nm 12.5, blue and gold.
Weft: spun-silk Nm 10, red, 14 wefts per cm.
Reed: 9 dents per cm, 4 ends in each dent, 36 ends per cm.

↓ **Figure 53** In the enlarged detail of the silk the irregular outlines come out clearly from the red weft.

vertical column in the pattern are 1–2–2–1 shown at E by inverted V's. Thus two ends of each colour are always placed together; at the same time we could lift with treadles 3 and 4 for tabby wefts. Again we used treadles 1 and 2 for lifting respectively red and blue while we counted up pattern; later on when the pattern heddle rods were knotted these treadles were superfluous and in principle could have been removed.

In the little 'picture' of the pattern at the left in Figure 51, one small square means two visible warp ends of the same colour (and two invisible of the other colour on the reverse side) and two wefts, one tabby weft and one pattern weft. Two rows in weft direction are always drawn identically giving pattern wefts 2–4, 6–8 and so on as indicated by Burnham.

Knotting pattern heddle rods

The counted-up part of a pattern row on a stick is shown at C in Figure 51. For this example we used the pattern heddle rod system described in Chapter 1 on monochrome weaves. Only thirteen rods were needed. The loops were knotted up throughout with two threads in each as shown at D in Figure 51.

At the vertical boundaries between colours some irregularities appear. To the left of a blue part four ends, two blue and two red, are lifted. To the right of a blue part four ends, two of each colour, stay down. In the original Chinese silks with a thread count of ca. 100 per cm this could perhaps not be seen with the naked eye. We intentionally used a red silk for the weft in order to bring out this difference in contours, see Figure 53.

Again it is necessary to note the 'working partners', 1–2–2–1, marked by inverted V's uppermost in the draft Figure 51. These four threads constitute the 'working company' for one vertical column in the 'picture' at left. In the draft it can be seen in the four shafts marked B that two blue ends on shafts 2 and 3 within a 'working company' are what we have called true neighbours; they will always work just beside each other, as shown in the detailed draft. Red threads on each side of the two blue threads entered on shafts 1 and 4 belong to the same working company; therefore when we take two red threads next to a blue part as shown at C in Figure 51, marked by crosses, we disturb the working companies and four threads will be lifted next to each other as can be seen in the draft below. The opposite effect is shown at the left of a red part ending with two red threads from

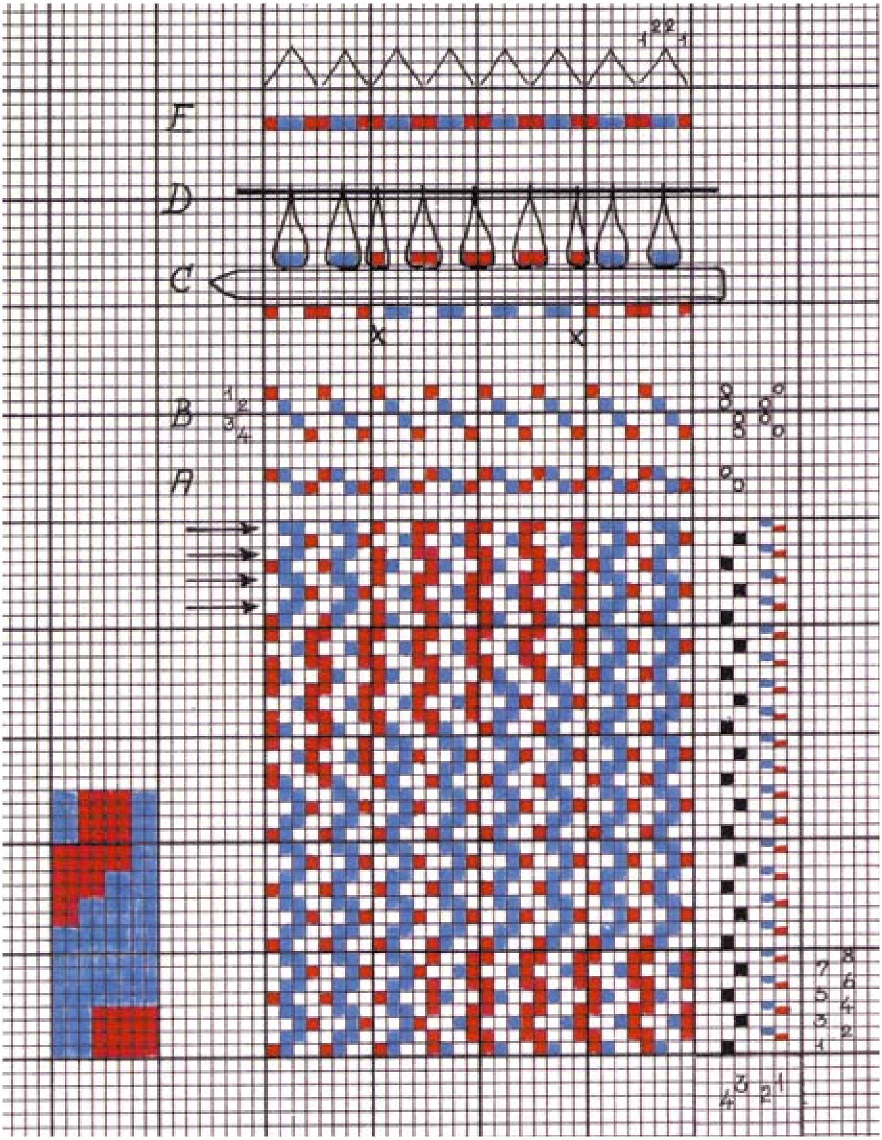


Figure 54 This draft shows the improved way of knotting up pattern loops, see C and D. A red part of the pattern starts and ends up with one single thread in one loop. The irregularities in vertical outlines have disappeared. Compare this draft with the draft in Figure 51.

different working companies; then a blue part is lifted, and the result is four threads left down on the reverse side.

To avoid these irregularities we altered the order of threads in the pattern loops as shown at C and D in the draft Figure 54. The two blue warp ends in our sample are true neighbours according to the draft and can always be knotted up two in one loop. The two red warp ends which belong together in the same working company according to the pattern are those entered into shafts 1 and 4, on each side of the two blue ends. Therefore a red part of the pattern must be started with a single thread from shaft 4 and ended up with a single thread from shaft 1, marked by crosses; in between they can be knotted two in one loop. It can be seen in the detailed draft that there will not now be any divergence in the vertical lines. This we did not try out here but used this technique in our next examples.

A three-coloured sample

The third example is a polychrome silk in three colours. We made a simplified design based on one of Aurel Stein's finds from Loulan now in the National Museum, New Delhi, reproduced by Riboud (1977b, p. 269, fig.

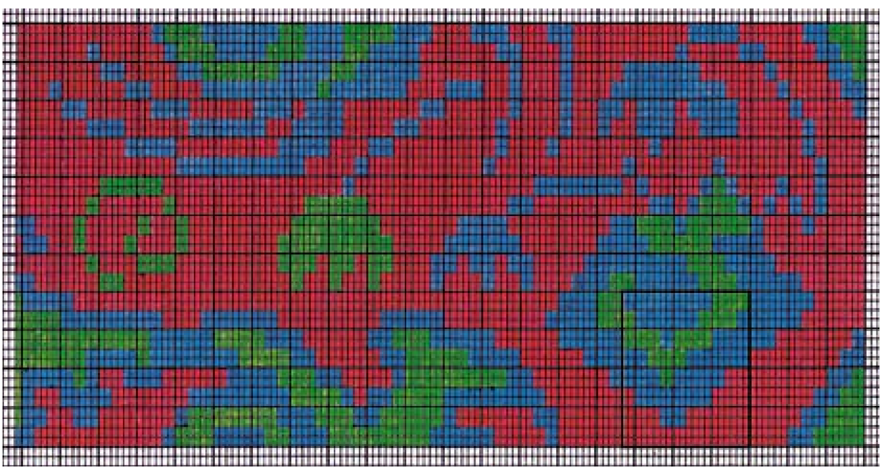


Figure 55 The simplified design for a three-coloured sample. One little rectangle means two visible warp ends of the same colour and two wefts, one tabby weft and one pattern weft. Twenty-two rods are used for the pattern unit. Below at the right is shown by a box the part drafted in Figure 56.

15). Unfortunately we stepped the outlines too roughly; it is a very time-consuming job to knot a large amount of loops and we wished to reduce the number.

Our loom was entered and tied up as shown in the draft, Figure 56; each small rectangle in the design, Figure 55, means two warp ends of the same colour on the face side. Because we had throughout drawn the steps in four (two small rectangles), a pattern row was easily counted up in front of the shafts, always four threads at a time, and each single row could be woven correctly.

When a row has been counted up it can easily be woven, as can the next rows. But when pattern heddle rods are used to preserve units for repeated use then it is necessary to follow the intricately planned order of colours discussed here. This experience we obtained in a very expensive fashion. We had momentarily forgotten the importance of the order of colours. Because it was so easy to count up the pattern rows in front of the shafts in groups of four, 1 am sorry to say, we also knotted loops on four threads at a time on all twenty-two rods without trying to use the heddle rods little by little. We ought to have realized that groups of four ends in

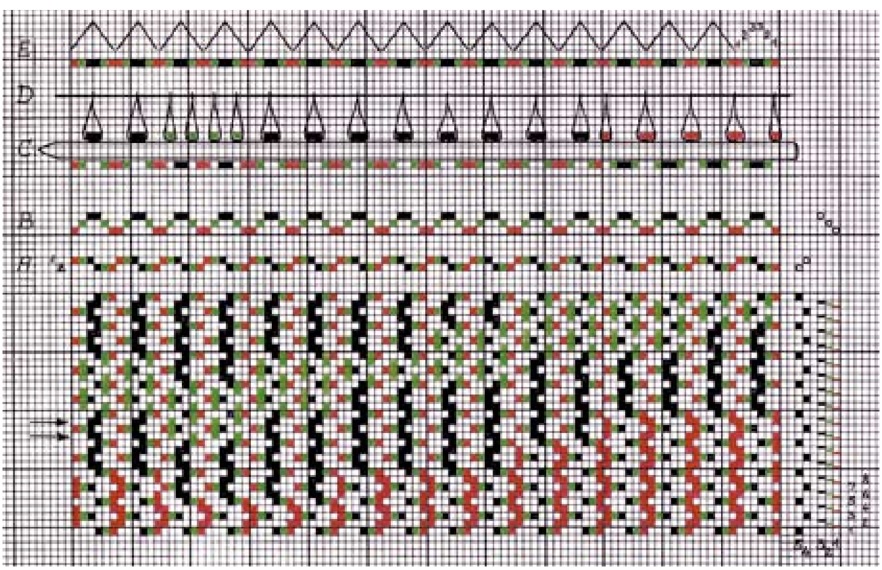


Figure 56 Detailed draft representing part of the pattern unit. Note at A two shafts for tabby connected with two treadles (marked black) for lifting alternately for tabby wefts. At B are shown three extra shafts for lifting individual colours when pattern is counted up. D shows the arrangement of pattern loops for rows marked by arrows at the left of the draft. The order of colours can be seen at E.

one loop would never be able to go past other groups of four of another colour. The nearest heddle rod could be lifted and absolutely none of the rest. We had to cut every loop and start anew.

A fragment of the design (denoted by a box in Figure 55) is drawn out in detailed draft, Figure 56, showing the individual threads. just above the detailed draft are two tabby shafts marked A; one end of each colour is entered into one heddle. This we have presumed to be in accordance with the Chinese loom in the Han.

We do not know how Chinese weavers managed to part the three colours. Possibly a stick was placed between each colour in such a way that the colours were divided into separate layers. For our use we entered the colours singly into three extra lifting shafts as shown at B. Three extra

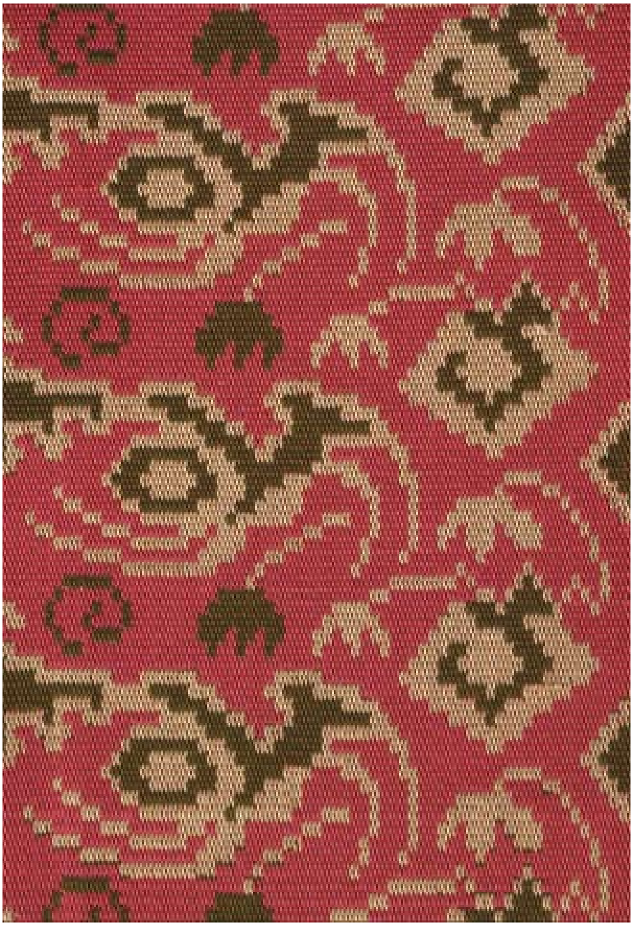


Figure 57 The three-coloured sample woven according to Figure 56.

Warp: organzine Nm 12.5, red, olive, buff.

Weft: spun-silk Nm 10, ochre, 12 wefts per cm.

Reed: 9 dents per cm, six ends in each dent, 54 warp ends per cm – 18 visible.

Figure 58 The loom set up with a three-coloured silk. Note our device for lifting one pattern heddle rod. One flat stick is placed below the lifted rod, the other stick helps to open the pattern shed to the weaver.

treadles were tied up, making it possible to raise each colour separately. The most important now is the way loops are knotted onto the threads counted up for a pattern row. Each counted-up pattern row is taken through the shafts by means of a broad stick and placed at the back of the loom near the shed rods. It is easy to follow the exact sequence of the colours by means of the shed rods.

Rather inconsistently black in our draft, Figure 56, refers to the light buff in our silk. In this three-coloured sample the 'working company' has expanded to six members. The group 1–2–3–3–2–1 shown by inverted V's at E in the draft means a vertical column of squares in the design, and these groups must always be kept clear of neighbouring groups. The black threads marked 3 are what we have called true neighbours and may be lifted always two in one loop. The red threads marked 1 are apparently neighbours too but it must be kept in mind that the first red end entered into tabby shaft 2 and the next red on tabby shaft 1 belong to the same 'working company' and must not be parted accidentally. When a red part of the pattern is to be knotted up the first red end is taken singly in one loop, and so is also the last one. In between the red ends can go two in one loop as shown at D in the draft. The green ends marked 2 are never adjacent and must be dealt with individually in the knotting up of loops.

This is in fact a rule without exception. Even if only two single green ends, each in a separate loop, should happen to change their order on one rod, the whole arrangement will be locked up from where the fault occurs (we experienced this too).

Finally we ended up with twenty-two pattern heddle rods correctly knotted, and then the weaving proceeded reasonably. Our woven replica is shown in Figure 57.

One assistant, perhaps two, are needed not only to lift the pattern heddle rods but (equally important) to put in a smooth flat stick under the lifted rod into the warp and, by pressing the stick up and down, to open the shed clearly, see Figure 58.

When every loop in the pattern heddle rods is placed correctly the weaving process is straightforward. The correct knotting-up of loops

Figure 59 One example of a pile-warp patterned silk from the Mawangdui Tomb no. 1 (*Mawangdui* 1973, p. 131, fig. 137).

cannot be emphasized enough. As far as we know this fact has not been pointed out before.

The pile warp pattern, **qirong jin** *or* **rongquan jin**

The last experiment is a polychrome silk patterned with pile warp. One example of this weave is preserved in the State Hermitage Museum, Leningrad (no. 14029) reproduced by Riboud (1977b, p. 263, fig. 8). A large number were found in the Mawangdui Tomb No. 1, and one example is shown in Figure 59. A group of textile technicians has made a very extensive and intricate description of two of these pile warp silks (KGXB 1974.1:175–186). Their article seems too much influenced by modern weaving implements; these silks can be woven by much simpler techniques than they describe. (The English resumé appears to have been written by a translator who knows very little about weaving. It says among other things that this weave 'requires a Jacquard heddle', but there is no mention of this fantastic hypothesis in the Chinese text).

Of the two silks especially dealt with in the article one has four warp colours with one colour always kept to the reverse side, presumably to make a tighter ground better able to hold the small loops. The other silk has three colours, one for pile warp and two others for a linear pattern in the ground.

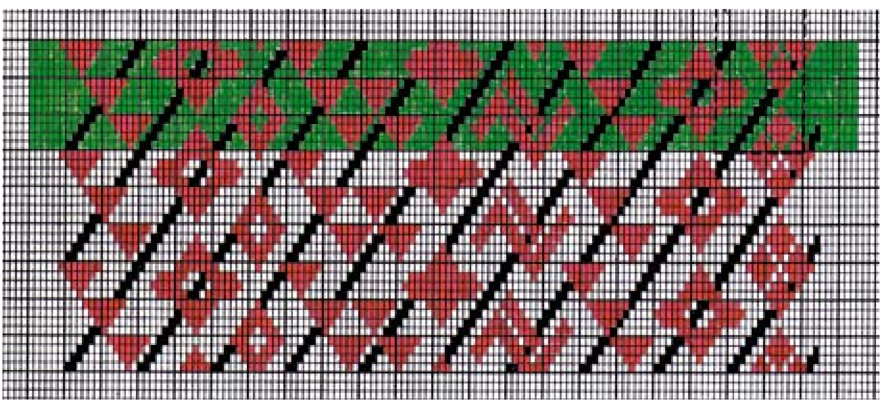


Figure 60 Our design of a simplified version of a pile-warp silk. One square means two visible warp ends (and four invisible) and two wefts. Three pattern units are shown vertically; for clarity green ground is painted only in the upper unit. The broken lines at the upper right indicate the part drawn out in detailed draft, Figure 61.

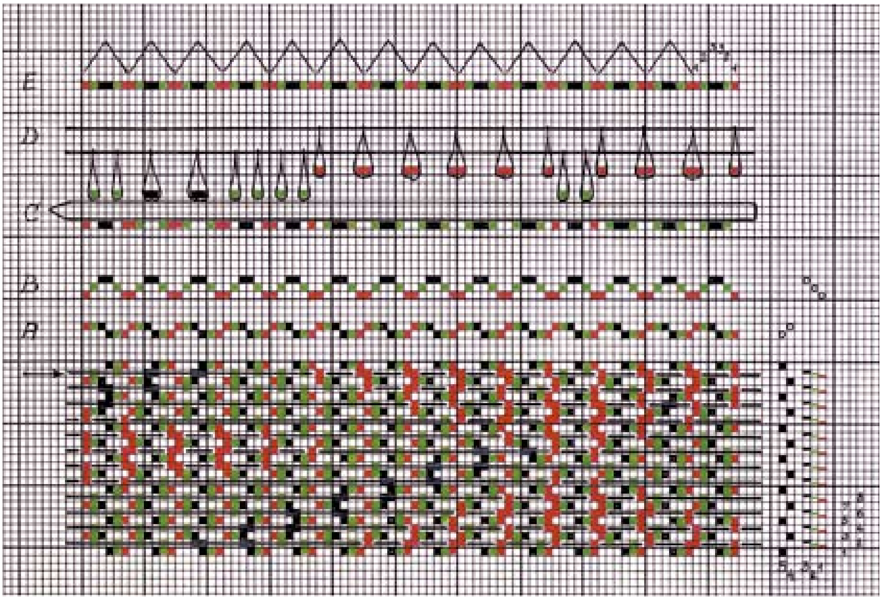


Figure 61 The draft for a pile warp silk shows part of a pattern unit. The entering and tie-up shown at A and B is the same as is used for a three-coloured warp-faced tabby. The rod marked C is counted in for the pattern row marked by an arrow. At D is shown the two rods necessary for each row, the upper rod lifts the red pile warp, the lower rod lifts two colours for patterned tabby ground. The transverse black lines denote the knitting needles put in below the red pile warp.

It is obvious that the pile warp needs far more yarn than the rest of the warp. We loosened the red warp ends from the warp beam, grouped them in small bunches, chained these up, and supplied each group with a weight (see the photograph, Figure 62).

We made a design, Figure 60, which resembles the patterns of the original silks. One small square denotes two visible warp ends as in the three-coloured Figure 55. A part of the design (marked by broken lines) was made out in detailed draft showing each individual thread, Figure 61. The pattern rows were counted up in front of the tabby shafts onto a flat stick according to the design, Figure 60, in the same way as described above with the three-coloured silk. The pattern sheds are taken past the shafts ready to be knotted up into loops near the shed rods at the back of the loom.

In the pile warp silks an extra heddle rod is needed for each row of pile warp. On one rod the red pile warp ends are taken up into loops according to the rule described above, see D in Figure 61. The two other colours for

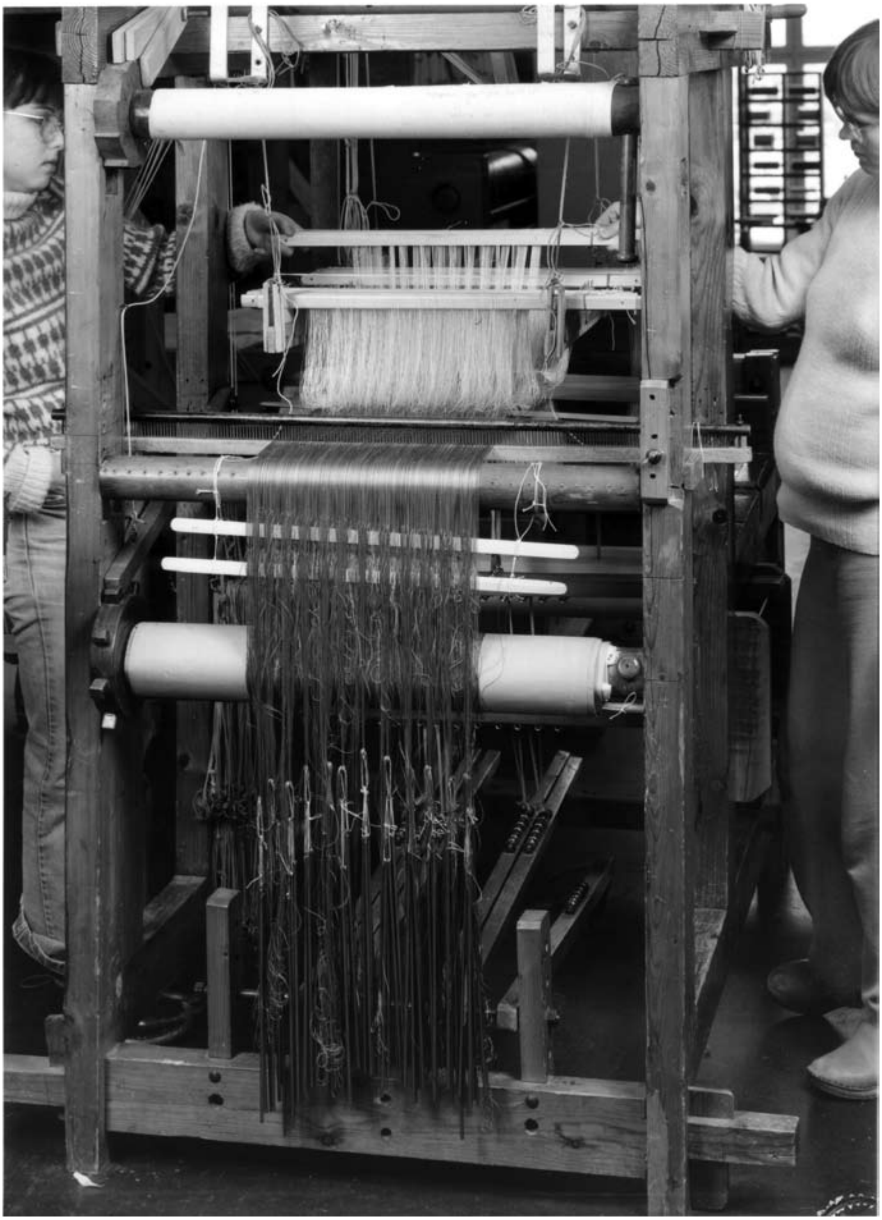


Figure 62 The loom set up for a pile warp silk. Note the small weighted groups of pile warp hanging over the warp beam. The cross sticks are moved to the vertical part of the warp to give more space for pattern heddle rods. Two assistants lift two pattern rods for the pattern weft.

the patterned tabby ground are knotted into loops on another rod, see the lower rod at D. Both pattern heddle rods are lifted when the pattern weft is thrown in; see the photographs in Figures 62 and 63. Then the rod with two ground colours is let down and a thin knitting needle (1.5 mm) is placed below the lifted red pile warp ends, shown by black lines across the draft. See also the photograph, Figure 64. The second pattern heddle rod is also let down before the tabby weft can be woven.

When twelve to fourteen needles have been woven in the first rows of small silk loops are secure; the nearest needle can be pulled out and used again, and so on. We used knitting needles as the most convenient implement for velvet rods, as we may call them.

The material used for raising the warp loops in the Han is discussed by Hsio-Yen Shih (1977, p. 327, note 14). A thread is proposed to raise the pile, the thread being removed after weaving. It may be worthwhile to discuss this point a little further. A silk thread would be too soft, so that the resulting row of loops would be uneven. A more hard and rough textile material would certainly spoil the silk loops when it was pulled out afterwards. Much more likely would be the use of finely polished splits of bamboo, as also mentioned by Hsio-Yen Shih.

The small loops formed by the pile warp appear naturally in two different heights. In most cases the pile warp ends go over three wefts on the face side, two pattern wefts and one tabby weft, just as in the other polychrome weaves. The pile ends accordingly go over two knitting needles; see the draft, Figure 61. When colours change, every other thread goes over only two wefts, one pattern weft and one tabby weft. Accordingly these threads go over only one knitting needle, and the silk loop is that much lower, see Figure 66. Compare in the detailed draft the lifts over two wefts instead of three.

In the above-mentioned Chinese description an extra warp beam for the pile warp is proposed. This is a possibility, but the take-up of threads is variable, and it is easy to loosen the small weighted groups behind the warp beam to rectify the differences. It is on the other hand remarkable in the original silks how evenly spaced these mostly geometrical patterns are drawn. Certainly the Chinese weavers intentionally made these patterns in such a manner that a rather even use of material was obtained.

The wefts must be beaten in very firmly to keep the small loops from sliding out. Different thicknesses of yarn were used for this weave. The yarn for the pile warp was about three times as thick as the other warp

Figure 63 Two pattern heddle rods are lifted for the pattern weft; the shed is cleared up by means of a flat stick.

Figure 64 The rod for the ground pattern weft is left down, only the rod for the red pile warp is still lifted, and the knitting needle is put in before the next tabby weft can be woven.

← **Figure 65** Our sample of a pile-warp patterned silk.

Warp: organzine Nm 12.5 olive, buff, red.

Weft: spun-silk Nm 10, ochre, 12 wefts per cm.

Reed: 9 dents per cm, 6 warp ends in each dent, 54 ends per cm.

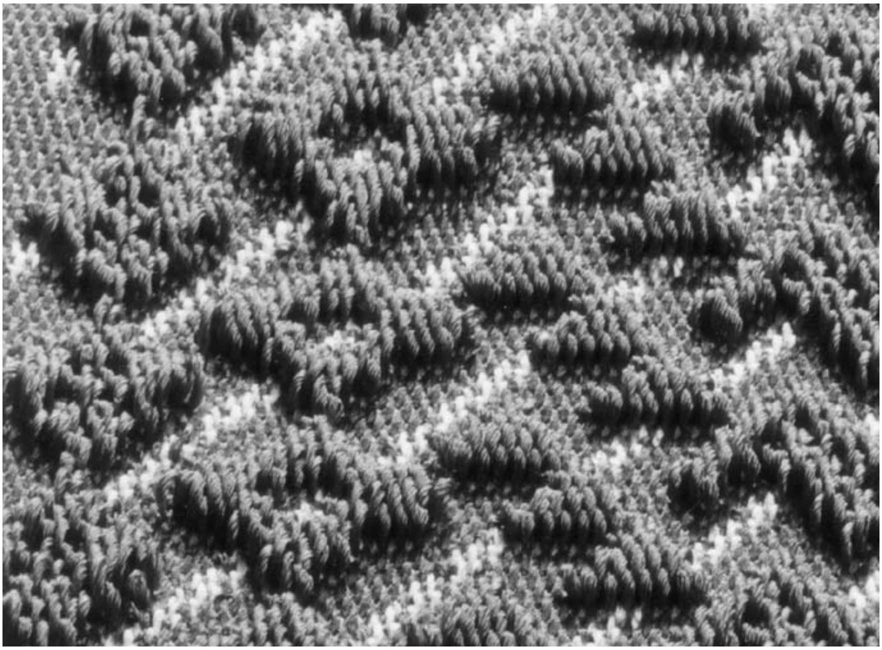
→ **Figure 66** In this enlarged detail the different heights of the loops are clearly seen in the outlines of figures.

ends. Unfortunately we did not have any thicker material available for the pile warp in our experiment; still we think the effect obtained is acceptable. Our woven replica is shown in Figure 65.

These polychrome pile warp silks must be the first step to true velvet, which in later centuries was developed to the highest sophistication in China, Persia, Italy, and France. Unfortunately we cannot show any experiments with true velvet, as we do not have the fine instruments needed for velvet weaving. Luther Hooper has very detailed descriptions of velvet in his book *Handloom Weaving* (1920). Harold Burnham (1959b) in a booklet from the Royal Ontario Museum, Toronto, describes some Chinese velvets and gives detailed analyses.

Setting up a new pattern

We are convinced that a new pattern for a polychrome silk in the Han was started by the experienced weaver, translating the artist's sketch to his loom, and that the two tabby shafts were supplied with clasped heddles (type B in Chapter 12) and two treadles for weaving tabby. When the new pattern was knotted up, possibly another weaver of lesser experience



would go on with the weaving helped by two assistants who lifted the rods and cleared up the sheds.

We have discussed among ourselves whether it would be possible for a weaver in the Han to lift pattern heddle rods from his seat in the loom and thus be able to weave patterns without the help of assistants. The lifting would not be too difficult to arrange by means of a cord over a pulley. We did this ourselves for easier adjustment of the height of lifting; see the photograph in Figure 58. But as long as only loose loops on pattern rods are used the lift alone does not give a useable shed; it must be cleared up by an assistant. And certainly there would have been no shortage of assistants to help the weaver in these distinguished workshops.

Some centuries after the Han we find a certain dryness and regularity in polychrome silks. This may indicate that other methods were used in weaving patterns, methods which required that the pattern be determined beforehand.

PART II

Patterned Weaves of Early Western Asia

Chapter 4
Western Asia

The weaving techniques of the Han period, discussed in the previous three chapters, continued in use for the next thousand years if not more. They are particularly Chinese, and show no sign of foreign influence; this is a remarkable fact, for commercial relations with the West were already lively during the Han.

Foreign influence in Chinese weaving is first seen in the centuries after the Han. In a later chapter we will show a number of samples from the Tang period which indicate that techniques evolved in the countries near the eastern Mediterranean were assimilated by Tang weavers in connection with their original Chinese techniques.

It will therefore here be useful to show how weavers in Western Asia made patterned textiles in the first centuries of our era, because it is evident that characteristic Western techniques influenced Chinese techniques in the centuries between the Han and the Tang.

It is important to bear in mind that weaving methods always depend on the material available.

The characteristic warp effect in Chinese polychrome patterned silks is a natural result of the highly developed silk cultivation from ancient times in China. The weavers had the even, smooth and strong silk thread at their disposal; they were able to use long tightly set warps.

Before the beginning of commerce along the Silk Road in the early Han, weavers outside China did not have the fine and even silk material available and had to find methods and implements for spinning the shorter fibres of wool, flax, and cotton before any weaving was possible. At first yarns were not fine, nor even. Only in districts where suitable material was available in quantity, and far-sighted and prosperous organisations were able to lay foundations for a sufficiently large production, was it possible to obtain a product of the highest quality: e.g. the fine worsted cloth from Syria, or the linen from Egypt.

The spinning of the fibres had the greatest influence on the weaving methods. Weavers in the western world could not use their laboriously spun yarn for very long and tightly set warps. They had at first to work with more open warps; the finest and most expensive yarns were reserved for the weft. And the weft took over the part of forming patterns.

This difference from East to West is clearly evident from early textile finds.

Archaeological material

Egypt has been a very rich source of archaeological material in the last centuries. Several conditions, the dry climate, the sandy soil, and also rather peaceful conditions helped to preserve richly furnished burial grounds and deserted ruined cities. An enormous wealth of material from ancient times has come to light in Egypt; not least of the finds are textiles of many different sorts, not only of local origin but also imported from foreign countries.

The greater part of tapestry-woven roundels and panels appears to be of Egyptian origin. Numerous samples are preserved all over the world. They have been widely described stylistically and technically in several languages, and they will not be described here (e.g. Kendrick 1920–22, Kybalova 1967).

Here we are primarily interested in the pattern-woven textiles (as opposed to tapestry weaves), woven from selvedge to selvedge, usually in several colours, by means of some patterning device. We will try to give some evidence of the development of patterning methods. To illustrate the different methods of mechanically repeated patterns we will use samples from excavations in Egypt.

Especially two renowned expeditions yielded very rich material for the study of ancient textiles. Akmim, situated on the right bank of the Nile 225 km north of Thebes, was one of the chief seats of the famous Egyptian linen manufacture. The burial grounds east of Akmim were first discovered by Maspero in 1884, and excavations were carried on until 1893. A large number of textiles from Akmim were acquired by the Victoria and Albert Museum, London (Kendrick 1920–22).

The other very important site was Antinoë. The city of Antinoë was founded by Hadrian in the year AD 130, also on the right bank of the Nile, 444 km north of Thebes. The city was connected with its commercial harbour, Berenike, near the Red Sea. In AD 297, when Diocletian divided Egypt into three provinces, Antinoë became the administrative centre for

Lower Thebes. Until the middle of the fifth century it was a magnificent city of the same splendour as Palmyra and other Graeco-Roman cities of the period (Geijer 1963).

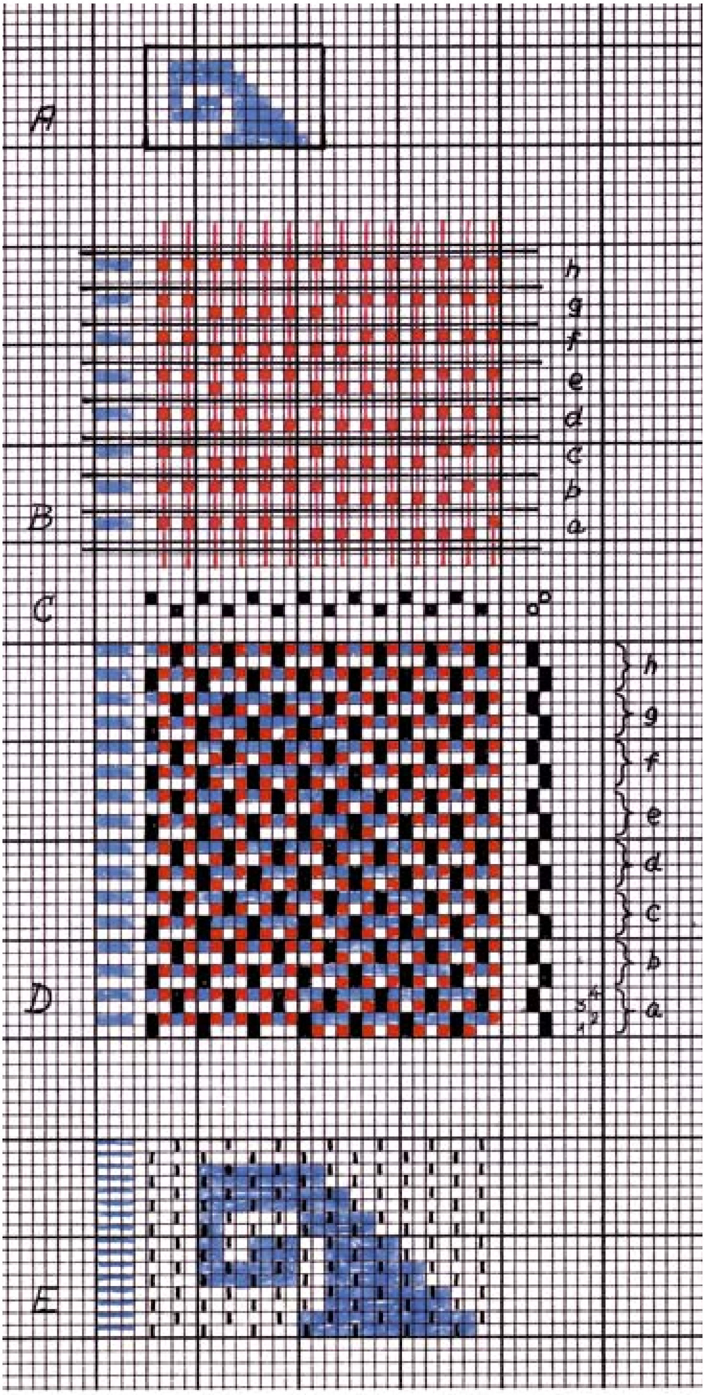
A French expedition under the leadership of Albert Gayet worked here from 1896 to 1906. Unfortunately this very important excavation was not carried out with sufficient archaeological care. Only scanty descriptions were written during the excavations. Each year a sales exhibition was arranged in Paris; luckily a great part of the finds were acquired by museums in Paris and Lyon.

In the exhibition catalogues Gayet gave some data; even though they are haphazard and imperfect they appeared to be a rather good source for further research. The French scholar Rudolf Pfister identified some notes with some of the existing finds and was able to establish a basis for dating. Prompted by a 'new find' of a silk from Antinoë in the Victoria Museum of Egyptian Antiquities at Uppsala University, Sweden, Agnes Geijer made a painstaking new study of Gayet's catalogues and wrote her very important article 'A silk from Antinoë' (1963).

Thanks to these two great scholars we have a reliable knowledge of the rich collection from Antinoë. The largest and best part of the Antinoë finds now belongs to the Musée Historique des Tissus in Lyon, where we had the occasion to study some of the samples. Thanks to the great kindness of the museum we were allowed to use selected photographs and descriptions for this work.

Weft-faced compound tabby (taqueté)

Among the large number of tapestry-woven textiles excavated in Egypt there also appeared a considerable number of patterned textiles in wool or wool and linen woven in weft-faced compound tabby. The texture of these textiles is very similar to that of the tapestry weaves; the most noticeable difference lies in the regularly repeated pattern units. Flanagan (1919) suggests that weft-faced compound weaves were invented by tapestry weavers. The idea is perhaps not too far-fetched when one considers the very tightly woven tapestries in two colours. It must certainly have been tempting for an experienced tapestry weaver to find a method of weaving these patterns with wefts continuing from side to side instead of the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everlasting and laborious putting in of tiny bits at a time as is done in the tapestry technique.

It is not possible to say where and when the weft-faced technique was first brought into use. Was it first known by Syrian or Aramaic weavers?

The dating of these finds is often rather questionable because of the slipshod nature of the excavations; furthermore many of the artifacts were 'found' by local people and sold to foreign tourists without any information at all. Ornaments are of little help; they were frequently copied from tapestry weaves and it is also evident that tapestry weavers copied ornaments from the weft-faced compound weaves.

An interesting example is found in the Victoria and Albert Museum (no. 243-1890), brought from Akmim and dated to the fourth century AD. It is an entire piece finished off with borders. The pattern consists of octagons framing a bird woven with dark brown and buff-coloured wool in weft-faced compound tabby. Two small squares of tapestry in purple wool and linen thread are woven on the same warp near two corners.

The best-dated finds of ancient weft-faced weaves are three pillow covers found at Antinoë. Pfister (1948) made a thorough study of these pieces and was able to date them to before the year AD 300 by exceptional burying customs; he also proved that they were woven in Persia. One of the pillows will be used as the basis for an experiment below.

The principle of weaving weft-faced compound tabby or taqueté

Very roughly it can be said that the warp in this weave has the same two functions as the weft in the polychrome warp-faced silks from the Han. But the comparison is a little dangerous and not absolutely true. The Han weaves could not be executed on the looms of Western Asia, nor vice-versa.

In the weft-faced compound tabby the same yarn is used for the entire warp; in our diagrams the two different functions of every other warp end

← **Figure 67** The principle of weaving weft-faced compound tabby or taqueté. At A is shown the wave motif used for the draft. The lifting plan is shown at B, red squares mean lifted harness cords. Eight passées a–h are used for the motif. One passée consists of two wefts, one of each colour, here white and blue. Binding warp (black) is entered into two shafts at C. In the detailed draft D each thread is drawn individually. Two passées (four wefts) are shown for each 'découpure' (the lowest number of warp and weft threads for each little square in the motif A). E gives an impression of the textile when it is beaten in. Black dots denote the binding points in tabby.

are denoted theoretically by two colours. The binding warp is coloured black and the main warp is coloured red, see Figure 67 D.

The patterns come out by means of two differently coloured wefts: weft 1 (white in our diagrams) and weft 2 (blue in our diagrams), see the draft Figure 67 D.

The entire purpose of the main warp is to form the pattern; when a main-warp end is lifted the current weft will go under and disappear to the reverse side. When a main-warp end is left down the weft will appear on the upper side. The main warp does not partake in the tabby binding.

The purpose of the binding warp is entirely to provide the tabby weave. The binding warp goes regularly through the material irrespective of the pattern. Each tabby shed (see wefts 1 and 2 in Figure 67 D) is used for two wefts, one of each colour; only the lifting of main warp is altered. This group of two colours is called a 'passée'.

As a sample to illustrate this weave we have used the little wave motif shown at A; it is a detail from one of the three pillow covers in the Musée Historique des Tissus mentioned above. In the motif A one vertical column of squares means one main-warp end. One horizontal row of squares in this sample means two passées. In the 'lifting plan' at B are shown the different positions of the main warp for this motif. Between black lines is shown one passée. Compare passée a with wefts 1–2–3–4 in the draft D. Red squares in the lifting plan mean lifted main-warp ends.

In Figure 67 C is shown the binding warp entered into the heddle eyes of two shafts which are mounted nearest the weaver. Filled squares mean heddles with eyes; o in the tie-up means a lifted shaft. The threads in the binding warp go past any heddle or other arrangements for the lifting of main warp. Therefore the shafts must be adjusted so that the eyes are at the same height as the lower shed face.

The detailed draft D shows the individual threads as if the material had not been beaten in, so that wefts do not cover each other.

Note that both warp threads and weft threads are shown in our drafts. Black always means lifted binding warp, red means lifted main warp. White denotes weft 1 and blue denotes weft 2. The sequence of wefts is shown at the left.

To weave this weft-faced compound tabby one treadle is pressed down and, as seen in Figure 67 D, seven main-warp ends are lifted for weft 1 (white). While the tabby shed is kept open the group of main-warp ends at first below weft 1 is lifted; then the blue weft 2 is thrown in.

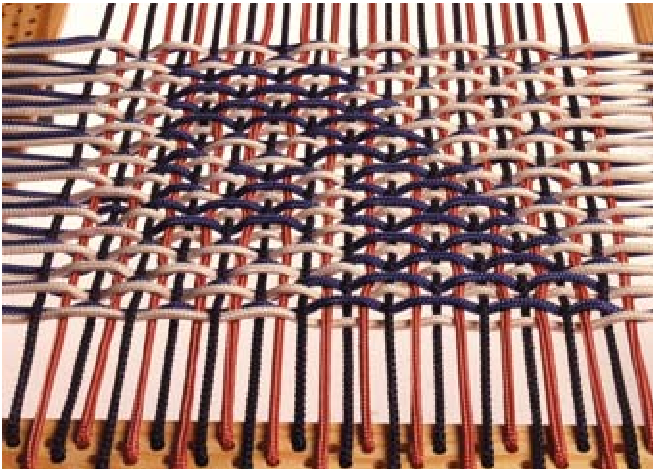


Figure 68 To show the binding more clearly, thick cords in the corresponding colours are plaited in a frame.

An impression of the material when it is beaten in tightly is shown at E. White and blue wefts appear clearly where they are meant to be; white covers blue in the ground, and in the figure blue covers white. In this case, where only two colours are used and the basic weave is tabby, the reverse side will show the same pattern with the colours reversed. The binding points are denoted by black dots.

In order to show the binding more clearly we have made an illustration of the draft by means of thick cords in the corresponding colours plaited in a frame, Figure 68.

This system with two warps, main warp for patterns and binding warp for the weave, was really a stroke of genius, and variations of the method have been used for centuries. It is therefore very useful to be acquainted with this method from the first stages.

The simplest samples of weft-faced compound weaves

From burying grounds and scrap heaps in Egypt are preserved a large number of woollen textiles woven with weft-faced compound tabby. The patterns in this group of textiles are very simple, squares and rectangles in different combinations.

The simplest form of this patterning is illustrated by the chequered pattern drawn uppermost in Figure 69 A. Lilian M. Wilson (1933, pl. 3) shows one sample with this design from the University of Michigan collection (24/5016 A/S) and describes it as drawloom woven. Here there is no need

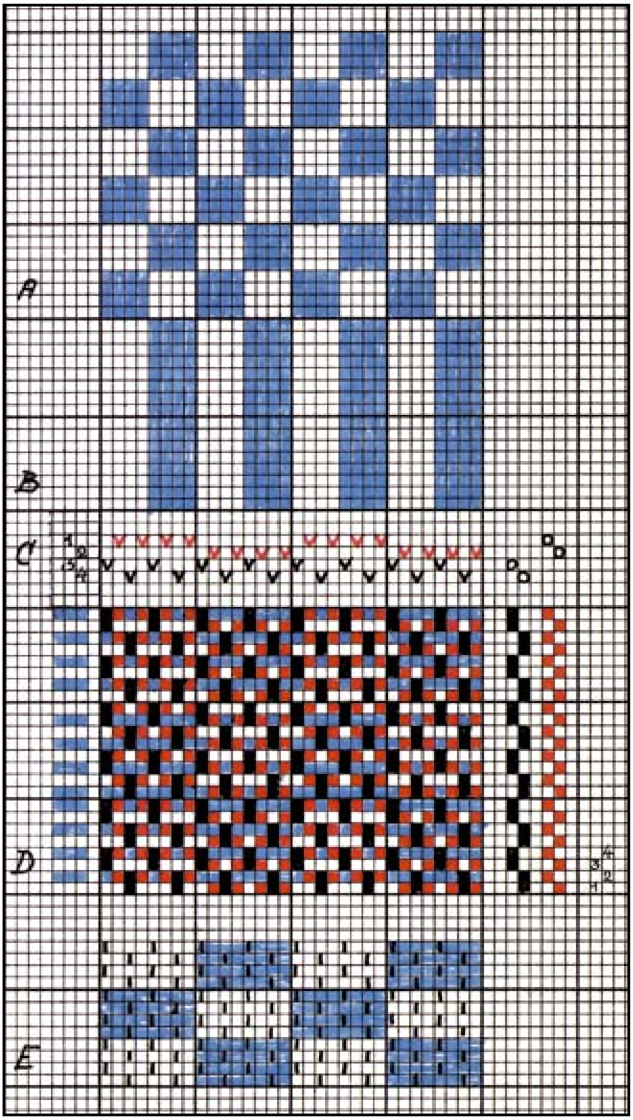


Figure 69 The draft for the simplest form of patterning. At A is shown the chequered pattern, at B the striped pattern. At C can be seen the way used for entering binding warp (black) and main warp (red) into lifting heddles on four shafts. Note in D at the left the order of wefts for changing pattern from stripes to chequers. Below at E can be seen an impression of the material beaten in so that colours come out clearly. Black dots denote the binding points in tabby.

for any sort of drawloom. We have made a reproduction of this chequered material using four shafts and four treadles, see Figures 69 and 70.

The two shafts nearest the weaver are used for the binding warp (black). The two shafts behind are used for alternating blocks, here four main-warp ends for each block. We used lifting heddles denoted v v, C. Two treadles must be used at the same time: one tabby treadle (black) is kept

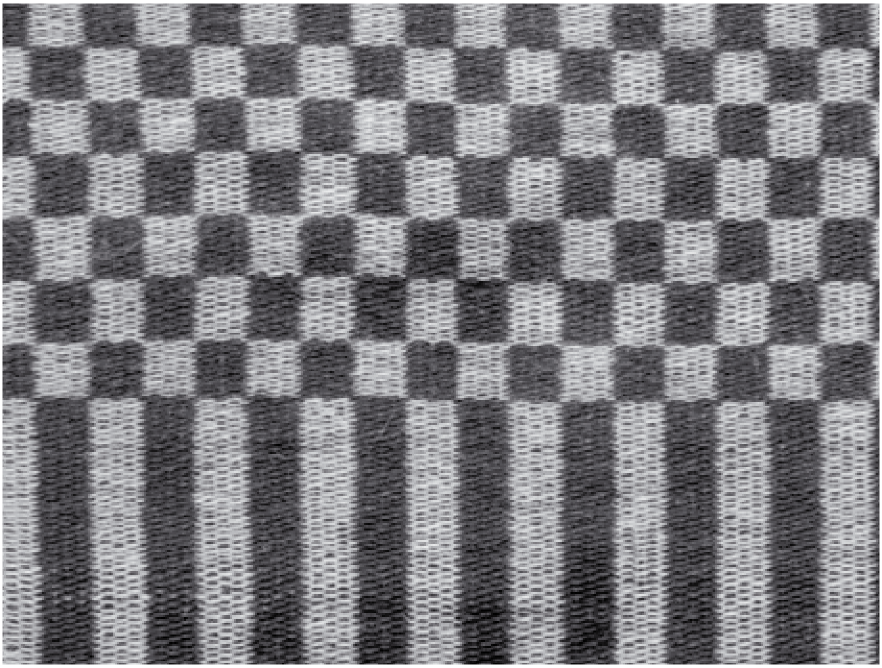


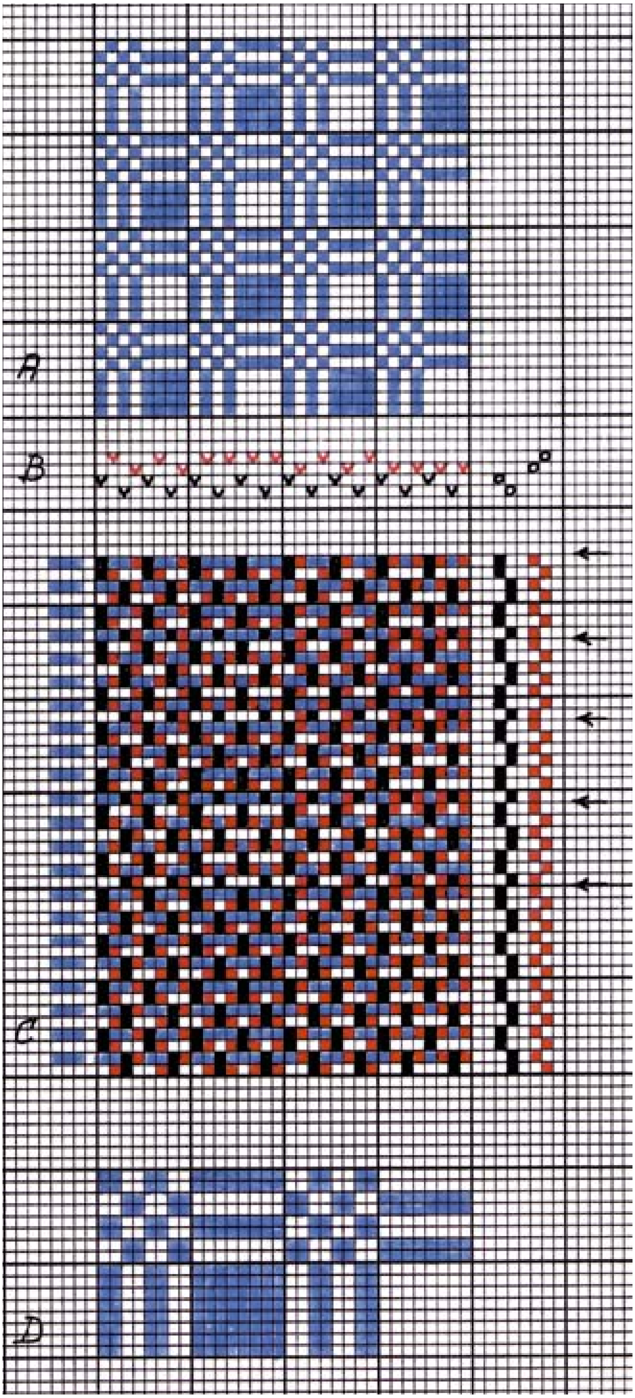
Figure 70 Our woven sample, showing stripes and chequers.
Warp: wool, one end Z-spun, six per cm.
Weft: wool, one end Z-spun, 14 passées (28 wefts) per cm.

down while two pattern treadles (red) are used alternately for white and blue wefts.

This way of making simple geometric patterns is now called block patterning. The lowest number of blocks is two, light and dark stripes of any width as shown at B. When the two colours are interchanged we have the chequered pattern shown in Figure 69 A. This means two blocks in warp direction and two blocks in weft direction.

The block patterning method has been used throughout textile history till our own day for uncomplicated geometrical patterns in combination with different sorts of weave (D. Burnham 1980, pp. 8–9). Here we will show only this first two-block pattern used in connection with the weft-faced compound tabby.

One vertical column of small squares in the patterns A and B means one main-warp end. When the binding unit represented by wefts 1–2–3–4 is used regularly throughout, a pattern of stripes will appear; see Figure 69 B.



← **Figure 71** The draft for the textile from University College, London.

A is the motif; one vertical column of squares represents one main-warp end. One horizontal row of squares in this case means three and one-half passées (seven wefts) because of the method used for changing colours: see arrows at the right of the draft C. D is an impression of the woven piece of the textile.

→ **Figure 72** Our woven sample. Note near the middle that two large squares of the same colour come next to each other. Note also the horizontal stripes in one colour.

Warp: wool, one end Z-spun, 6 per cm.

Weft: wool, one end Z-spun, white and dark blue 14 passées (28 wefts) per cm.

Thanks to the method of using alternately one weft of each colour for each tabby shed, it is possible to form the second block in weft direction by reversing the colours from one vertical stripe to the next. This change will take place if one colour is used for two adjacent wefts; see the sequence of colours at the left in Figure 69 D.

In the draft are shown only four passées for each row of squares. In the actual material it was necessary to weave 14–16 passées to obtain the desired height of the square, because the weft is nearly five times tighter than the warp.

A similar woollen textile belonging to University College, London, is extensively described by Grace M. Crowfoot and Joyce Griffiths (1939); here it is correctly stated that this textile was woven using four shafts and possibly four treadles. We have drawn the pattern as shown in Figure 71 A. It can be seen that this is also a two-block pattern with the dimensions of the blocks varied. Crowfoot describes the pattern as octagons framing rectangles; this is an optical illusion often encountered in block patterns.

In Figure 71 is shown how we entered the warp into four shafts. The two front shafts, marked black, are used for tabby; the two shafts behind are used for the two blocks, four main-warp ends on block 1, then four ends alternately on blocks 2 and 1, then four on block 2, and so on.

Near the middle of this piece a fault can be seen: two large squares of the same colour come next to each other. Only three small blocks

were entered between the large ones instead of the normal four, and this brought about the fault.

Horizontal stripes in one colour can be seen between the patterned parts. To obtain these stripes only one colour is used for both wefts; the weaving is still done with two changing blocks as in the patterned areas. This can be seen from the analysis by Griffiths. The surface of the textile here also gives the impression of an even weft-faced rep; the same colour appears on both sides.

Griffiths' analysis of this sample is very thorough; the method of changing weft colours is clearly described, and this is followed in our reproduction. In the draft Figure 71 C the colour changes are marked by arrows at the right.

The method used to change colours is not the same as in the previous sample (Figure 69); there the same weft colour was used twice where the pattern required a colour change; here the order of weft colours is invariant, and the colour change is effected by a change in the order of treadles.

The entering and tie-up shown by Griffiths would certainly function very well; but we found it more logical for our version to use two front shafts for the binding warp and two other shafts for the pattern blocks.

The weaving of these two-block patterned fabrics is obviously not complicated. It can be done on nearly any sort of loom, be it vertical or horizontal.

Figure 73 Photograph of the original silk from Dura-Europos. Yale University Art Gallery, no. 1933-486 (Bellinger and Pfister 1945).

Crowfoot concludes that the looms used for these fabrics were horizontal looms with treadles on account of the regularity of pattern repeats and the exact changes of colour. Crowfoot also suggests the use of clasped heddles for the treadle-operated loom.

The dating for most fabrics of this type is fourth to fifth century. This dating appears a little late compared with the more intricately patterned finds from Antinoë (Chapter 5). Certainly these woollen fabrics were produced as home craft and intended for some practical use in the household. Many of them are found in scrap heaps in ruined cities. Presumably such textiles had been woven for centuries and it is reasonable to see this sort of weave as a first stage in weaving weft-faced compound cloth.

The silk from Dura-Europos

During the Han dynasty the first commercial connection from China to Western Asia was established over the Silk Road. The Silk Road consisted of several caravan routes through the dangerous deserts and mountain areas of Asia. The roads were protected by fortifications so that Chinese merchants could bring their silk and other precious products as far as the frontier of the Parthian Kingdom. Parthian merchants then took over and passed the goods on to western entrepôts such as Dura-Europos and Palmyra (Geijer 1979, p. 109). Dura-Europos in Mesopotamia, situated far east of Palmyra and other known trading places in Western Asia, was presumably among the next to receive the silk material from China after the Parthians.

In the year 1933 a combined French-American excavation in Dura-Europos brought to light among other textiles a single piece of silk in weft-faced compound tabby, see Figure 73. This silk is now preserved in the Yale University Art Gallery (no. 1933-486). It was first described by Pfister (1937, pl. IX), and at that time ascribed to China. In 1945 Bellinger and Pfister in collaboration described the textiles from Dura-Europos, and it was here made clear that the technique of this silk is weft-faced compound tabby. The fall of the city about AD 256 gives a limit for the dating of the silk.

This silk has been discussed in several articles, among others by Krishna Riboud (1974).

The material is silk, not the Chinese reeled silk but a rather heavily Z-spun thread. The thread count in warp is 24, in weft 64 per cm.

In the Final Report from Yale University (Bellinger and Pfister 1945) the silk is illustrated both in colour and in black and white. The latter is so expertly printed that it was possible by means of a magnifying glass to study the binding in detail.

It is a weft-faced compound tabby with only two colours used at a time. In Figure 74 A we have drawn part of the motif; on parallel horizontal stems are placed angular symmetrical figures. As far as we know this silk is the only example of an intermediate stage between the above-described two-block patterns and the more elaborate patterns found in Antinoë and Akmim. It is not possible to state any place of origin for this silk; it is considered here only to demonstrate a stage in the development of this type of weave.

The pattern can be described as a five-block pattern. To determine how many blocks are needed in warp and weft the pattern is treated in the same way as a weaving draft; for each different column of squares in warp direction a new shaft (warp-block) is needed and for each different row in weft direction a new treadle (weft-block) is needed. In this way it can be seen here, Figure 74 A, that the pattern has five blocks in warp direction and five blocks in weft direction. This is the usual way of determining the number of blocks in similar geometric patterns. Afterwards the required binding can be considered in accordance with the number of blocks.

In this case there was some doubt as to whether the weft block for the horizontal stems and the lines between the patterns was necessary. In our previous sample (Figures 71 and 72) we have shown one-coloured horizontal stripes woven with two blocks but only with one colour used for both wefts; in such a case the same colour appears on both sides. Unfortunately we have had no opportunity to see the real silk, and we have not seen the reverse side. However in the photograph, Figure 73, it is possible in the red stems to see glimpses of a light weft from the reverse side, and also in the light stripes between borders a dark weft from below is faintly to be seen. This means that a special weft block was used for the one-coloured stripes contrary to the stripes shown in Figure 72 where the same colour appears on both sides; in this case each side has its own colour. Accordingly also wider areas without pattern could have been woven with different colours on each side.

In the preserved piece there is apparently no such unpatterned area. Below the two red borders on white ground, a white border appears on a tan ground. Below this is an area which seems to be without pattern: but when this part is studied more closely another row of pattern is revealed by the binding. The colours seem to have faded to the same tint, but the narrower weft floats in the vertical outlines of the pattern show that a pattern was woven here too. The coloured illustration in the Final Report shows a more yellowish tan in this place. For our experiment we used four colours: red, white, tan, and ochre.

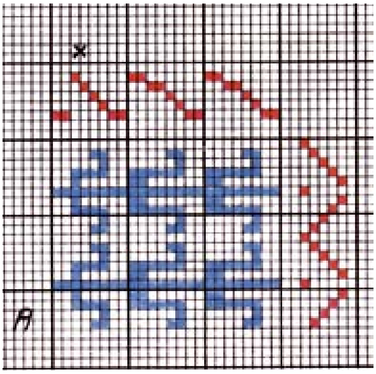
We used a shaft loom set up as shown in the draft Figure 74 C: two shafts, marked black, for the binding warp and five shafts, marked red, for the main warp. The tie-up is divided into two separate groups, and two treadles must therefore be used at the same time as shown at the right. The tie-up is shown as usual for a shaft loom without any draw arrangement with black squares for depression shafts and empty squares for lifting shafts.

In the left part of the silk is a fault: one figure, marked by crosses, is narrower than the rest. At this point, in each of the shafts 1 and 2, is entered only one thread instead of the usual two.

In the motif A one vertical column of squares means one main-warp end, and one horizontal row means four passées (eight wefts). In order to show the pattern more clearly in the detailed draft we have included the warp ends only in the upper half of the pattern unit. The treadles for tabby (black) and the treadles for lifting pattern in the main warp (red) are drawn for the entire pattern unit. Two treadles are used at the same time, as in the two samples described above. One tabby treadle (black) is kept down while one of each colour is woven with two main-warp treadles (red).

In this way there was no problem in weaving the replica on our loom with seven shafts and twelve treadles, Figure 75.

We have no knowledge of the loom used for the original silk, be it in Syria or a neighbouring country, in the first half of the third century; here we can only conjecture. Crowfoot (1939) writes that there is little to be gained by multiplying ‘heddles’ (i.e. shafts) unless they can be controlled by treadles; but we feel it is doubtful that so many treadles were used at that time. Crowfoot proposes the use of pattern rods instead of treadles. Even if time and labour were not an important factor the use of pattern rods in the warp appears rather awkward for this type of weave. For the two colours in one passée the groups of main warp had to be lifted above the binding warp for one colour, while for the other colour the lowered groups of main warp had to be lifted, also above the binding warp. This



→ **Figure 74 A–E** Our draft for the Dura-Europos silk. The motif is shown at A; note the fault at the left, marked by a cross where one figure is narrower than the rest. The number of blocks needed is denoted above and at the right. At C is shown our way of entering the main warp and the binding warp into seven shafts. At the right treadles are shown in black and red for the entire pattern unit. Note the tie-up in two separate groups. For the use on an ordinary shaft loom without any draw arrangement the tie-up is shown by black squares (depression shafts) and empty squares (lifting shafts).

In the draft D we have drawn the warp threads (black and red) only in the upper half in order to show the pattern more clearly. E shows the impression of the beaten-in material.

At B is shown the normal theoretical method for a draw arrangement, but it is certainly too advanced for this early date.

means that the pattern rod had to be pulled out and a new rod counted in for at least every other weft.

We believe that pattern heddle rods of some sort were used. In Figure 74 B we have drawn five pattern heddle rods and at the right shown theoretically the lifting for this pattern by means of cords over pulleys. Certainly this monture is too advanced. When only a limited number of pattern sheds were needed, it would not be too difficult to arrange a practical lifting method for an assistant. Note that here, in contrast to the very tight silk warps of the Han where loose loops would easily become entangled, in these early weft-faced weaves not more than eight to twelve main-warp ends per cm were utilized.

A pillow cover from Antinoë

From the excavations in Antinoë parts of three pillow covers woven in weft-faced compound tabby now belong to the Musée Historique des Tissus, Lyon. One of these (no. 26812/19) we have used for our next experiment.

R. Pfister (1948) has given an exhaustive description of the three pillows. They were found in tombs from the Roman period with plaster masks and the bodies wrapped in painted linen representing clothing. According to Pfister this burial custom was not used later than the end of the third century; therefore the pillows were certainly woven at an earlier date, perhaps

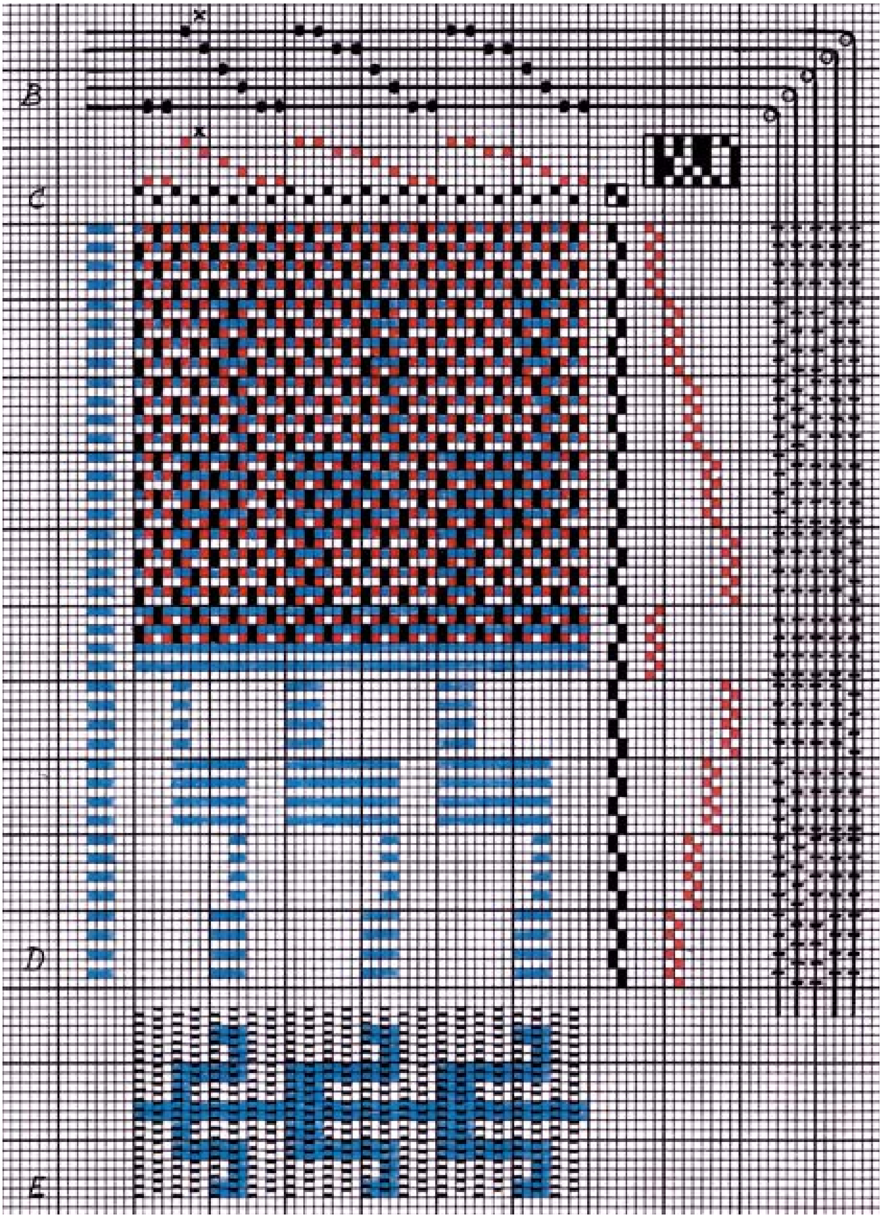

B
C
D
E

Figure 75 Our woven replica of the Dura-Europos silk.
Warp: spun silk Nm 10, eleven threads per cm.
Weft: organzine silk Nm 12.5, 20 passées (40 wefts) per cm.
The extension of the pattern beyond what can be seen in the original photograph is of course a conjecture.

in the first part of the third century, possibly even earlier. They were not produced in Egypt; here it was a general rule in the 3rd–5th centuries that woollen yarns were S-spun. The material in the Antinoë pillows is Z-spun, and certainly of foreign origin, probably somewhere in Western Asia. Pfister also shows that the ornamentation belongs to Iranian art and considers the place of origin to be Persia.

This example from Lyon has a ground pattern of stylized dark blue leaves on a yellow ground. Above are five borders, three are 'à la grecque' borders in red on a near-white (undyed) ground, one border of blue waves on white, and a pampre with tendrils in green and white. There is also a bit of a lozenge-like weave, woven with undyed wool, presumably part of the back of the pillow.

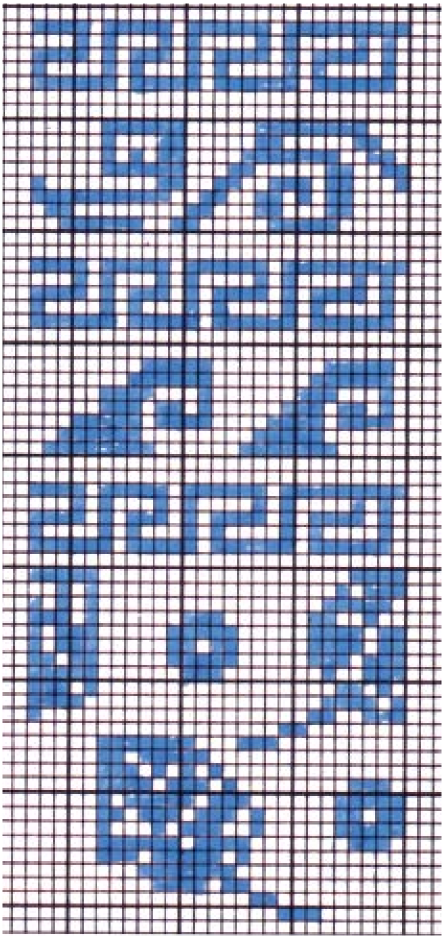
The selvedge is preserved on the left side; it consists of two cords of sextupled yarn. In the photograph, Figure 76, can be seen that the leaves near the selvedge are rather narrow, gradually widening toward the middle of the textile. This is a certain indication that no reed was used. When a textile is 'drawn in' during weaving it is always most noticeable near the

Figure 76 Part of a pillow placed under the head of a Roman lady buried at Antinoë, Musée Historique des Tissus, Lyon, no. 26 812/19.

Warp: wool single end Z-spun, 14–17 per cm.

Weft: wool single end Z-spun, 22–24 passées (44–48) wefts per cm.

Photo: Musée Historique des Tissus, Lyon.



← **Figure 77** One unit of the pattern. One vertical column of squares means one main-warp end. In the pattern of leaves and berries one horizontal row of squares means three passées; in the border one row of squares means four passées.

→ **Figure 78** A fraction of one border is used for the draft. We have presumed that 27 pattern heddle rods were used in weaving this textile. Accordingly we have shown such a system theoretically. Uppermost at A are the 27 pattern heddle rods. From each rod a draw-cord is taken over a pulley (slanting row of squares at the right) and led vertically downward at the right. Here, for the sake of clarity, pattern lifts are shown for only one passeé in each découpure; each passée is repeated four times. In the left half of the draft C the warp threads are left out, also for the sake of clarity.

Lozenge weave is shown at B; in the right half each individual thread is shown; in the left half only the lift of main warp is shown. Here it is certainly easier to see how the odd number of pattern shafts causes the change of twill direction at the point marked by a cross.

selvedges. This does not mean any difference in the number of main-warp ends in the pattern units. The thick selvedge is also inconsistent with the use of a reed. A sword beater must have been used to beat in the weft.

One single pattern unit is drawn in Figure 77. One vertical column of squares means one main-warp end. Twenty-seven different main-warp ends are necessary for the pattern. In this case it can only be a matter of conjecture whether twenty-seven pattern heddle rods were used, or a more developed drawloom with twenty-seven draw cords repeating the units was already in existence. We tentatively presume that pattern heddle rods were used in some way. These considerations will be discussed in more detail in Chapter 11 on different drawlooms.

The pattern used here (Figure 76) is a good example to illustrate the difference in pattern weaving between Han China and Western Asia in the same period. We have in earlier chapters demonstrated the characteristics of the Han patterns, varied horizontally all over the width and with the pattern units rather low. We presumed that pattern heddle rods were knotted onto the warp already set up in the loom. In the Persian sample rather narrow pattern units are repeated several times in the width. On

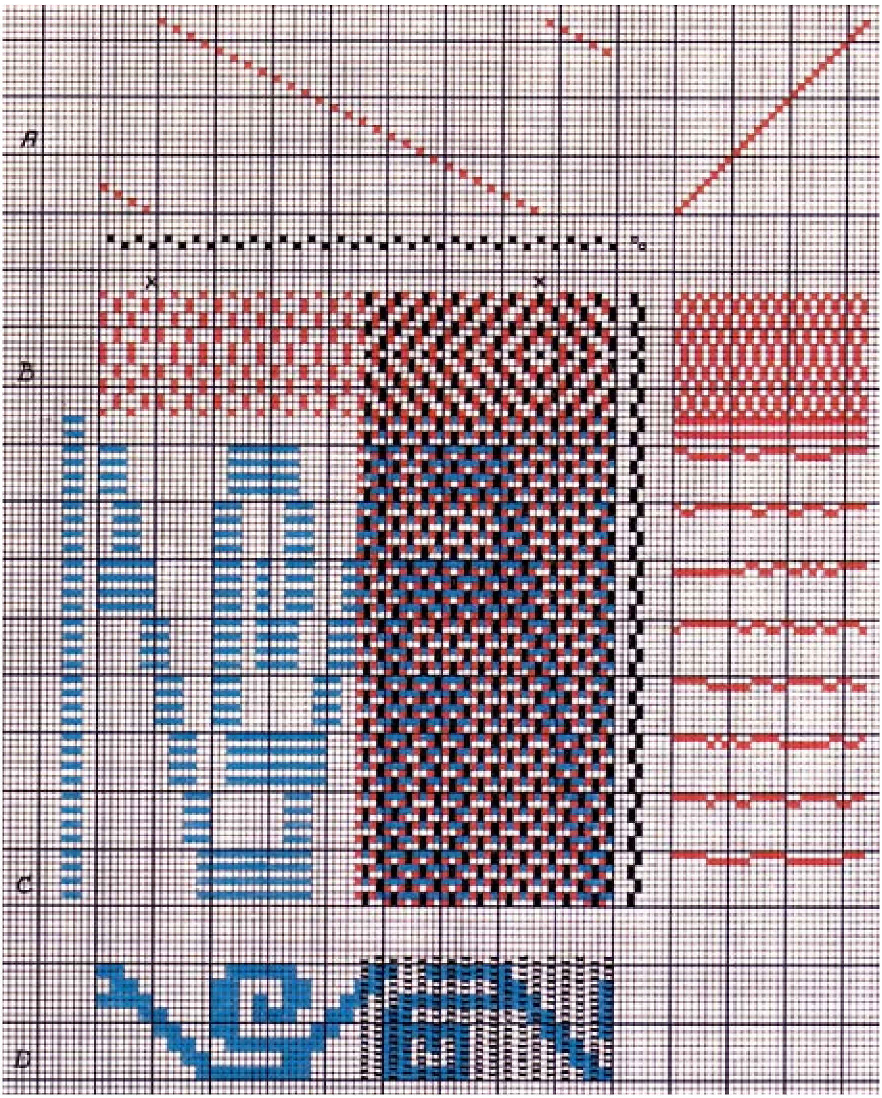


Figure 79 Our woven replica of the pillow.

Warp: unbleached cotton 12/2, eight threads per cm.

Weft: wool, one end Z-spun, twelve passées (24 wefts) per cm.

the other hand the twenty-seven pattern heddle rods are made the most of in warp direction. It is obvious that the possibilities are unlimited as long as it can be done with a certain number of pattern heddle rods. It presumably means in this case that the weaver disposed of twenty-seven pattern heddle rods and was able to enter even-numbered warp ends (red) into these heddle rods in straight repeat, the odd-numbered ends (black) into two tabby shafts ahead of them.

Certainly weavers in China and Western Asia had to start their first experiments in pattern weaving in a similar way by means of rods in the warp etc., but here we think the difference from East to West comes out very clearly. Chinese weavers developed their patterns to still more sophistication all over the width. Weavers in Western Asia made use of an increasing number of pattern heddle rods or shafts for repeated pattern units in the width. Pattern units were at first narrow; thanks to the increasing number of pattern shafts, units became wider, and at the same time the possibilities in the height were nearly unlimited. We will show more on this development in later chapters.

We have drawn part of one border in detailed draft, Figure 78. Uppermost at A are shown twenty-seven pattern heddle rods plus a number of the neighbouring heddle rods on each side. The slanting row of red squares at the right means theoretically twenty-seven pulleys. From each pattern heddle rod a draw cord is taken over a pulley and led vertically along the right side of the draft. Each vertical column of squares here means one draw cord. Black squares denote the two tabby shafts.

For better clarity we have drawn the warp threads only in the right half of the draft, Figure 78 C. Two treadles nearest the right side of the draft (marked black) lift the tabby shafts. In the pattern unit Figure 77 each horizontal row of squares in the border means four passées (eight wefts). In the pattern lift at the right (red) we have drawn only one passée for each découpure in order to show more clearly the different pattern lifts.

Figure 78 D shows the pattern as it appears when it is beaten in. Black dots denote the tabby binding as in the samples above.

The lozenge weave, presumably a fragment of the back cover that turns up at the upper side of the fragment, is shown at B. The weave is here a twill 2/2 and to obtain this both main warp and binding warp are utilized at the same time, here functioning as a single warp. Odd-numbered and even-numbered main-warp ends are alternately lifted simultaneously with one tabby shaft, see the lifting of pattern shafts at B. The twill direction changes along the warp at the points marked by crosses above the draft. This shift in direction comes about because there is an odd number of pattern shafts so that the first and last shafts are lifted for the same shed. For better clarity we have shown only the lifted main-warp ends in the left part of this binding, Figure 78 B. In weft direction the twill can be turned over when a tabby treadle is used for only one weft and the same lift of main warp is used for three wefts; see the lift at the right in our draft at B.

For our experiment we had no loom available with a large number of pattern shafts, so we used, rather inconsistently, our drawloom (described in Chapter 12). We entered the main warp (red) individually into leashes. The binding warp (black) was entered into two shafts operated by treadles. Pattern lifts were counted in row by row onto the harness cords and supplied with loops of string for repeated use (when used in this way the loops are called lashes; this will be described in Chapter 12). We had no woollen yarn thin and strong enough for the warp, so we used a cotton thread.

Figure 79 shows our woven replica of the pillow cover.

The hunting scenes

Wool weaves in weft-faced compound tabby illustrating hunting scenes were evidently much in vogue around the 4th to 6th century, if one may judge from the large number of samples preserved. The Musée Historique des Tissus, Lyon, has one sample (no. 24.566/3) with figures in undyed wool on a buff ground. From museums in Berlin Ernst Flemming (1957) illustrates two examples; one has green figures on a red ground. Sylwan and Geijer (1931, fig. 5) have another sample with a border included. There are variations in the figures and the way they are placed, but the motif is always the same: hunting men on foot or on horseback and several animals. One rather good example belongs to the Museum of Decorative Art, Copenhagen (no. A 40/1929), reproduced in Figure 80.

The figures are of undyed wool (nearly white) on a buff ground. The border is patterned with white on purple ground; outside this is a remnant of an entirely purple area woven in the same weft-faced compound tabby as the patterned parts.

The pattern unit in weft direction has 76–78 different main-warp ends. No repeat in the height (warp direction) can be seen, even though this piece is rather large (height 26 cm, width 48 cm).

It is generally presumed that these weaves are of Egyptian origin; the yarn is S-spun as was the general case in Egypt. Renate Jaques in her reedition of Flemming (1957) places the two samples in Syria, 3rd century AD. At any rate a highly developed patterning technique is evident.

Weaving with as many as 78 pattern shafts, varied over a considerable height, demanded an experienced weaver; certainly the looms had undergone a development by this time. Unfortunately the height of patterns cannot be stated; it is not possible to see a real repeat. Still we presume that true repeats were made, partly on account of the large number of identical examples preserved and partly because it would have been very

Figure 80 Hunting scene in weft-faced compound tabby belonging to the Museum of Decorative Art, Copenhagen, no. A 40/1929.
Warp: wool, one end S-spun hard twisted, undyed, ten main-warp ends (20 threads) per cm.
Weft: wool, one end loosely S-spun, undyed, buff, and purple, 36 passées (72 wefts) per cm.
Warp découpure: one main-warp end.
Weft découpure: two passées.
Photo: Ole Woldbye.

troublesome to produce these textiles freely with inspiration for any larger expanse. Although variations are found some of the finds are absolutely identical.

Taqueté in three colours

Our last example is meant to show the use of three colours with this weave.

One of the pillows in the Musée Historique des Tissus, has a pattern of white palmette-like figures on green ground. Between these figures are round spots in alternately yellow and red. We have used only these spots as a motif for our experiment, see Figure 81 A.

In our draft white means weft 1, blue weft 2, and green weft 3. But note that in the woven replica, Figure 82, the green ground colour is weft 1, yellow spots weft 2, and red spots weft 3.

In Figure 81 B are shown the pattern lifts of the main warp for one row of spots, see the framed part at A. When three weft colours are used (passées b–f) one passée consists of three wefts, one of each colour; for the ground between spots (passées a and g) only two colours are used.

Figure 81 C shows the entering of the binding warp into two tabby shafts (black).

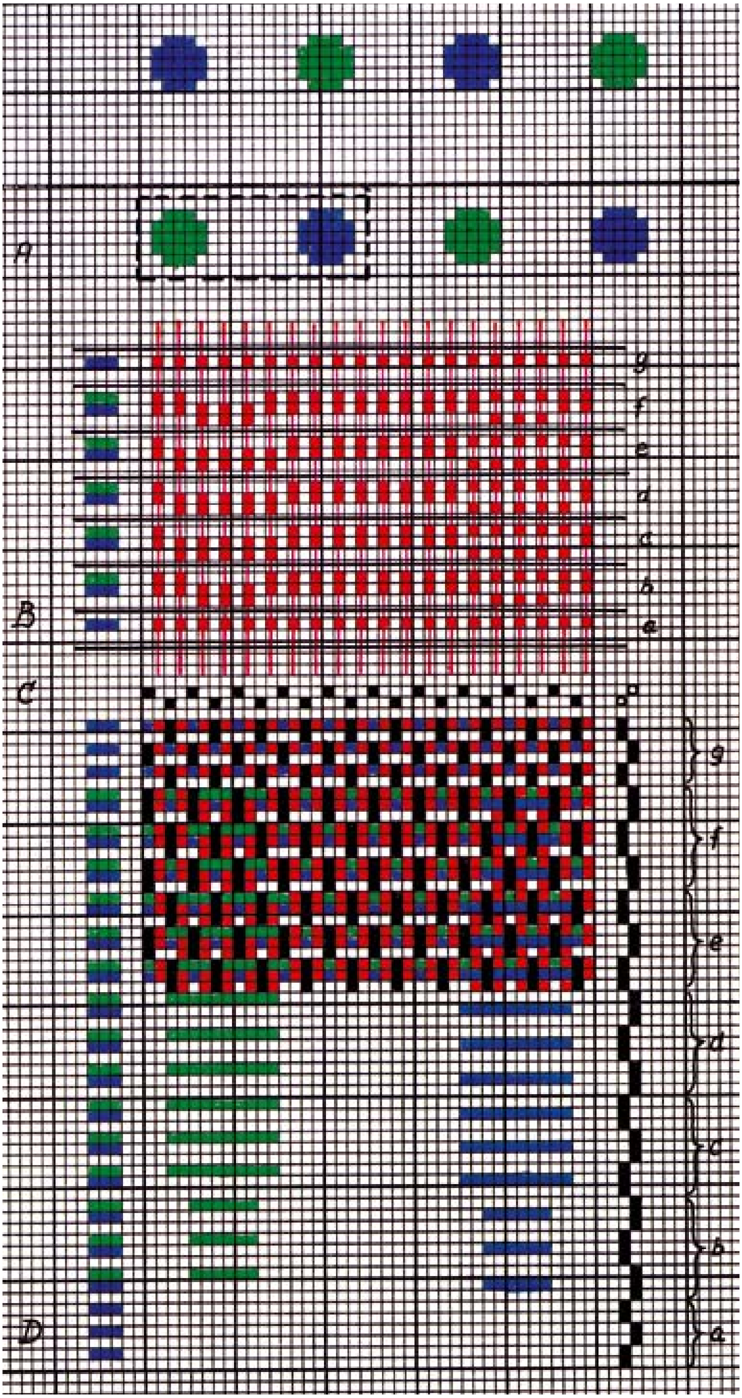
In the detailed draft at D we have drawn the warp threads only for the upper part in order to show the pattern more clearly. Weft découpure is three passées. At the right we have marked the découpures (a–g) by braces, each containing three passées.

As usual in these weft-faced weaves each tabby shed is used for one weft of each colour. In the ground the shed is used for two colours; in the row of spots the shed is used for three colours.

In Figure 82 is shown our woven replica of a three-coloured taqueté.

We have shown above a rather large number of weft-faced compound tabbies because we think they give a good illustration of the early development of mechanically repeated patterns.

→ **Figure 81** The draft for a taqueté in three colours. Note that the ground between spots is woven with only two colours, while the row of spots has three colours; see the order of wefts at the left.


A
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D
g
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a

Certainly the weft-faced compound tabby was widely used, as can be seen from preserved textiles, but of much more importance became the weft-faced compound twill (samitum), to be described in the next chapter.

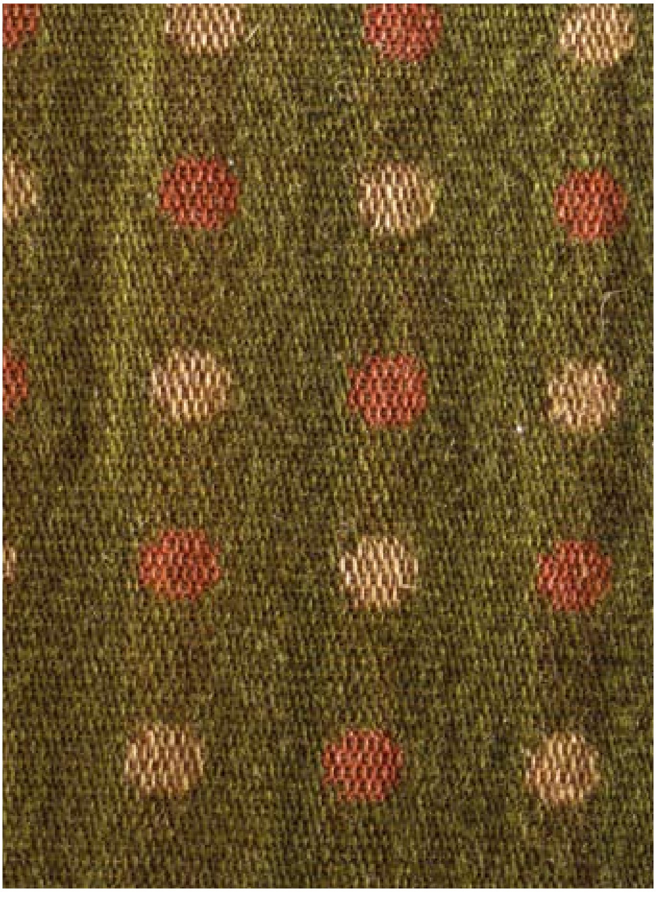


Figure 82 Our woven sample in three colours.

Warp: cotton 12/2, four main-warp ends (eight threads) per cm.

Weft: wool, one end Nm 7. Spots: twelve passées (36 wefts) per cm. Ground: fifteen passées (30 wefts) per cm.

Chapter 5
Weft-faced compound twill or samitum

The principle of weaving samitum

The principle of weaving weft-faced compound twill is very like that of the weft-faced compound tabby described above. The only difference is in the way the binding warp is worked. Here twill 1/2 on three shafts is used instead of tabby. This means that each weft goes over two binding-warp ends (besides the main-warp ends in question) and under one binding-warp end, with the result that more of the weft comes up onto the face side, see Figures 83 and 84. The difference between face and reverse side is very pronounced. The step from tabby to twill 1/2 was certainly not without connection to the acquisition of silk. A new material was very often followed up by a new technique (Geijer 1979, p. 63).

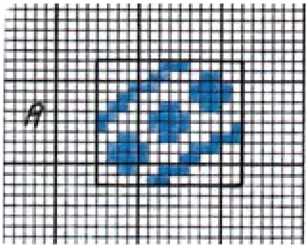
Without doubt the twill weave displayed the character of the silk material to a greater advantage; the surface became softer and more lustrous. This effect was already known to Iranian tapestry weavers. Ancient Iranian silk tapestries are woven not only with tabby, as is the usual technique, but also with twill 1/2. Presumably both weft-faced weaves were inspired by the Iranian tapestry weave (Geijer 1979, p. 120).

Weft-faced compound twill is also designated in several languages by the mediaeval term *samitum* (from the Greek *hexamitos*, 'six threads'; when twill 1/2 is used the binding unit is six: three binding-, three main-warp ends). Samitum became the main technique for multicoloured silk weaving during the first millennium of our era. Certainly it was first developed in Iran; the earliest samples of the highest quality were found among the Antinoë finds. The greater part of the marvellous silks from Byzantium are woven in samitum up till the eleventh century. From nearly all Mediterranean areas silks woven with this technique give evidence of its very widespread use.

→ **Figure 83 A–E** The principle of weaving samitum.

The motif used in this example is a detail of a pearl roundel, shown at A. One vertical column of squares means one main-warp end, while one horizontal row of squares represents two passées. At B is shown the lifting of main warp for twelve passées, a–m. At C the binding warp (black) is entered into the heddle eyes on three lifting shafts; the eyes are adjusted to the height of the lower shed face. The draft D shows the individual threads face side up. At the right, black squares denote three treadles for twill binding. The braces marked a–m denote two passées for each découpure.

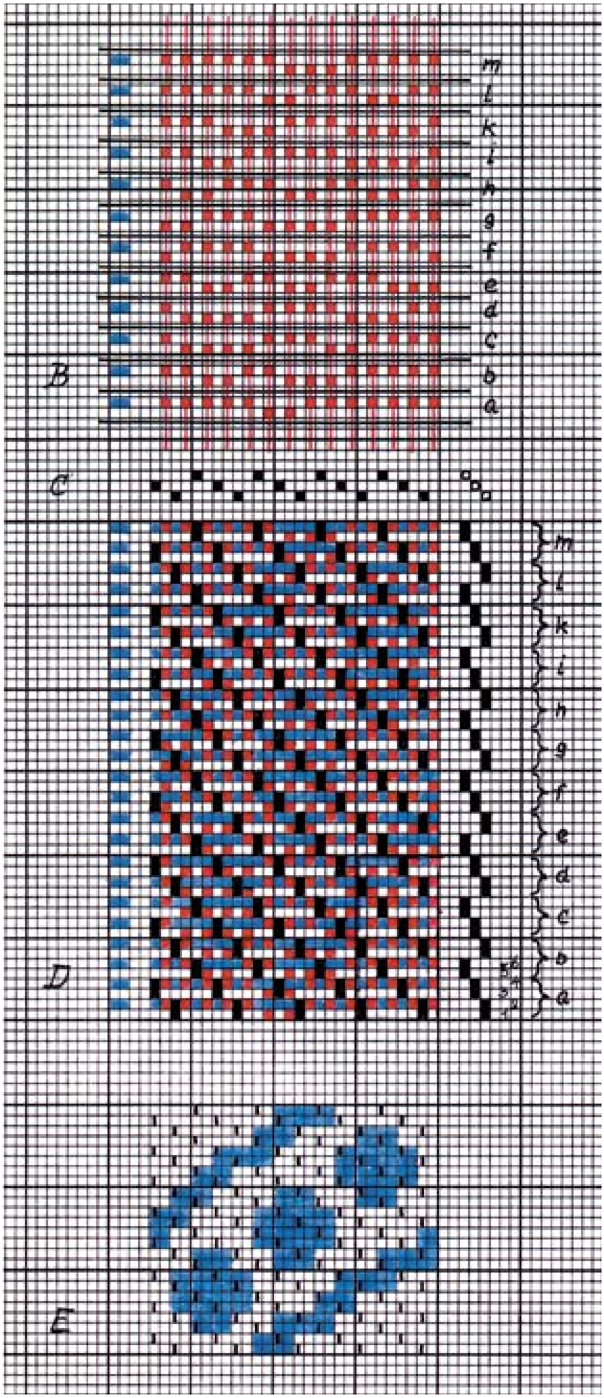
At E is given an impression of the textile when it has been woven.



Several variations within the definition of samitum exist; these are described below. It is possible also in later centuries or in other countries to trace this technique as a basic element for further variations.

It is significant for both weft-faced compound weaves that only the weft, in two or more colours, is visible. The warp is always hidden by the weft, and binding points can be seen only faintly. The surface of these textiles has a uniform texture in tabby or twill. The different colours give the decorative effect.

Figure 84 The draft D is here plaited with strings in the corresponding colours in order to show more clearly the course of the individual threads.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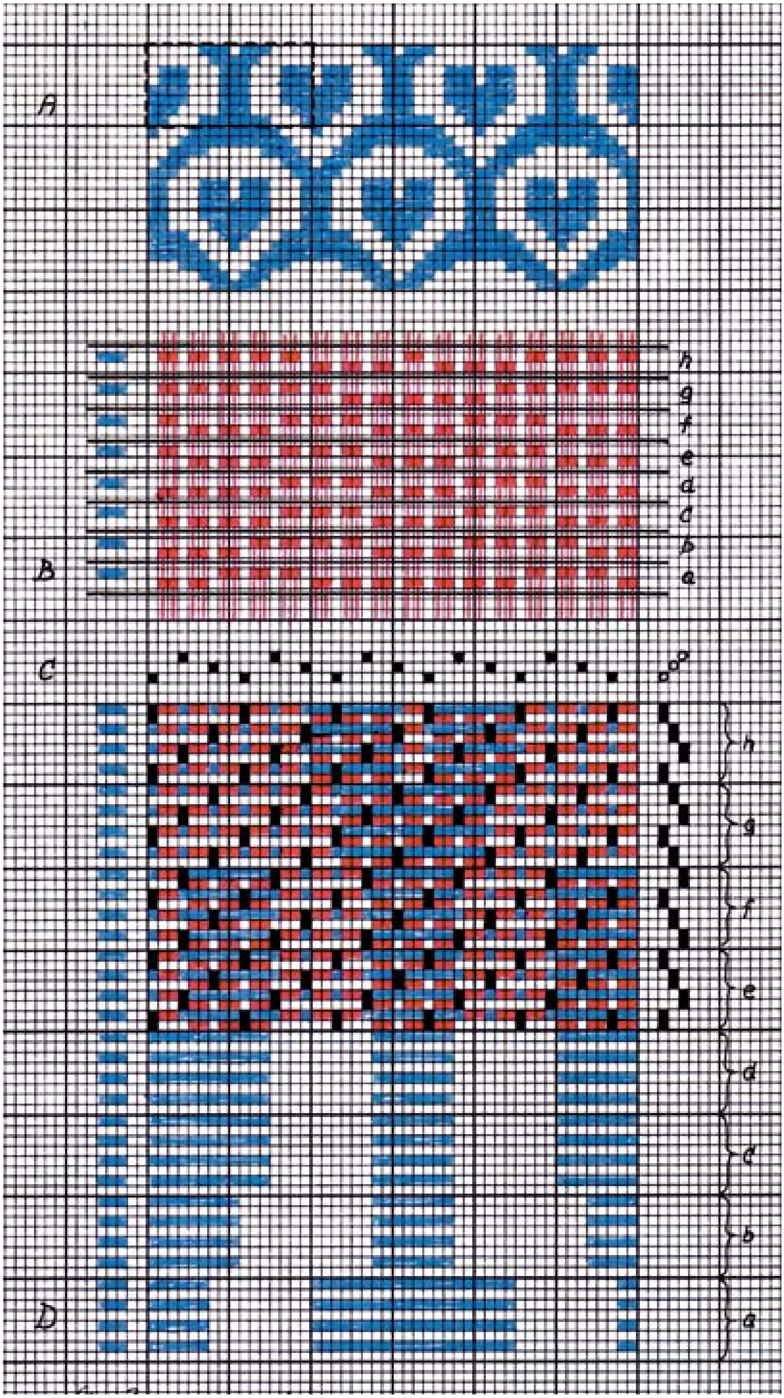
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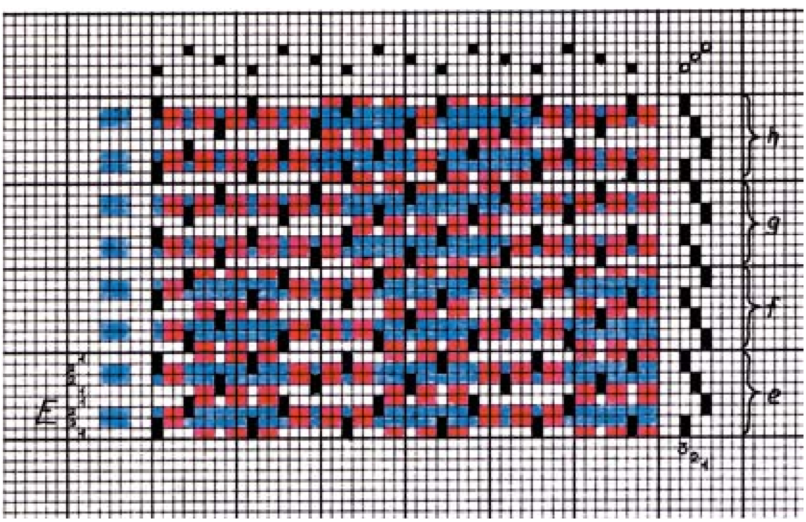
Samitum in two colours

For our first experiment with a two-coloured samitum we used as a motif the stylized feathers from the neck of the proud eagle on the chasuble of Bishop Albuin (975–1006). His chasuble is now preserved in his home cathedral, Brixen, Austria; it is described by Sigrid Müller-Christensen (1935). This chasuble is an exquisite sample from the imperial workshops in Byzantium.

The pattern is shown in Figure 85 A. Only the part framed by a broken line is shown in the draft D. As is often the case in samitum silks the main-warp ends are doubled in order to give still more effect to the weft. Generally it is sufficient to draw only one vertical column of red squares and in a description to note whether the main warp is doubled or tripled. But in this first example we feel it is useful to show the main-warp ends individually to demonstrate the extended floats of the weft threads, compare the draft Figure 83.

In the lifting plan Figure 85 B the lifting of main warp for the eight different passées (a–h) is shown. In our replica each passée was used four times

← ↓ **Figure 85 A–E** A two-coloured samitum. Part of the pattern is shown at A. The draft shows only the area framed by a broken line. At B are shown eight Pattern lifts for passées a–h. Red squares denote lifted main-warp ends. The two threads of the doubled main warp are in this case shown individually. Binding warp (black) is entered into three lifting shtafts at G. For greater clarity the individual threads are shown only in the upper half of the draft D. Four passées are utilized for each découpure, see braces a–h at the right. At E is shown an alternative draft using two wefts of each colour following each other; this method reduces the work involved in changing pattern lifts. The woven replica is shown in Figure 86.



for each découpure (eight wefts); see braces a–h in the draft D. In order to make the pattern lifts clearer we have drawn the individual threads only in the upper half of the draft.

Each of the three treadles for twill at the right is used for both weft 1 and weft 2 (one passée) in the same way as in the above-described compound tabby.

The shedding order 1–2–3 must be followed continuously irrespective of the number of passées for one découpure. If this is not maintained, faults will appear in the twill.

From preserved samples of rather early date it appears that experienced weavers developed a faster method for weaving samitum. Note in Figure 85 E the découpure marked e in the lower part:

white weft 1 with treadle 3
pattern lift changed
blue weft 2 with treadle 3
blue weft 2 with treadle 1
pattern lift changed
white weft 1 with treadle 1
white weft 1 with treadle 2
pattern lift changed blue weft 2 with treadle 2

Figure 86 Our woven sample of a two-coloured samitum.
Warp: spun silk Nm 10. One binding-, two main-warp ends, 12 threads per cm.
Weft: spun silk Nm 10 dark blue and purple, 18 passées (36 wefts) per cm.

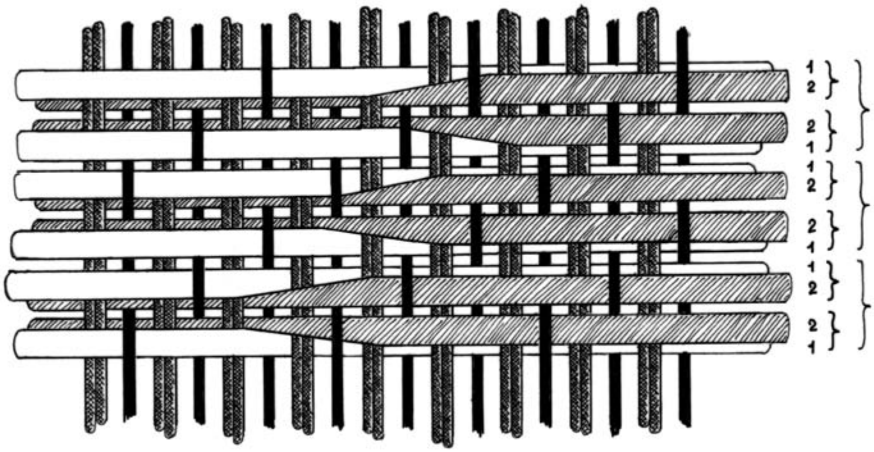


Figure 87 Weave diagram of a two-coloured samitum showing the change of colours on the face side; cf. Figure 85 E. Binding warp marked black, doubled main warp cross-hatched. Weft 1 white – weft 2 hatched. The order of wefts is shown at the right: 1–2–2–1. Smaller braces denote one passée. Larger braces denote one découpure.

and so on.

This means that it is possible to avoid every other change of pattern lift. The order of wefts is now 1–2–2–1; two wefts of the same colour now follow each other. At the same time the rule that each binding treadle must be used for two wefts, one of each colour, is maintained.

When only half the number of pattern lifts is needed this method is evidently time-saving and became generally used, as can be seen from analyses of preserved silks. The surface of the weft twill is still smooth and even and it is only by magnification that the use of this method can be demonstrated.

Note in this case that the drafts are shown with the face side up.

In Figure 87 a weave diagram shows the change of colours on the face side.

A three-coloured samitum

For our experiment with a three-coloured samitum a border from an Iranian silk was used. Geijer (1979, pl. 12) illustrates this silk excavated at Antinoë and dated to 3rd–6th century; it belongs to the Musée de Cluny, Paris.

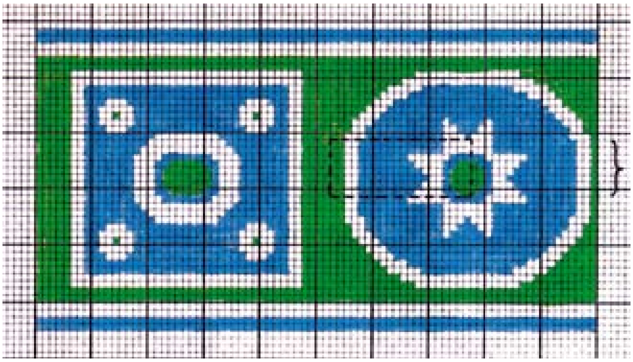


Figure 88 A three-coloured samitum. Part of the border of an Iranian silk (Geijer 1979, pl. 12). Only the detail framed by a broken line is shown in the draft.

We have not seen the actual colours; we used for our replica the colours available.

Part of this border is shown in Figure 88. Weft 1 is marked white, weft 2 blue, and weft 3 green. The area framed by a broken line, enclosing a part of the stylized flower, is used for the draft Figure 89.

The pattern lifts for the main warp are shown at B. For this experiment the main-warp ends were also doubled, but the doubling is not indicated in the draft.

When three colours are used one passée comprises three wefts, one of each colour. Note here the treadles at the right of the draft; the same shed is used for three wefts. Similarly when four colours are needed, one passée means four wefts. Certainly more than four different wefts were very seldom used simultaneously. When more than three or four colours were needed they were usually shifted in horizontal bands according to the design.

For our replica (Figure 90) three passées were used for each découpure, see braces a–h in the draft.

For a three-coloured samitum it is possible to reduce the number of pattern lifts by a method similar to that described above for the two-coloured weave. Each twill shed (passée) must have one weft of each colour; then the order of colours is: 1–2–3–3–2–1 and so on. The order of colours can be said to change to the opposite direction between passées. Colours 1 and 3 are used following each other two and two, while colour 2 in between must always be dealt with individually, see Figure 89 E.

In textiles with more than three colours several variations have been found according to pattern and number of colours. This can be seen from various analyses by Guicherd and Vial in the *Bulletin de Liaison de CIETA*.

Generally samitum and taqueté would have been woven face-side down, at any rate when more than two colours were used. To illustrate why this method is preferable we will at first contemplate the pattern and lifting plan for the three-coloured weave Figure 89 A–B. For each passée it can be seen that:

for white weft 1, main-warp ends for blue and green are lifted

for blue weft 2, main-warp ends for white and green are lifted

for green weft 3, main-warp ends for white and blue are lifted

Thus main-warp ends must always be lifted twice for each passée.

For the same detail of pattern we have drawn a new lifting plan, Figure 91, to the opposite effect: face side down.

Above it was pointed out that a lifted main-warp end means that the current weft goes under. In the new lifting plan it can be seen that:

for white weft 1, main-warp ends for white are lifted

for blue weft 2, main-warp ends for blue are lifted

for green weft 3, main-warp ends for green are lifted

Thus main-warp ends are lifted only once for each passée.

When samitum is woven face-side down the binding warp must of course also work face side down; see the tie-up in the next draft, Figure 98.

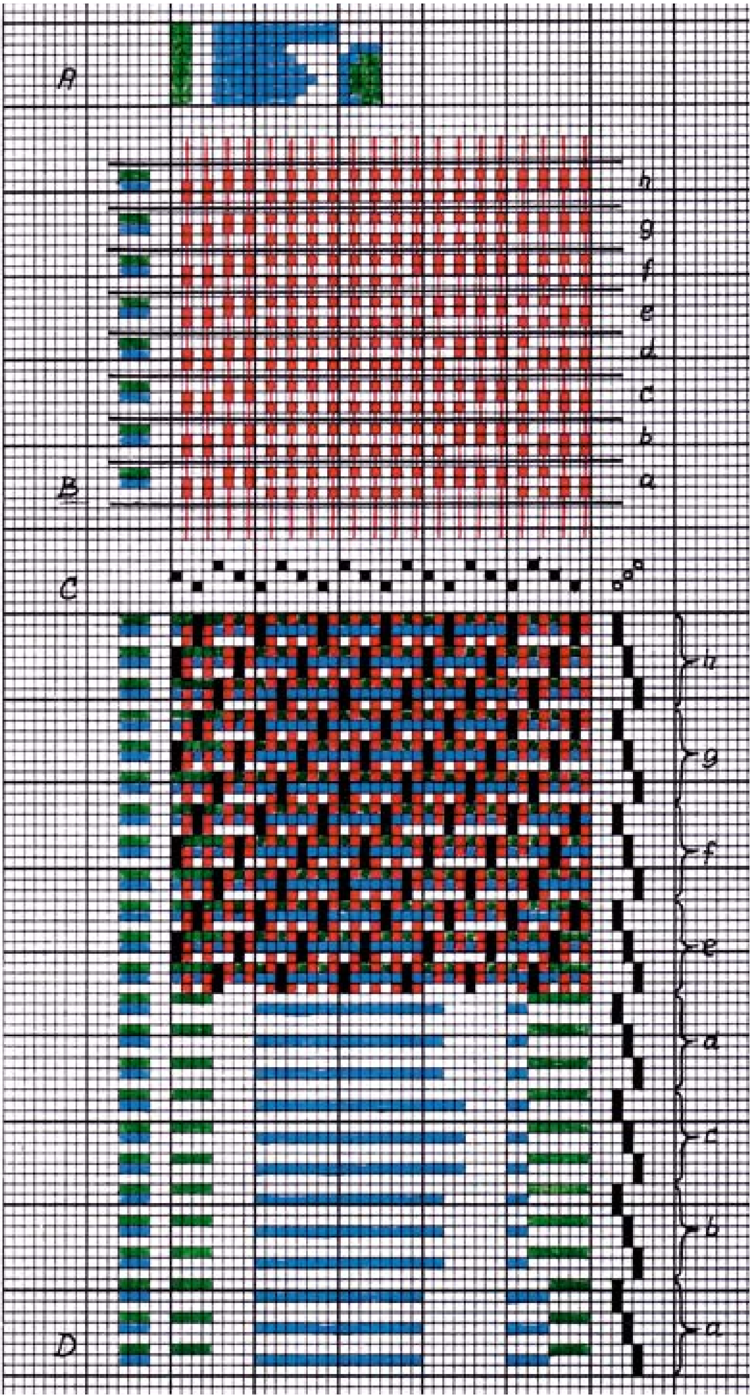
The detail of pattern in Figure 91 is shown face-side up as in Figure 89 A–B. This can be somewhat confusing as the design from the under side comes out laterally reversed; however it is easier to see the details this way.

It has seemed useful to mention the matter of weaving face-up or face-down here, but to avoid too much repetition, detailed description of the lifting for patterns is deferred to Chapter 11.

From the multitude of preserved samitum weaves we have chosen a few examples to show the diversity of the weave; three ancient examples are shown in Figures 92–94. A modern specimen of samitum weave is shown in Figure 95.

A silk from Antinoë

Our first example, Figure 92, a very precious remnant of an early samitum silk from the Antinoë excavations, was 'rediscovered' by Agnes Geijer in the collection of the University Museum for Egyptology, Uppsala, Sweden.


A
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D

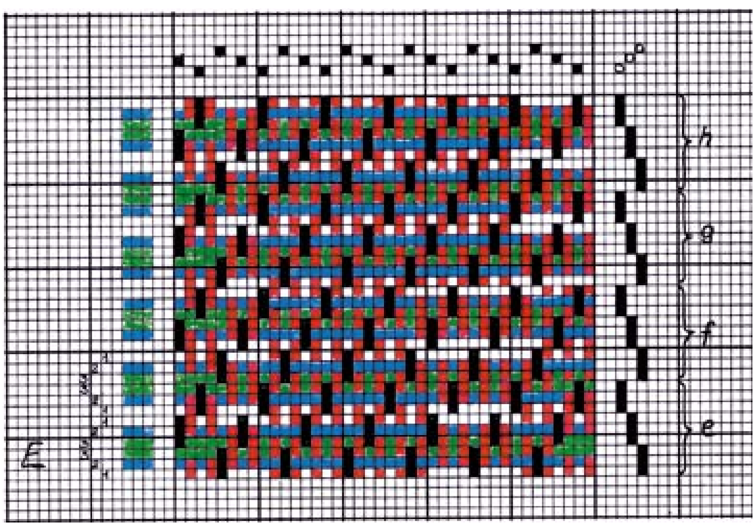
Figure 90 Our replica of an Iranian three-coloured samitum, cf. Figures 88 and 89.

Warp: spun silk Nm 10, one binding-, two main-warp ends, 12 threads per cm.

Weft: spun silk Nm 10, white, blue, and grey, ca. 18 passées (54 wefts) per cm.

← ↓ **Figure 89 A–E** Draft for the three-coloured samitum. The detail used for the draft is shown at A. The lifting of main warp for pattern is shown at B, one vertical column of red squares denoting two main-warp ends. One passée in this case is three wefts. In the draft D three passées are used for each découpure. The draft is shown face-side up.

At E is illustrated the method for reducing the number of pattern lifts.



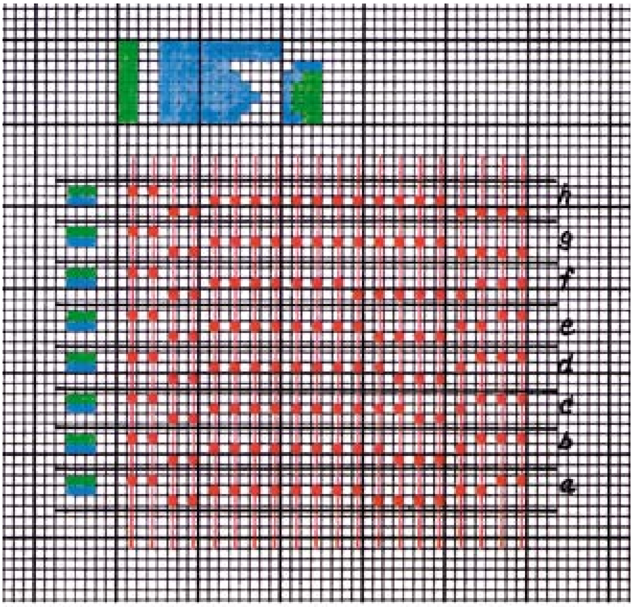


Figure 91 A new lifting plan for the pattern Figure 89 A to the opposite effect (compare Figure 89 B), face side down. Note here that the main-warp ends are lifted only once for each passée.

In her very important article, ‘A Silk from Antinoë and the Sassanian Textile Art’ (1963), Geijer gives a very instructive and clear description of this silk and its relation to other finds from Sassanian Iran. She concludes, partly from the style of the pattern and partly from the fine material and careful execution, that it belongs to early Sassanian Iran. It is cautiously dated to the beginning of the 5th century.

In the photograph it can seen that the face side is badly worn, but the better preserved reverse side shows how the close fine warp enables details and softly rounded outlines to come out clearly.

The pattern unit has 85 single main-warp ends. The widths of the units vary from 3.3 to 3.8 cm; this indicates that the loom had no reed. The pattern units are used in a point repeat: i.e. there is an axis of symmetry in warp direction across which the pattern is ‘turned over’ to produce a mirror image.

The point repeat of a pattern unit is characteristic for the early Iranian silks and is a useful method for enlarging a pattern when the number of harness cords is limited.

A later method to enlarge patterns was the practice of using a doubled or tripled main warp. When this method was driven too far it could

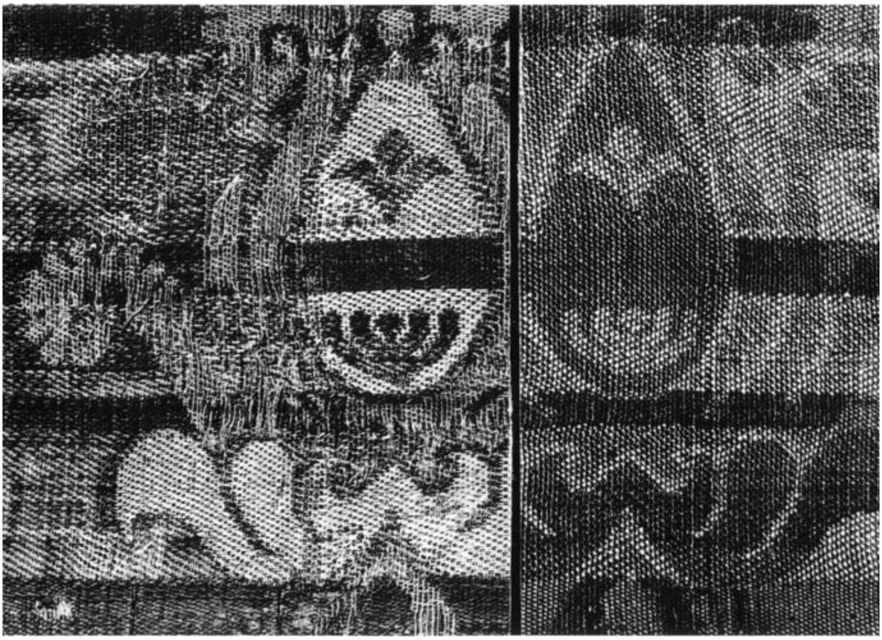


Figure 92 A silk from Antinoë. The University Museum for Egyptology, Uppsala, Sweden.
Warp: fine Z-twisted silk, 25–28 main-warp ends (50–56 threads) per cm.
Weft: silk in five colours, but with only three or four colours used simultaneously. The number of wefts per cm varies between 55 and 82 according to the colours. Photo: ATA, Stockholm.

have a disastrous effect on the figures. The multiplying of main warp led up to what was later called scaling: i.e. visible steps in the outlines of figures.

The Antinoë Pegasus silk

This example, Figure 93, the famous Pegasus silk in Lyon, was also derived from Antinoë excavations. Unfortunately only one pattern unit is preserved from this very beautiful and elegantly designed silk – therefore it is not possible to decide whether the pattern was used symmetrically. The height of the unit is ca. 13 cm, the width nearly the same. The larger number of harness cords needed for this silk indicates a certain development of the loom and places this example to a later date than the Uppsala silk, perhaps the first decades of the 6th century.

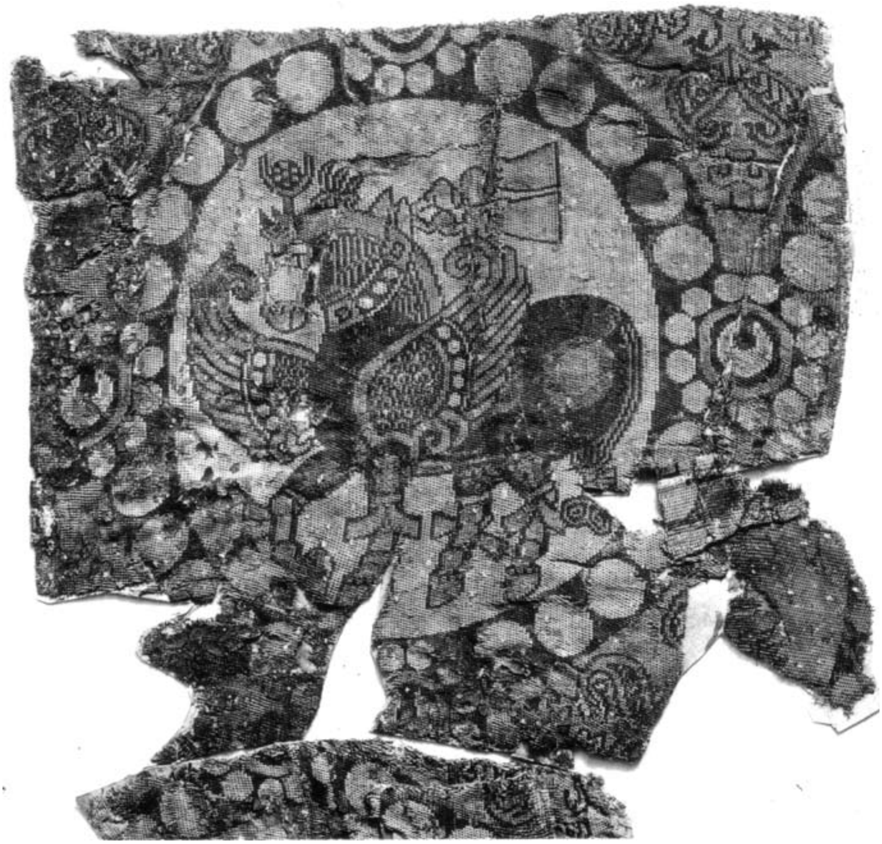


Figure 93 The Antinoë Pegasus silk. Musée Historique des Tissus, Lyon, no. 26.812/II

Warp: fine twisted silk, one binding-, three main-warp ends. 15.5 tripled main-warp ends (62 threads) per cm.

Weft: nearly untwisted silk in three colours: white, dark blue, and red. Découpure: two passées. Ca. 52 passées (156 wefts) per cm. Photo: Musée Historique des Tissus, Lyon.

In this silk the main warp is tripled, but the master weaver apparently was careful not to exaggerate the enlarging method. The design shows no deformation and seems unaffected by technical difficulties (Geijer 1963).

Certainly the little remnant preserved in Lyon is in a bad state; a few fragments, one with a selvedge, are also in existence. Still the colours have retained their clarity and together with the lustrous silk and perfect design give a vivid impression of the original splendour of this marvellous textile.

'St. Knut's Cover'

This precious relic, Figure 94, preserved in the Cathedral of Knut the Pious in Odense was according to tradition presented by his widow, Queen Ethele, in AD 1101 for his shrine together with a little pillow covered with another silk. Queen Ethele was at that time married to Prince Roger of Apulia. Both artifacts are still preserved in Knut's shrine in Odense Cathedral.

Several scholars have described the eagle silk (Burman Becker 1886, von Falke 1913). Agnes Geijer (1935) gives an exhaustive description of both of the silks and a report on its conservation in Stockholm in 1934.

The eagle motif, the Imperial symbol above all from about AD 1000, appears in some very exclusive silks which from inwoven scriptures can

Figure 94 'St. Knut's cover'. Odense Cathedral, Odense, Denmark.

Warp: red-brown Z-twisted silk, one binding-, two main-warp ends, ca. 45 ends per cm.

Weft: loosely twisted silk, rather uneven, in two colours: dark blue nearly black and purplish red.

Pattern unit: width 65 cm, height 82 cm. The preserved cover: width 133 cm, height 110 cm.

Photo: The National Museum, Copenhagen.

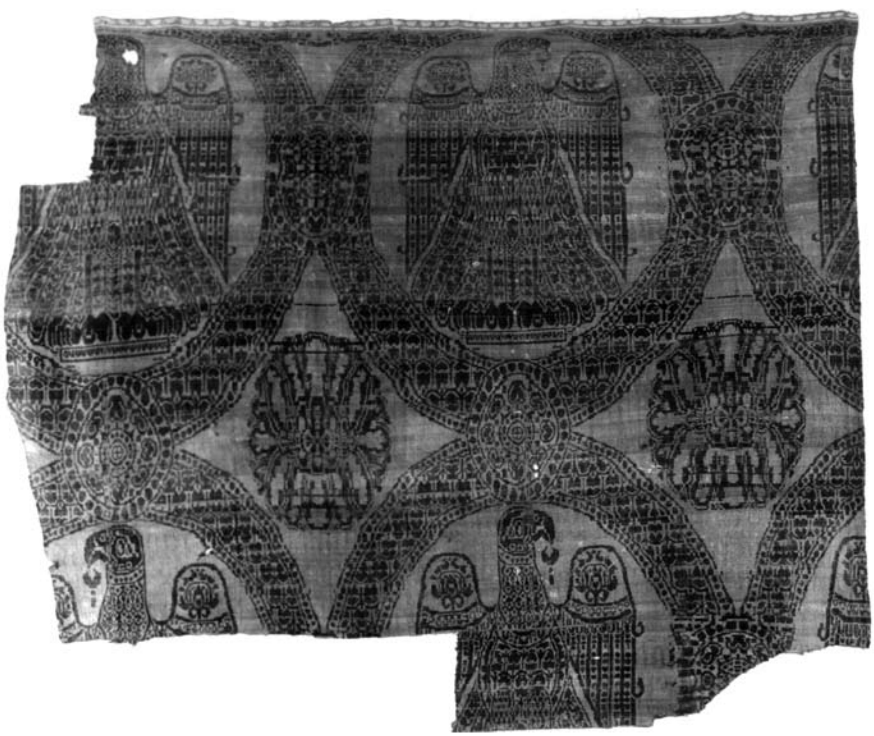


Figure 95 Jette Friis: Two lengths of a wall hanging. Woven with samitum technique, 1980. Warp: unbleached linen 16/2 lea, one binding-, two main-warp ends, 9 threads per cm. Weft: linen thread in white, dark grey, and shades of pale grey. Photo: Ulla Eberth.

be securely stated to be products of the Byzantine Imperial workshops. Compared with the clear and strong designs in these silks our example from Odense appears rather degraded in style; details are loosely drawn. This silk is regarded as a 'provincial imitation'.

Still this silk is an imposing example of silk weaving from the 10th to the 11 th century. The fabric is of a solid and tight quality. The twill direction appears uniformly in S-direction.

From the photograph it can be seen that the center-line of the loom must have been between the two roundels of the left part. At each side of this line the heads of the eagles are turned in opposite directions, and other smaller irregularities also appear laterally reversed on each side of the centerline. The right side of the cover has been cut straight off. Possibly a half roundel or perhaps a whole roundel was originally included within the selvedge. The width of the silk would have been at least 195 cm, possibly 230 cm. Either dimension is imposing for a silk loom of that time (Geijer 1935).

Jette Friis: Two lengths of a wall hanging

This example, Figure 95, is meant to demonstrate the use of the samitum weave in our day. A young student, Jette Friis, in the School of Arts, Crafts, and Design, Copenhagen, made the wall hanging as a project for her final examination.

It was woven on our simplified drawloom, described in detail in Chapter 12. The material used was linen thread in white and grey-black, and some pale grey colours were added. The samitum weave was made with a doubled main warp, the binding warp worked with twill 1/2.

The wall hanging consists of six lengths in all, each measuring: width 50 cm, height 140 cm; only two are shown here. The design was planned as a unique artifact, and no pattern repeat was used. Instead an outline of the design in true size was placed below the warp and harness cords were lifted according to the figures.

The lustrous linen material in this rather rough weave gives a new and remarkable effect to the textile.

Patterned samitum in one colour

Some variations of samitum appear from around AD 1000. Possibly as a reaction to the multi-coloured silks used for centuries a demand arose for patterned silks woven in one colour.

The pattern effect is here derived from the outlines of figures or from the contrast between shining surfaces and more rough and dull grounds. The first group we have called 'incised weaves'; they appear as if they were drawn by means of a scriber on the soft lustrous surface. The other group we have called 'pseudo-damask' because of the damask-like effect with lustrous against dull surfaces.

As an experiment we set up on our drawloom a two-coloured samitum with the main warp doubled. Without any alteration in the monture of the loom and with only one pattern, shown in Figure 96, we wove first a two-coloured samitum, Figure 97 A, then an incised weave, B, and finally a pseudo-damask, C. Two samples of unpatterned samitum were also woven, Figure 97 D and E.

This experiment was mainly inspired by Sigrid Müller-Christensen's work on the tomb of Pope Clemens II in the Cathedral of Bamberg (1960). This important group of monochrome patterned silks is extensively described historically and stylistically, and is illustrated with many examples. It is noteworthy that ecclesiastical vestments from such material preserved in European churches are often traditionally connected with historical princes of the church, which of course helps to give a reasonable date to the textiles. In some cases sentences woven in Cufic script are found hidden in a seam of a vestment. This means that the weave was done in an Islamic region, probably Syria: Antioch or Palmyra. Apparently such silks were woven in Syria to order from Byzantium and sent from there to churches and courts in Europe.

Without doubt these elegant subtle silks in one colour were in demand for the most exclusive use of their time. Also some of the marvellously decorated copes were embroidered on this material (e.g. the Reitermantel and the Kunigundemantel in the Cathedral of Bamberg, Müller-Christensen 1955).

Generally the monochrome patterned silks were expertly woven in a tight and solid quality. Warp threads are Z-spun with a thread count of 14–18 binding-warp ends per cm. The main warp is doubled. The soft lustrous weft is nearly unspun. The weft is solidly beaten in with a weft count of 90–120 per cm.

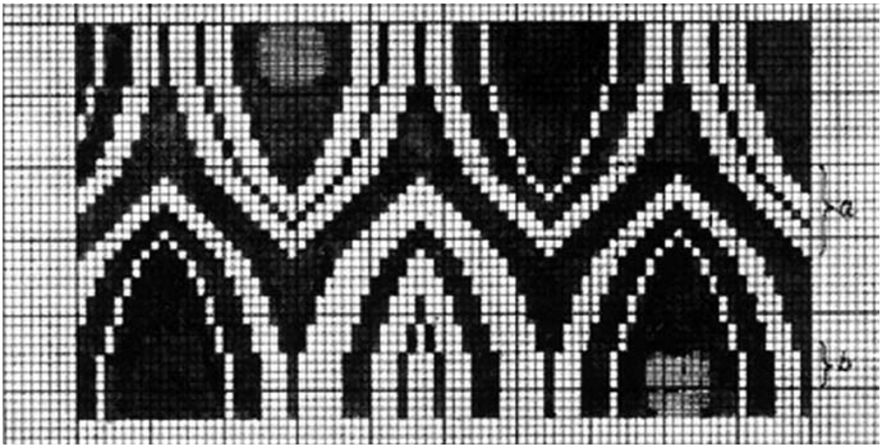
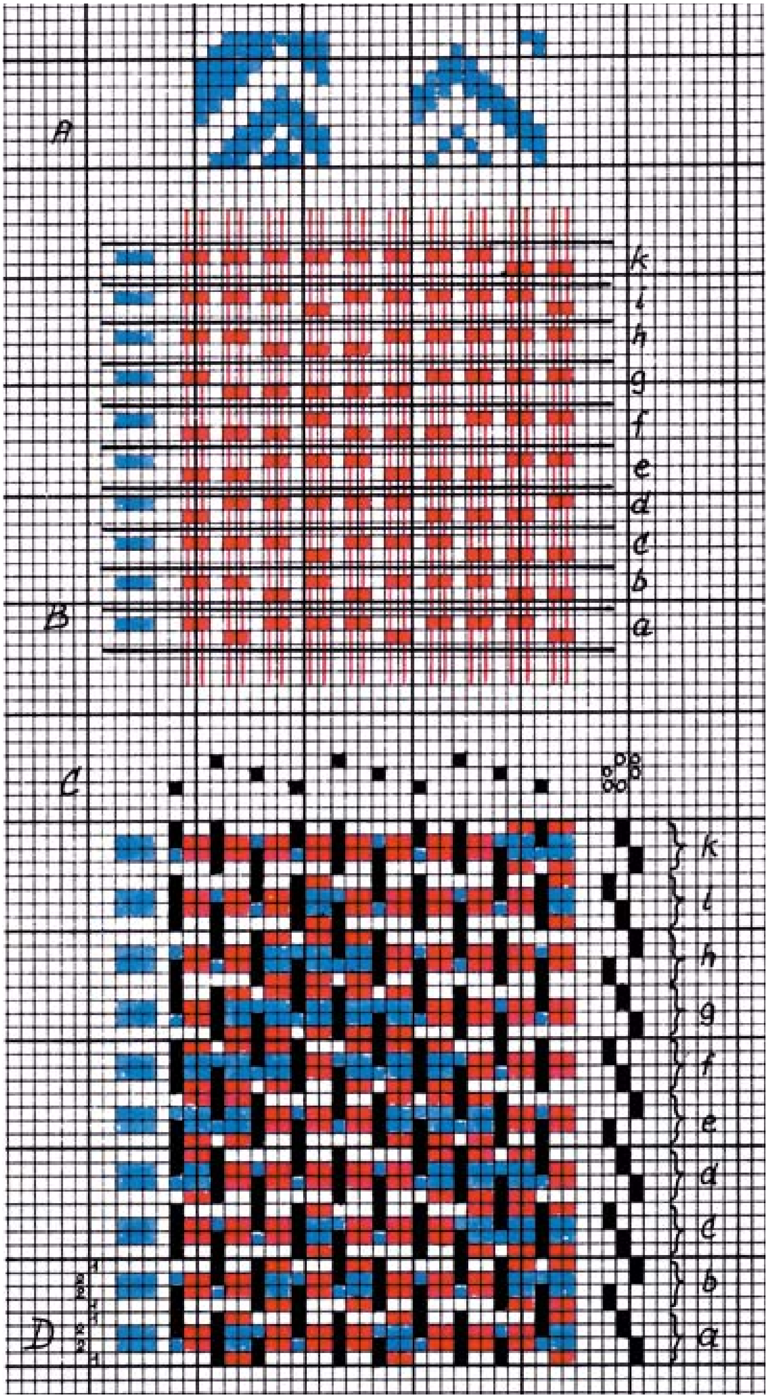


Figure 96 The pattern used for the experiment with three weaves, Figure 97, for incised weave, Figure 100, and for pseudo-damask, Figure 101. The part marked a is shown in the detailed draft, Figure 98. The part marked b is used for the draft on brocading, Figure 99.

Figure 97 Our sample with three variations of samitum (A, B, C) woven in succession on our drawloom with the same warp, pattern, and setup. Two types of non-patterned samitum (D, E) are also woven with the same implement.

Warp: spun silk Nm 10, one binding-, two main-warp ends, 12 threads per cm. Weft: organzine silk Nm 12.5 A: two-coloured samitum. B: incised weave. C: pseudo-damask. D: one-coloured samitum without pattern. E: reversible samitum without pattern, each side of a different colour.


A
B
k
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a

The incised weaves

This weave is in principle a two-coloured samitum but only one colour (one weft) is used for both in each passée. When the weft changes from face to reverse side and the next weft comes up, a tiny aperture appears. These repeated apertures come out as lines incised in the lustrous surface.

Obviously straight lines in weft direction do not appear with this technique. It is interesting to study the different patterns illustrated by Müller-Christensen (1960). Pointed ovals are often used as motif (e.g. Figure 70: the Willigis chasuble). When larger roundels are the motif (see Figures 23–24: the red silk from the Pope's cope) the little pattern of stylized leaves decorating the roundels had to substitute for the outlines of the upper and lower form of the large roundel.

As mentioned above the samitum weave is characterized by its even surface of weft twill, and the colours give the pattern effect. When only one colour (very often white or a pale colour) is used, only the outline of the pattern is visible; this gives a refined simplicity to the textile.

The design shown in Figure 96 was intentionally drawn with some resemblance to the typical incised weaves and was therefore used again for this replica.

The draft, Figure 98, is shown reverse-side up, A is a detail of the pattern used for the draft. At the left it is shown from the face side, at the right it is turned over to the reverse side.

At B is shown the lifting plan for the detail of the pattern. Main warp is shown doubled. Binding warp (black) is entered into three shafts, C; D is the detailed draft. Four passées are used in our sample for each découpure, but only two passées are shown in the draft. The shedding order is 1–2–2–1, as discussed above, in order to reduce the number of pattern lifts.

In this sample we have used an extra effect of small dots brocaded with gold thread. In Figure 99 a fraction of the brocading is drawn in detailed draft to show that it is necessary to have the reverse side up when brocading is done. A detail from the pattern is shown at A, the face side at the left, the reverse side at the right. The latter is used for the draft. At B

← **Figure 98** The draft for the incised weave shown reverse-side up. At A is shown the detail of pattern: at the left face side up, at the right turned over to the reverse side. This is used for the lifting plan at B. In the detailed draft D only two passées are shown; four were used in our sample. Note that the shedding order is 1–2–2–1.

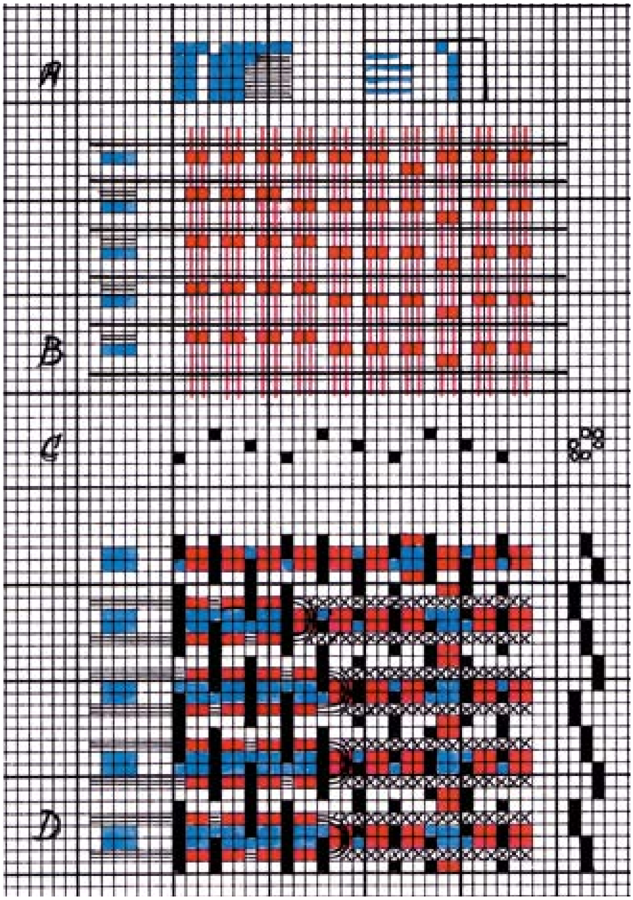


Figure 99 An example of brocading. The brocading thread is denoted by a black double line. In order to show the course of the brocading thread in the draft D for only a detail of pattern the empty white squares are crossed out to avoid any mistake.

is shown the lifting plan; here the brocading gold thread is denoted by a black double line.

Brocading means the use of an extra weft working to and fro over a limited detail; for each weft it turns back along the outline of the detailed figure. It is clear that the turning round of the brocading thread must not be visible on the face side, therefore it must always be made from the reverse side. Note that both weft 1 and weft 2 are on the reverse side when

→ **Figure 100** The incised weave woven according to the draft in Figure 98. Small roundels brocaded with gold thread can also be seen.

Warp: spun silk Nm 10, one binding-, two main-warp ends, 12 threads per cm.

Weft: organzine silk Nm 12.5, 16 passées (32 wefts) per cm.

the brocading thread is on the face side. To avoid any mistake we have crossed out the empty white squares along the brocading threads.

Our woven replica is shown in Figure 100.

Pseudo-damask

The other method for weaving monochrome patterned silks is the 'pseudo-damask'. The yellow silk from the pontifical stockings of Pope Clemens 11, who died 1047 (Müller-Christensen 1955) was our first impression of a pseudo-damask, at that time technically rather vaguely described. In the course of our experiments with Byzantine silk weaving, some patterns executed in various techniques appeared to be nearly identical. In this case our concern was the yellow silk from the Pope's stockings. When the book on Pope Clemens II (Müller-Christensen 1960) appeared it became evident that the weaving of this yellow silk was very closely connected with the weaving of samitum. Therefore we made the experiment shown above in Figure 97.

CIETA refers to the weave as 'lampas' (Vial 1963, Schmedding 1978), but this term is used for so many different weaves. We prefer to call it 'pseudo-damask' in order to have a term for this special weave. Perhaps it would be still better to 'invent' a new word; it is always disconcerting to use words with a distinct designation for another special technique. But for the moment we will, following Agnes Geijer, stick to the term 'pseudo-damask'.

Müller-Christensen (1960, p. 70) also suggests the term 'pseudo-damask' as more correct than 'pseudo-diasper' (diasper is now called lampas). Diasper did not appear before the 12th century.

Flanagan (1956, p. 498) outlines a technical development of patterned weaves in one colour based on plain tabby decorated with pattern wefts. This line of development is the theme for our next chapter. It is a mistake to place the pseudo-damask weave in this context. But Flanagan gives in a footnote a perfectly correct description of the technique.

He writes:

> . . . These silks were woven on the same loom as the silks in the early Byzantine figured-twill weave but without the usual background weft. Like many other silks woven at about the same time the weft is in one colour only. Before every three design picks a first tabby pick was made

> with the whole of the figure-harness warp lifted. A second tabby pick was made, with the whole of the binder warp lifted. One or two design picks separate the two tabby picks. This produced a background effect resembling tabby, but not a true tabby as the normal figured-twill shed was used for design picks. (Flanagan 1956, p. 498, fn. 2).

We would rather say that the 'tabby ground' is secondary and not the basis for a development. Pseudo-damask is clearly derived from a weft-faced compound twill (samitum).

The effect of pseudo-damask, not unlike the true damask, derives from the contrast between the lustrous twill pattern and the more dull 'tabby ground'. The longer weft floats of the twill give a faint relief to the pattern. The twill pattern simply consists of one of the wefts from the normal samitum with two wefts. The tabby weave is worked with the entire warp; alternately the whole of the binding warp or the whole of the main warp is lifted. At first we supposed that the tabby weft and the pattern weft alternated. Later analyses taught us that the shedding order is:

1 tabby weft

2 pattern wefts

1 tabby weft

1 pattern weft.

Certainly this is a very efficient combination of the two binding units: tabby two and twill three. One découpure is five wefts.

For our experiment, shown in Figure 97 C, the same warp and set-up was used as shown in the draft, Figure 98. Thedetailed draft for pseudo-damask is shown in Figure 101. In order to show the weave more clearly the lifts for tabby are shown with black points for lifted binding warp and with red points for lifted main warp. Weft 1, marked white, here denotes the tabby weft. For the pattern wefts (blue) the lifting plan Figure 98 B is still of use, but only the lifts for weft 2 (blue) are utilized (see blue points at the right). The three treadles for twill are pressed down simultaneously (shown by three black points). For the opposite tabby shed every main-warp end is lifted. In our simplified drawloom a rod is used to raise the harness cords for a row of pattern (this is described in detail in Chapter 12). In order not to disturb this pattern lift we used another rod to raise all of the harness cords together. Certainly the drawboy would be able to do this too. It is important to note that this lift does not need to interfere with the current lift for pattern. The already lifted groups of main warp

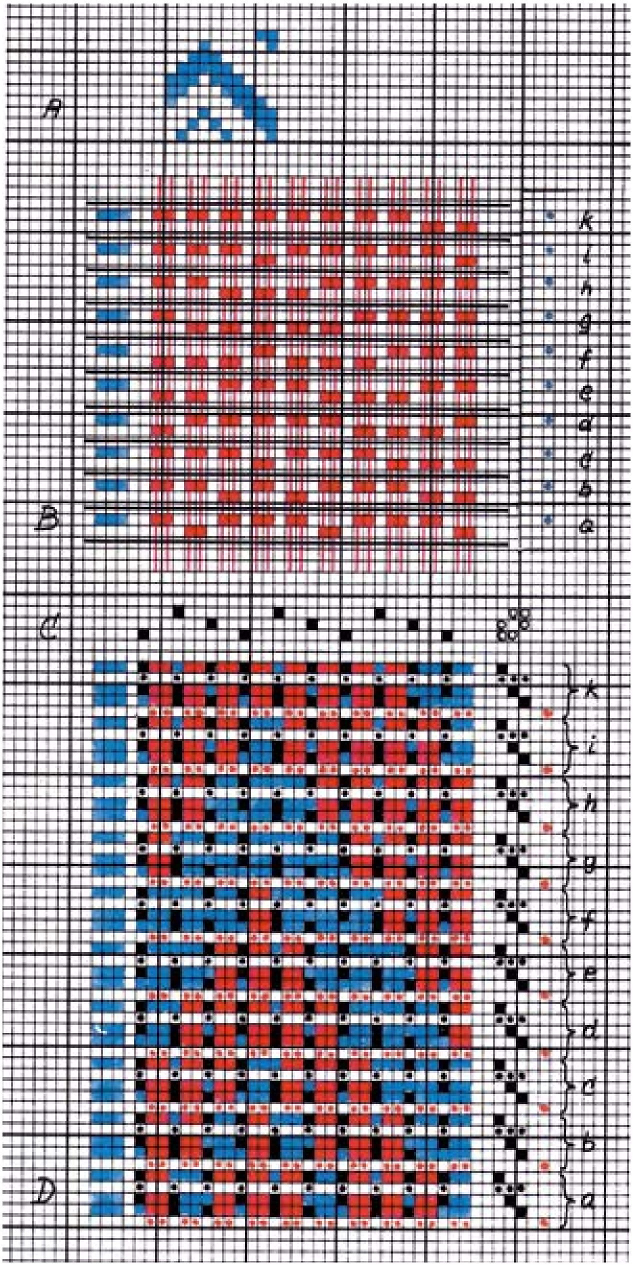


Figure 101 The draft for pseudo-damask is shown at D. Compare the draft in Figure 98; the same setup of the loom is used for both. Note in the lifting plan marked B that only lifts for weft 2 (blue) are used here (blue points at the right). In the detailed draft D white squares in this case denote the tabby wefts. For better clarity binding warp (black) and main warp (red) are shown by points when lifted for tabby. At the right side among the treadles, three black points mean three treadles pressed down simultaneously. Red points here show where the whole of the main warp is lifted. Each découpure comprises three pattern wefts and two tabby wefts (five wefts). The woven replica is shown in Figure 102.

→ **Figure 102** Our woven replica of a pseudo-damask.

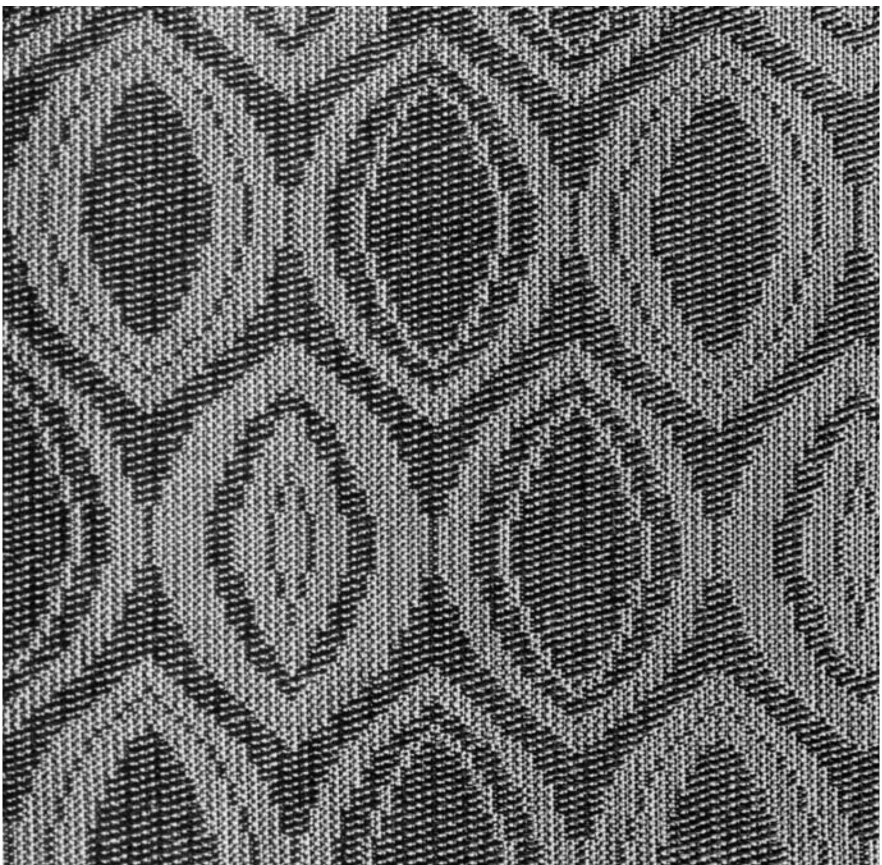
Warp: spun silk Nm 10, one binding and two main-warp ends, 12 threads per cm.

Weft: organzine silk Nm 12.5, four découpures (20 wefts) per cm. Photo: Ulla Eberth.

for the next pattern weft stay undisturbed in place when the rest of the main warp is let down again. When binding warp is lifted for tabby the current pattern lift must be let down; but it is easily lifted again without any change of pattern when the tabby weft has been woven. This means that one découpure can be woven without any change of pattern lift and consequently the weaving of pseudo-damask can be done in an easier and faster way than the weaving of samitum.

Our woven replica of a pseudo-damask is shown in Figure 102.

One-coloured samitum entirely without pattern is frequently found among preserved ecclesiastical vestments. It was usually used as a ground material for embroidery, but in some cases it was used directly without embroidery. Presumably the lustrous satin weaves were not known at that time.



Several types of this plain silk weave have been observed. Simultaneously with our experiment with different sorts of samitum in the same loom, see Figure 97, two types of non-patterned samitum were also woven. Thus these two sorts could be woven on a loom set up for patterned samitum. Of course such a loom was not necessary for the weaving of one-coloured silks but we presume this type of weave to have emerged while a patterned samitum was woven. Presumably also for very exclusive vestments of patterned samitum a piece of non-patterned silk in the same quality and in corresponding colour was sometimes in demand.

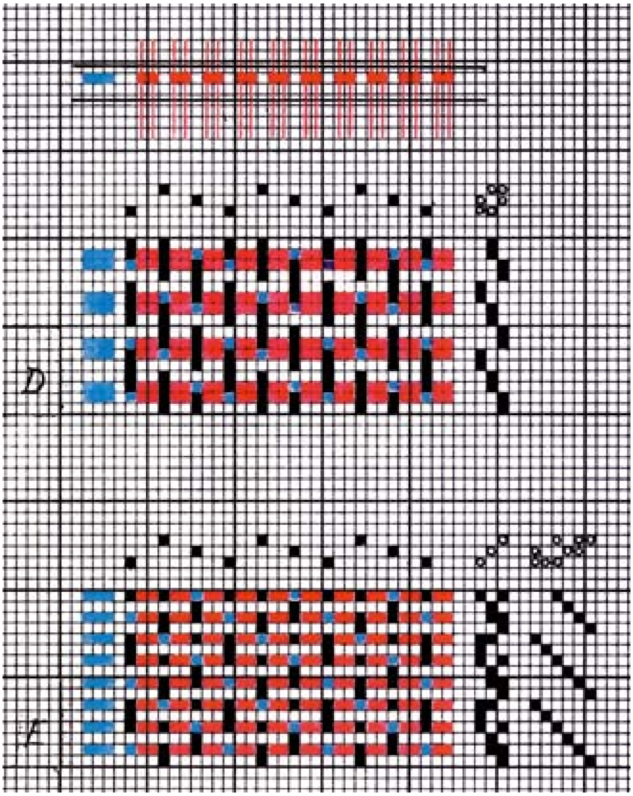
The type marked D in Figure 97 is a normal samitum in one colour without pattern and in common with this it has a face side and a distinct reverse side. Weft 1 (white) appears on the face side and weft 2 (blue), presumably of the same yarn and colour, is on the reverse side. In the draft fiigure 103 D the reverse side is shown upward. For weft 1 the main warp is let down, and for weft 2 the whole of the main warp is lifted.

The other type, Figure 97 E, is truly reversible and was very often woven with two colours: each side a different colour. The draft Figure 103 E illustrates the reversible weave. Weft 1 constitutes the colour of the upper face side and weft 2 appears as the other face side. For this weave it is necessary to alter the twill tie-up. For weft 1 (main warp down) only one shaft is lifted, while for weft 2 (main warp lifted) two shafts must be lifted. The alternate use of one treadle for weft 1 and two treadles for weft 2 is shown at the right of the draft, E. This method is easier in practice than in description; the shedding order is quickly learnt by heart. Another method is suggested at b: six treadles can be tied up as shown here; then the twill 1/2 changes alternately from face to reverse side.

Other basic weaves than twill 1/2 were used for samitum in later times. Twill 1/3 and also satin weaves can be seen in later examples (see for example Müller-Christensen 1960, p. 59 or Vial 1970, EO.1193/L, pp. 57–62). The principle of weaving samitum is still the same; the important factor is that the binding used must have a distinct weft effect.

Certainly when samitum was so widely used for several centuries the weaving methods varied between different weaving centres. For instance variations have been noted in the tie-up and use of the twill shafts. For our experiments described above we have used lifting shafts throughout. This means that the twill shafts when at rest are adjusted so that the heddle eyes are in the lower shed face, at the same height as the main warp when

Figure 103 The drafts for two types of non-patterned samitum. Both were woven on a drawloom set up for samitum. Letters D and E refer to the woven samples in Figure 97 D and E.



no pattern lift has taken place. When weaving is done reverse-side up, each treadle lifts two shafts for each passée.

In two analyses of samitum silks depression shafts are suggested: Guicherd 1958 on the silk with griffins from Monastier sur Gazeilles, and Vial 1961 on the elephant silk from Aix-la-Chapelle. This method means that twill shafts when at rest were adjusted to the upper shed face. Again, when weaving was done reverse-side up, each treadle depressed only one shaft for each passée.

It is important here to note that binding-warp ends are not entered into harness leashes, which are weighted down by their lingoes. Therefore binding shafts by their own weight, or if necessary supplied with extra weights, must be adjusted either to the lower shed face or to the upper shed face. To retain this adjustment effectively, the binding-warp ends are entered into the eyes of the heddles. Presumably this means that the warp ends were entered into both loops of the clasped heddles. Heddles with

Figure 104 Part of an altar frontal woven with samitum technique on a shaft loom. Warp direction i's shown horizontally.

Warp: unbleached linen 16/2 lea, one binding-, one main-warp end, 6 threads per cm.

Weft: white worsted wool Nm 20/2, bleached and unbleached linen 16/2 lea, and gold thread. Ca. 18 wefts per cm.

knotted eyes have never been used for tight silk warps where knots will always be disastrous. This method of entering is denoted in our drafts by filled squares (black).

We find it useful to mention this fact here in order to give a clearer illustration of the tie-up of binding shafts. More details will be discussed in Chapter 11.

A third method is described by Vial (1970, pp. 57–62). Here the binding-warp ends are entered also into the harness leashes. Lifting heddles on three shafts and depression heddles on three other shafts are employed for the twill weave. This will be shown in a practical experiment in the Chapter 10 on the silk weaves of Tang China.

For our narrow and rough samples of samitum only one warp beam was used for both binding and main warp. For a more sophisticated production of samitum the use of two beams was necessary. The main warp does not participate in the binding and accordingly goes straight throughout the material; there is no noticeable 'take up' of this warp. On the other hand the binding warp goes under and over groups of weft according to the binding used; therefore the binding warp needs a longer length of yarn. Furthermore it is important for the appearance of the product to be able to control the tightening of the two warps individually. For instance a strongly tightened binding warp gives a faint relief to the twill weft and the surface appears more soft and rich.

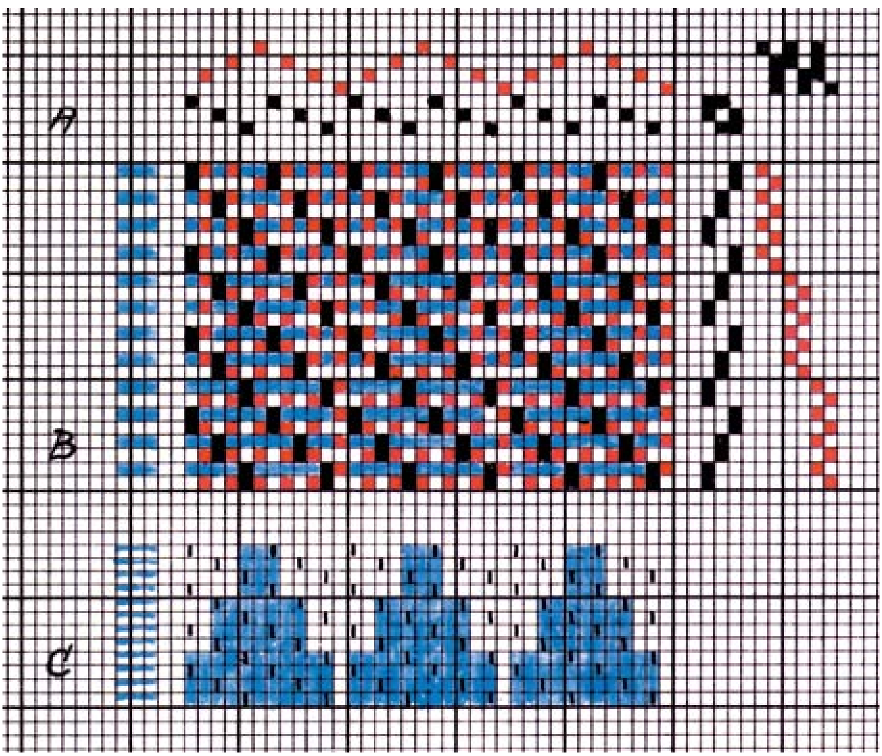
Imperial workshops in Byzantium and certainly also weaving centres in nearby countries, Persia, Syria, etc., must have enlisted unlimited hosts of experienced and skilled weavers. Large numbers of marvellously executed silks are preserved, mostly in European churches. Still this can be only a fraction of what was originally produced. In the centuries around AD 1000 pattern units were developed to a width of 70–80 cm, and silks are frequently extant in their original loom width, some up to 260 cm (Müller-Christensen 1960, p. 37). Certainly looms and other accessories were in no way primitive in these manufactories; still the quality of the products was absolutely dependent on the weaver's individual competence.

Other materials than silk were also used for samitum weave. From a later date and from different weaving centres (Venice and Spain) are preserved the so-called 'half-silks'. For main warp in the half-silks linen or hemp yarn was used as a cheaper substitute for the expensive silk material. This rough material naturally enlarged the design. In some cases designs were more or less debased, but well-woven samples of this kind are also found. Some examples of half-silks from Las Huelgas, Burgos, are shown by Gomez-Móreno (1946). Samitum weaves made from silk combined with fine woollen yarn and also cotton with wool have been found.

In Chapters 6 and 9 we have discussed block patterning, which was often used for simple geometric patterns in weft-faced compound tabby. We know of no ancient textiles woven in samitum with block patterning; still we have found such a procedure very useful for certain purposes. When a drawloom is not available it is possible on a shaft loom to weave samitum in many variations. As an example part of an altar frontal is shown in Figure 104. The material is unbleached linen and white worsted wool. Some gold thread is added to enhance the effect.

Our draft for this weave is shown in Figure 105, face side up. Three shafts, marked black, are entered with the binding warp and tied up to three treadles in an isolated group for the twill binding. The pattern has four blocks in warp direction entered in point repeat into four shafts, marked red. For a larger pattern two or more threads can be entered into the pattern shafts, still alternating with one binding-warp end in the shafts ahead.

Figure 105 Our draft for the samitum woven on a shaft loom. At A main-warp ends (red) are entered in point repeat into four pattern shafts, one for each block. Binding warp (black) is entered into three shafts for twill weave. For an ordinary shaft loom, without any drawing of pattern, the tie-up is shown by black squares (depression shafts) and empty squares (lifting shafts). Four passées are shown for each block or découpure.



In the weft direction each block needs two treadles, one for each of the two wefts. Here only three blocks are used (six treadles); nevertheless the possibilities for variation are nearly unlimited. Wefts of varied material and colour can be used, and it is also possible to change the order of wefts from one block to another, etc. For a rather low form each block is utilized for only a few wefts, and for a higher form each block can be used for several wefts. The binding treadles must be used consistently: one binding treadle is kept down simultaneously first with one pattern treadle, then with the other. This method of tying up binding treadles in one group and pattern treadles in another group gives many possibilities for variation on a loom with a limited number of shafts. With some practice it is not difficult to weave with two treadles at the same time.

PART III

Patterned Weaves of the Mediterranean Region

A

B

C

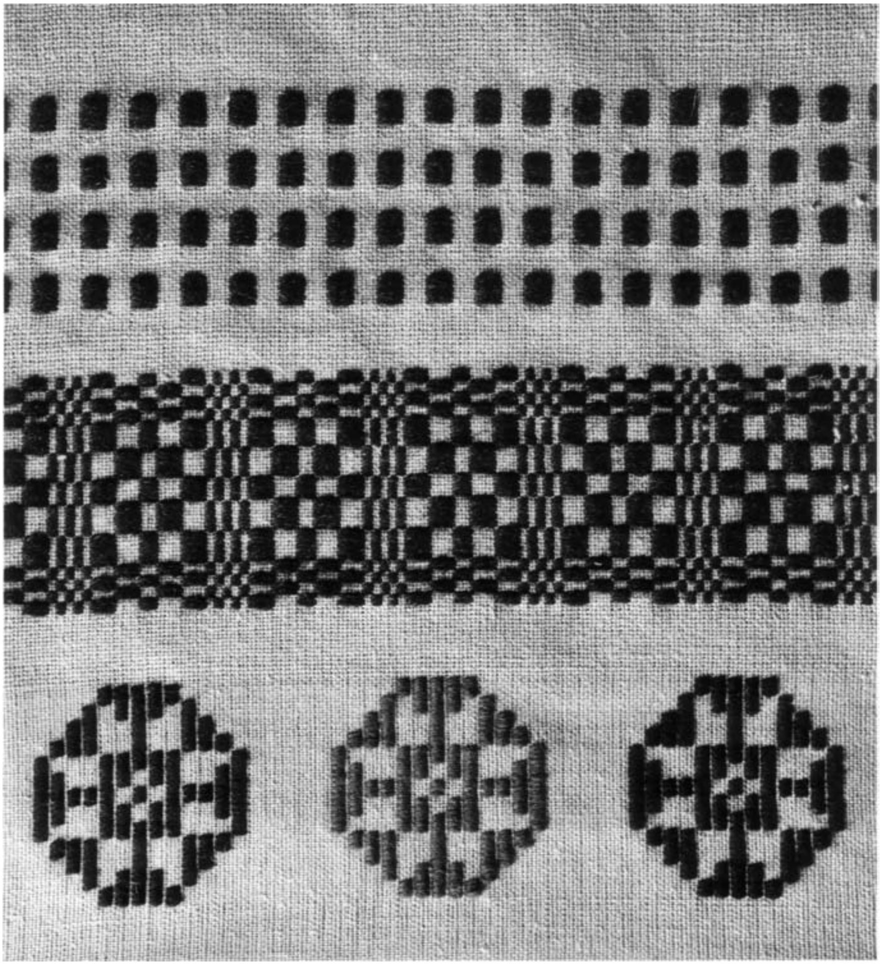


Figure 106 This sample was woven on a normal shaft loom to show the three types of weave: A 'à la planche', B monk's belt, C Egyptian 'inlaid design'.

Warp: linen 16/2 lea, 8 ends per cm.

Weft: A–B ground weft: linen 16/2 lea, 10 per cm; pattern weft: 2-ply wool. C ground weft: linen 16 lea, 12 per cm; pattern weft: doubled wool, 6 per cm.

In the following drafts, Figures 107–109, are shown the characteristic methods for each.

Chapter 6
Lampas

Tabby decorated with pattern wefts

This chapter outlines another line of technical development. Once again we shall consider patterned weaves from the first centuries of our era in Western Asia and the countries near the Mediterranean. The first development of patterned weaves (apart from tapestry) certainly started with plain tabby decorated by means of a single pattern weft. One sample is shown here, Figure 106 A. On a linen tabby ground rows of small squares are woven with a dark woollen yarn. The draft, Figure 107, illustrates the simple one-block pattern. Behind the lifting shafts for tabby a shed rod is taken alternately below and above six warp threads. Between tabby wefts the shed rod is raised on edge and the wool weft is thrown in. Burnham (1972) calls this type of patterning *à la planche.* It is seen occasionally in folk weaving in various parts of the world.

An example of a two-block patterning is shown in Figure 106 B. This type is still used in Scandinavian home craft and is here called 'monk's belt'. It is generally woven with four shafts and four treadles. The draft in Figure 108 illustrates the method used in Scandinavia.

A more specialized technique is shown in Figure 106 C. Examples of this weave have been found in great numbers in excavations in Egypt; they are generally dated 5th–6th century. Kendrick (1921, p. 76, pl. XXVII) shows some fine examples of this type of weave; he calls them 'inlaid designs'. They are found as trimmings on tunics, sometimes in connection with tapestry-woven panels or roundels on the same garment. Generally the woollen pattern is 'brocaded', i.e. the yarn for pattern is worked only within the outlines of each figure; the pattern wefts are not woven in from selvedge to selvedge. But examples are also found in which pattern weft is used over the entire width.

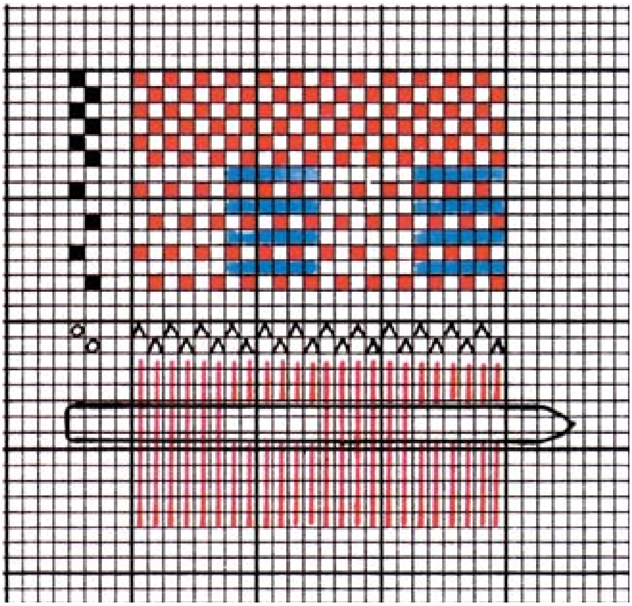


Figure 107 The draft for a one-block pattern. Behind the lifting shafts for tabby a shed rod is shown, alternately below and above six warp ends, ready to lift for the pattern weft.

The striped effect in warp direction is characteristic for this technique. In the Egyptian examples the wool weft is generally bound by every fourth warp thread.

Because the patterning method appears in connection with tapestry weave we presume that the vertical loom used by Egyptian weavers for

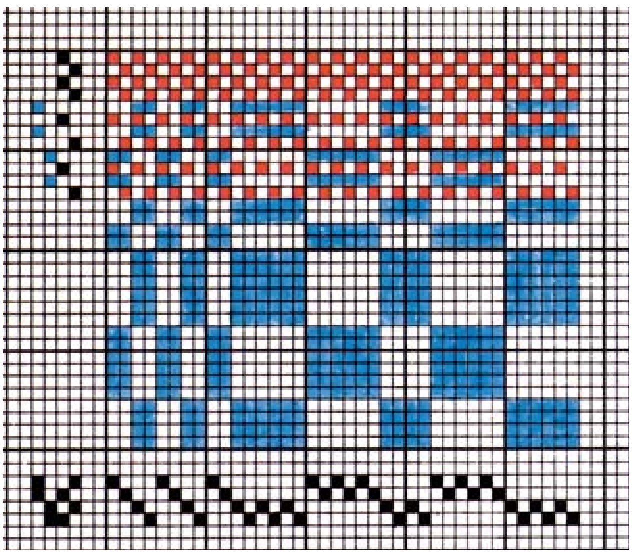


Figure 108 The draft illustrates how monk's belt is usually woven in Scandinavia on a loom with four shafts and four treadles. In the tie-up black squares mean depression shafts and empty squares mean lifted shafts. Ground weave (marked red) is shown only in the lower part.

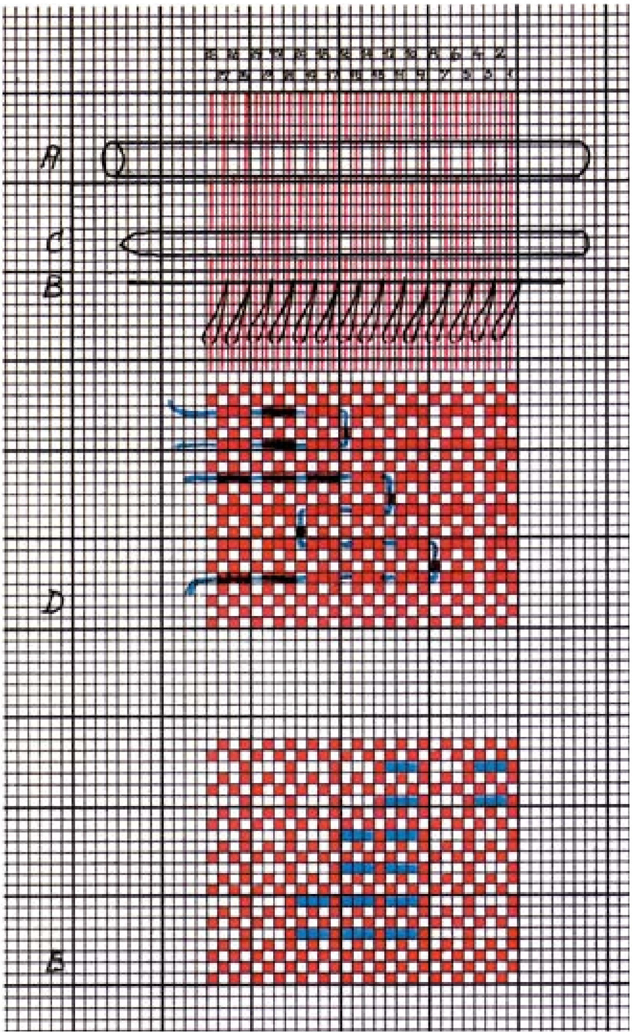


Figure 109 The method suggested for weaving the Egyptian 'inlaid design' on a vertical loom.

At A is shown the natural shed, at B the heddle rod for countershed. For the pattern shed, with three threads up and one down, an extra rod C is used. At D the 'inlaid design', marked blue, is shown from the reverse side; the face side can be seen at E.

the weaving of tunics was also used for this weave. The draft of Figure 109 shows the shedding method. A fixed shed rod A divides the warp into two layers – odd-numbered threads above, even-numbered below – for one tabby shed, the natural shed. For the countershed a heddle rod B is used. To obtain the shed for the brocaded pattern another rod, marked C, is taken into the lower layer of warp ends alternately over and under one end. When this rod is raised on edge the threads come up in groups of three and every fourth thread (the binding thread) stays down. The weaving would be done from the reverse side: see the blue 'inlaid design' in Figure

109 D. At E the face side is shown; the characteristic striped effect appears here. Note that two tabby wefts are always thrown in between successive pattern wefts in order to have the same thread ready for binding the pattern weft. This rule is important when both warp and weft are visible in the tabby ground. When a more open warp is used and the weft is tightly beaten in as a weft-faced rep the number of ground wefts between successive pattern wefts is adjusted to the proportion of the pattern.

In Scandinavia this type of pattern weave is called *dukagång.* From south-eastern Sweden some beautiful hangings are preserved; the rich patterns are generally woven with a dark blue wool on a white linen ground. Examples are also found from Finland, Norway, and the British Isles (Geijer 1979, pl. 88 a and 85 a).

The 'Durham' silks

Flanagan (1965, p. 497) gives a very interesting outline of what he calls 'the tissued taffetas', by which he means tabby decorated with pattern wefts. Apart from his treatment of the pseudo-damask, discussed above (Chapter 5), Flanagan's outline shows convincingly the development from Egyptian 'inlaid design' to the fully developed lampas weaves.

The next step after the Egyptian technique is here illustrated by two silks preserved in Durham Cathedral. The characteristic impression of these silks is the lengthwise striped effect of the pattern against a plain tabby ground. The same effect appears in some smaller pieces of silk preserved in Switzerland described by Schmedding (1978, no. 62, 63, 64, 135). In most cases the pattern weft is bound by every sixth warp thread; in a piece from St. Maurice (no. 135) by every fourth. The material in this group of weaves is entirely silk, generally of the same colour throughout.

This group of patterned silks is perhaps of little importance; but it demonstrates a step in the development of patterned weaves based on tabby.*

In these samples the pattern wefts are always thrown in from selvedge to selvedge. It is characteristic for this technique that the pattern weft, when it does not function for pattern, goes into the tabby shed together with the previous tabby weft.

* Flanagan (1956, pp. 503–504) dates these silks to the 7th century. Schmedding (1978, pp. 68–70 and pp. 166–168) dates them to 8th–9th century. The later date seems to be the most probable.

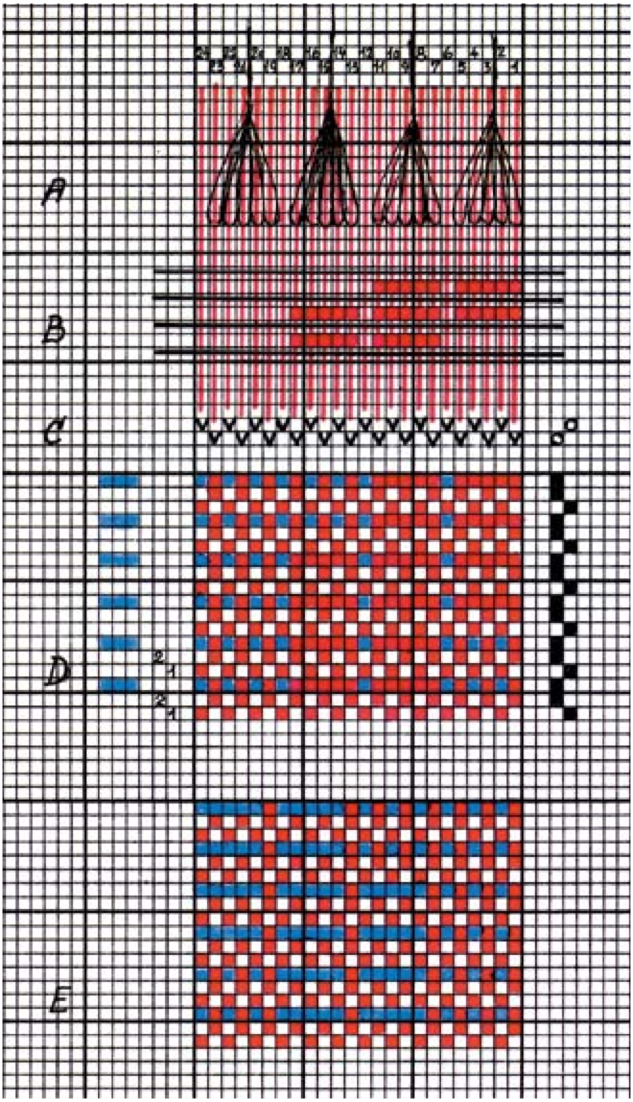
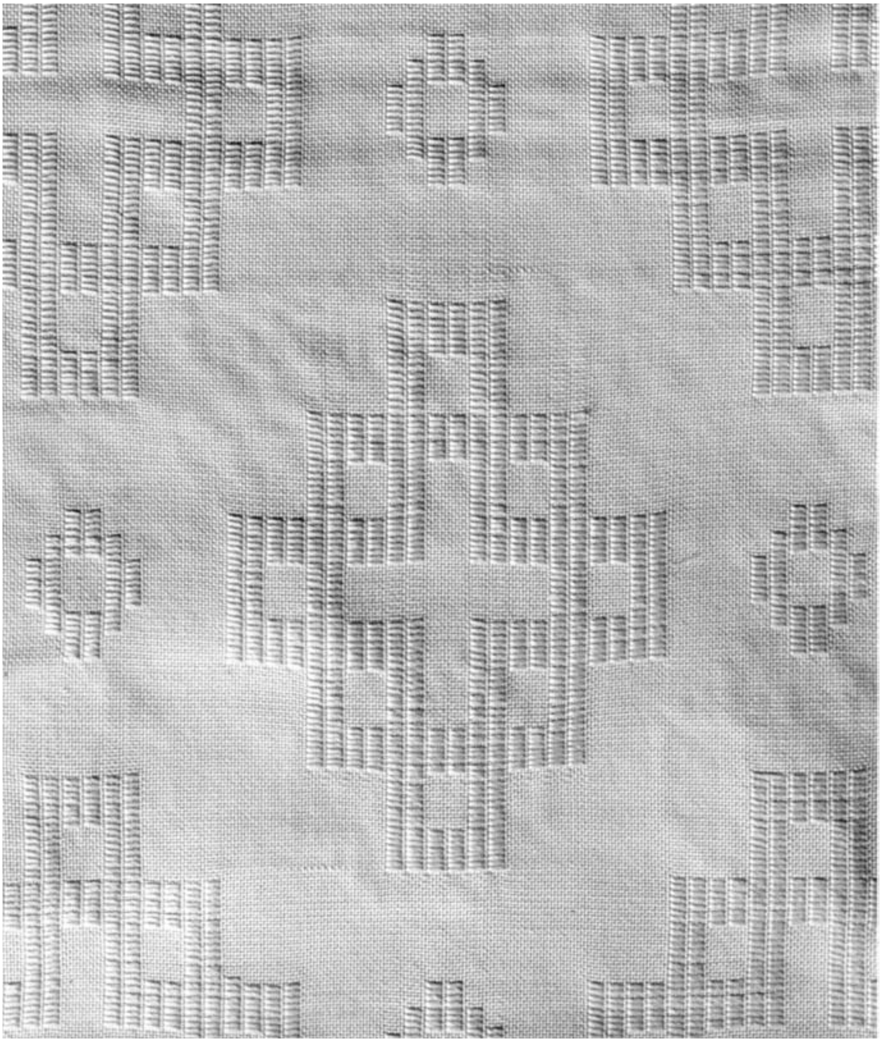


Figure 110 Our method for weaving the 'Durham silks'. At A are shown the harness cords, each of which lifts groups of five warp ends and leaves down every sixth. B is the lifting plan for the little fragment of pattern. The warp is entered into two shafts with lifting heddles, marked v.v. For pattern weft, marked blue, groups of five ends are lifted according to pattern simultaneously with tabby shed 2, shown at D from reverse side. At E the draft is turned over to show the face side where the striped effect appears.

Thus alternating wefts are doubled in the tabby ground. See the draft, Figure 110 D: the lower weft 1 (even-numbered warp ends lifted) is a single weft. The opposite tabby shed (odd-numbered warp ends lifted) has first a tabby weft 2; then the pattern weft (marked blue) goes in under groups of five warp ends for pattern, and when no pattern is needed it uses the same tabby shed. In spite of this the tabby ground generally appears rather even thanks to the great compressibility of silk yarn. In the Durham silks the same silk yarn is used throughout. In the sample from St. Maurice a very thin silk thread is used for tabby weft 2 in order to adjust the tabby weave. In another example (Schmedding's no. 63) the pattern weft is doubled.

It is noteworthy that silks in this group are in general not expertly woven. Flanagan (1956, p. 500) notes that the rather large design units are somewhat distorted; he also shows that the Durham fragments were probably used as linings for Byzantine figured samitum.

This sort of patterning can be woven in the same way as the early Egyptian 'inlaid designs' shown above in Figure 109. However such a primitive



method would be out of the question at such a late date for silk weaving. The Durham fragments have a warp count of 30–32 per cm and the weft count is 33–39 per cm.

Because of the inferior execution we tend to presume that these silks were a product of either a provincial workshop or some home craft. The rather extended pattern units woven in point repeat suggest that some discarded out-of-date drawloom could have been utilized by a weaver in his home.

For our experiment we arranged a sort of primitive draw system. Five warp ends were entered into loops lifted by a single draw cord, warp end 6 left out, then again five ends into loops, no. 12 out, and so on, as in Figure 110 A. Then the whole of the warp was entered alternately into two shafts with lifting heddles C. The lifting plan for the pattern is shown at B.

In the detailed draft, Figure 110 D, shown reverse side up, it can be seen that even-numbered warp ends are lifted for tabby weft 1. For tabby weft 2, with odd-numbered ends lifted, a thinner silk is used. While this shed is still kept open a row of pattern is lifted and the pattern weft, marked blue, is thrown in. These three wefts constitute the binding unit or passée. The pattern lift must be released while the following tabby weft is woven.

Our woven replica is shown in Figure 111.

Two silks from Burgos

The next step in our outline of technical development is represented by two exquisite ivory silks from the famous collection of textiles in the royal tombs at Las Huelgas, Burgos, Spain.

Alfonso VIII and his wife, Eleanor of England, founded the convent at Burgos in 1187; from this time until well into the 16th century it served as mausoleum for the royal family of Castille. Gómez-Moreno made a detailed and scientific examination of the contents of the tombs. Repeated plundering, most disastrously during the Napoleonic invasion, had caused considerable damage and left the contents in chaos. Gómez-Moreno made a meticulous description of each tomb and of each object found therein. In

← **Figure 111** Woven sample of the 'Durham' type.

Warp: spun silk Nm 10, 12 ends per cm.

Weft: Tabby shed 1 spun silk Nm 10, 8 per cm. Tabby shed 2 spun silk Nm 30, 8 per cm. The thinner silk Nm 30 for weft 2 together with the pattern weft.

Pattern: spun silk Nm 10, 8 per cm. 24 wefts per cm.

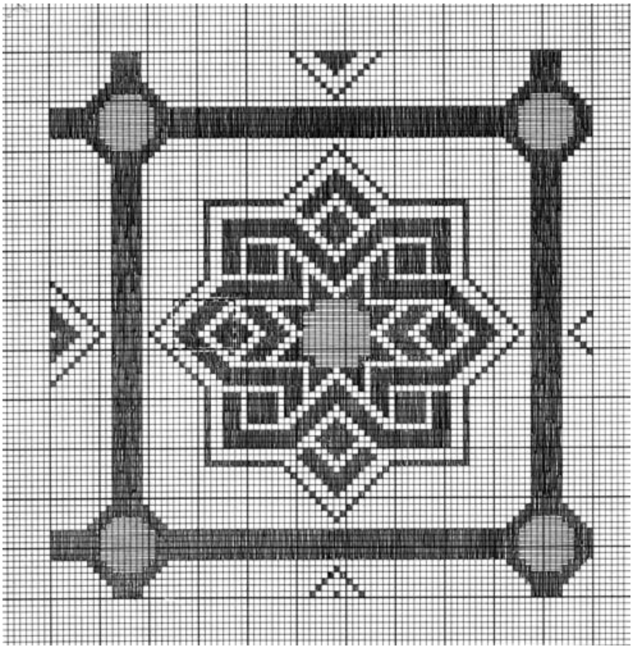


Figure 112 The simplified design from the Burgos silk (Gómez-Moreno 1946, no. 6 pl. LIII). One vertical column of squares means two main-warp ends and one binding-warp end. One horizontal row means four wefts (two main and two pattern wefts).

Brocading with gold thread is shown by double lines.

1946 he published the results of his studies including illustrations of each textile. This is an invaluable guide to this incredibly rich and varied collection. The detailed descriptions are not always technically unambiguous, and Dorothy Shepherd (1951), in her extensive review of the book, gives a valuable supplement. The Burgos silks yielded a rich resource for our experiments in diverse weaving techniques.

For our experiments with a more coarse silk material we made simplified designs with some resemblance to the original artifacts in order to show the weavings to their best advantage. Florence May (1957) gives a number of fine illustrations of the Burgos silks.

The pattern shown in Figure 112 was derived from a beautiful silk cover from the coffin of Eleanor of England. This silk was certainly woven in Spain in the early 13th century. May (1957, p. 76) describes this cover as a pure white silk that has taken on an ivory tinge and says:

> . . . in the center of each star and at all points where the lines of the squares cross are small dots or disks brocaded in gold thread, giving at first glance the impression of a handful of gold coins strewn on the cloth.

In our replica we have tried to obtain the same effect.

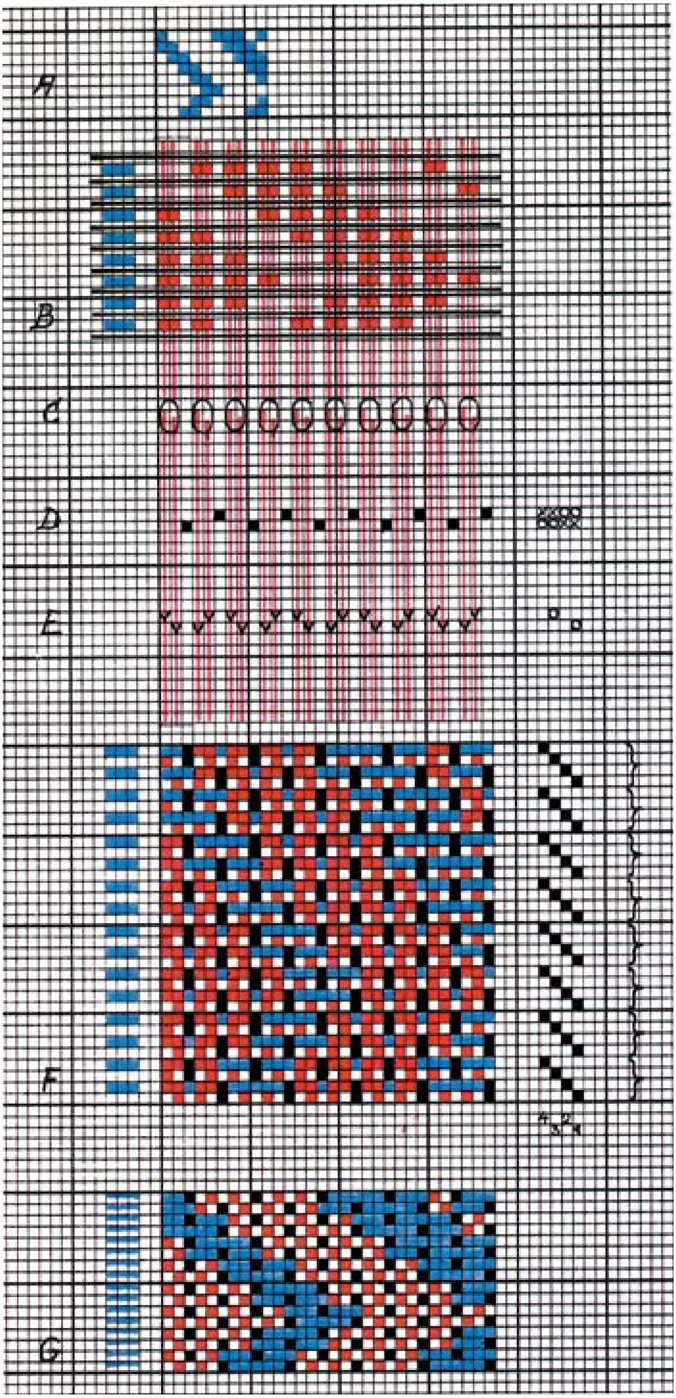


Figure 113 The draft for our experiment with the Burgos silk. A fraction of pattern, A, is shown as lifting plan for harness at B. C shows the leashes; each cord lifts two main-warp ends. At D filled squares mean binding threads (black) entered into the heddle eyes of two shafts. Main-warp ends are again entered, this time into lifting heddles on two tabby shafts at E. Note here the order of entering, 2–1–1–2.

Figure 114 Woven sample.
Warp: spun silk Nm 10, 18 ends per cm.
Weft: spun silk Nm 10, 12 main wefts and 12 pattern wefts, 24 wefts per cm.
Brocading: gold thread.

For this weave it is characteristic that the ground weave is a true plain tabby; see the 'impression' of the sample in Figure 113 G. Pattern weft (marked blue) is bound by every third warp end lifted alternately, see the draft at F, so that the individual pattern weft goes over five warp ends and under one, while on the lower side it goes under five ends and over one when tabby appears on the upper side. The material is reversible, with the effect of ground and pattern inverted.

For clarity we have marked the binding threads black; still it is questionable whether these warp ends should be called a true binding warp. At any rate it must be noted that the binding threads (black) work regularly in a plain tabby together with the rest of the warp ends.

It is of great importance to note, both in this weave and in the following more advanced techniques, that warp threads are now visible. In the discussion of weft-faced compound weaves (Chapters 4 and 5) it was pointed out that warp is always hidden; main warp does not partake in the binding. In these two examples from Burgos the main warp (marked red), besides being active in forming the pattern, also participates in the binding. In this case, Figure 113, a tabby binding is used. Main-warp ends (marked red) are lifted by harness cords in groups of two, see the 'mails', the eyes of 'leashes' or harness heddles, illustrated at C. To obtain a tabby shed the main warp is entered once more into two tabby shafts supplied with lifting heddles. Note here, at E, the order of entering, 2–1–1–2, to obtain a true tabby with the binding threads and main warp combined.

For pattern wefts (marked blue) a row of pattern is lifted as indicated in Figure 113 B; at the same time treadles 2 and 4 are used alternately to lift the binding threads. When tabby wefts (marked white) are woven with alternately treadles 1 and 3 it is necessary to release the lift for pattern.

For the brocaded gold coins the same binding threads are used. Therefore the normal pattern weft appears on the upper side where the binding threads are needed for the gold threads on the face side (downward).

Our woven replica is shown in Figure 114.

Our next experiment with the same technique was derived from a silk found in the tomb of the Infante Sancho, son of the founders (d. 1181); see Gómez-Moreno (1946, lam. L), Shepherd (1951, pl. III), and May (1957,

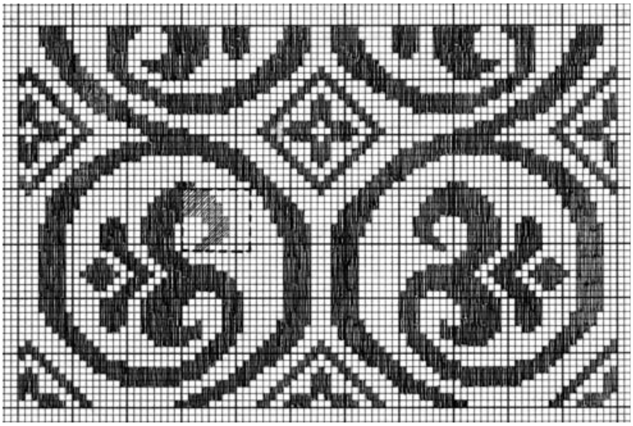
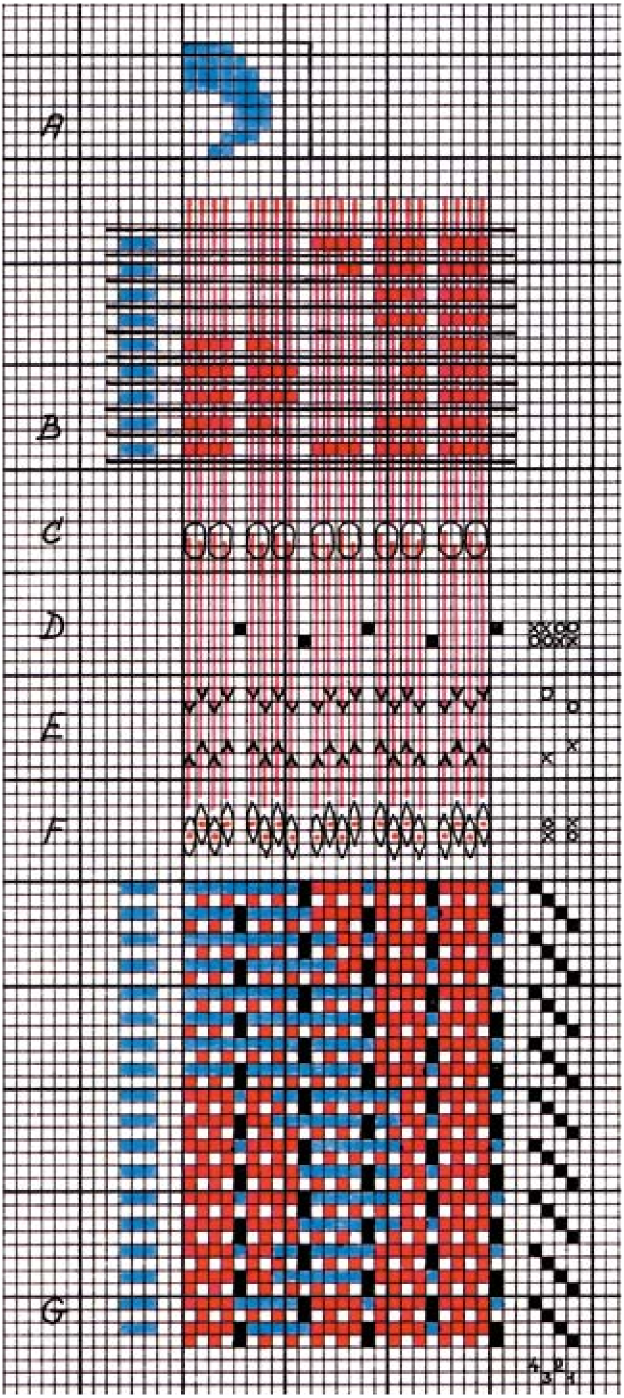


Figure 115 Our simplified design from the Burgos silk of Infante Sancho (Gómez-Moreno 1946, no. 1 pl. L).

One vertical column of squares means two main-warp ends; binding threads are used only between groups of four main-warp ends. One horizontal row of squares means four wefts, two main and two pattern wefts.



←↘ **Figure 116** The draft shows at A a detail of the pattern and at B the lifting plan. Entering into leashes is shown at C, two ends lifted by each cord. Binding threads are entered into heddle eyes at D. E illustrates two sets of shafts, one set for lifting and one for depressing the main warp. The alternative way to lift and depress the main warp by means of long-eyed heddles is shown at F. Note here again the order of entering, 1–2–1–2–2–1–2–1.

G shows the detailed draft from the face side. Lifted groups of main warp give tabby on the upper side. One découpure is four wefts, two main wefts and two pattern wefts, see the braces at the right.

An impression of the beaten-in material is shown at H.

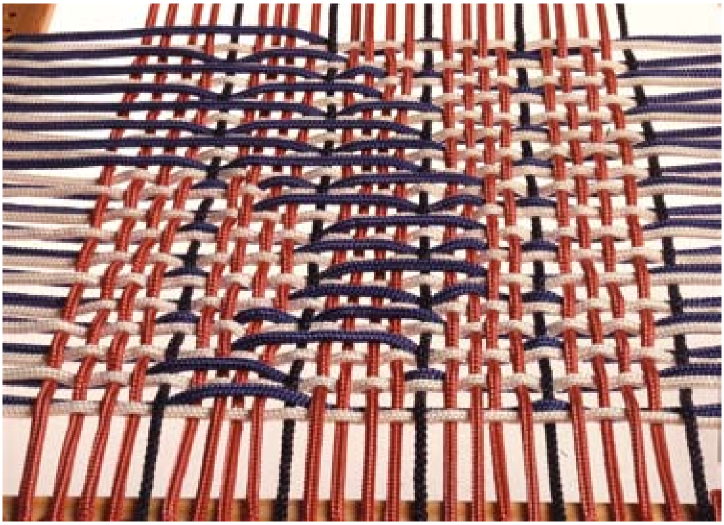
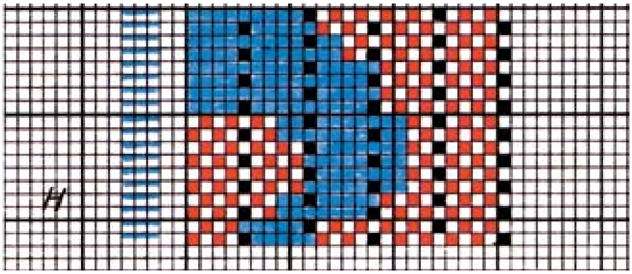


Figure 117 To show the draft G more clearly it is plaited in a frame with cords in corresponding colours.

fig. 49). The design of scrolling stems and curving branches with foliage is of a distinctly stylized effect. In this silk from Burgos stripes of gold occur at intervals. Other samples of this silk are found in Spain, described by Florence May (1957, pp. 78–79). One other example of nearly identical design is shown by Mechthild Lemberg in her description of the conservation of the tomb of Archbishop Rodrigo Ximenez de Rada. Here the silk was preserved from his tunic decorated with a rich border woven with gold thread in a similar way (Lemberg 1970, pp. 11–16). In this example the warp count is 60 ends per cm. The weft count is: ground weft 40, pattern weft 40; a total of 80 wefts per cm.

Part of the simplified design is illustrated in Figure 115. Only the fraction framed by a broken line is used for the draft. In this sample four



main-warp ends were used between binding threads. The pattern weft floats over nine warp ends; see the draft, Figure 116 G, and also the plaited frame in Figure 117. Two main-warp ends are entered into each of the leashes, see Figure 116 C. Binding threads (marked black) are entered into heddle eyes on two shafts at D. An improvement on the setup in our first sample is demonstrated at E. In the first case two shafts with lifting heddles (marked ∨∨∨) were used for the tabby wefts. Here are added two shafts with depression heddles (marked ∧∧∧). This means that tabby treadles 1 and 3 can be used while the pattern shed is still lifted; it saves time to weave continuously and avoid the eternal lifting and lowering of pattern. Furthermore this method gives a far better control over the warp threads.

From the lifted groups of main warp the depression shafts pull down alternately every other thread; from the lower shed face the lifting shafts lift alternately every other thread. This method with two sets of shafts, one set for lifting and one for depression, was presumably used from the earliest times for very fine and tightly set warps where knots on heddles would be disastrous. It is still used in high-quality silk weaving in Lyon where handwoven silks are still produced.

For our coarse material with a small number of warp ends per cm it was possible to use knotted heddles. Instead of two sets of shafts we have simplified by means of long-eyed heddles on one set of shafts. The heddles have a knotted eye with height about 7 cm. This height allows the opened pattern shed to stay clearly open as far as is necessary for the shuttle to go easily through the shed. The upper knots in the long heddle eyes pull down the threads in the same way as depression shafts. The lower knots lift the threads as a lifting shaft.

Detailed descriptions of heddles and methods for setup are given in Chapter 12.

Our woven replica is shown in Figure 118.

'Summer and Winter,' or Kuvikas

Harold and Dorothy Burnham (1972 pp. 264–272) describe a weave called 'Summer and Winter', utilized for coverlets by Canadian weavers. These coverlets were generally woven with a white cotton ground patterned by a darker coloured wool. The other side showed a darker coloured ground

Figure 118 Our woven replica from the Burgos silk.

Warp: spun silk Nm 10, 15 ends per cm.

Weft: spun silk Nm 10, pale grey, 15 main and 15 pattern wefts, 30 wefts per cm. For golden bands a gold thread is used for pattern weft with main weft of spun silk Nm 10.

patterned by white tabby. The use of the white side in summer and the darker side in winter is presumably the origin of the name 'Summer and Winter'.

Burnham supposes this weave to be a descendant from weft-faced compound weaves, described above in Chapters 4 and 5. Of course it is always difficult to determine whether a particular technique derived from another; but in this case the 'Summer and Winter' weave is exactly the same as the weave in the Burgos silks described above. If only one main-warp end is used between binding threads, instead of two or four, the 'Summer and Winter' weave appears as shown in the draft, Figure 119. This weave is woven on a shaft loom with block patterning. Two shafts, marked black, are used for the binding threads; for each pattern block only one shaft is needed. In our draft a three-block pattern is shown. Only five shafts

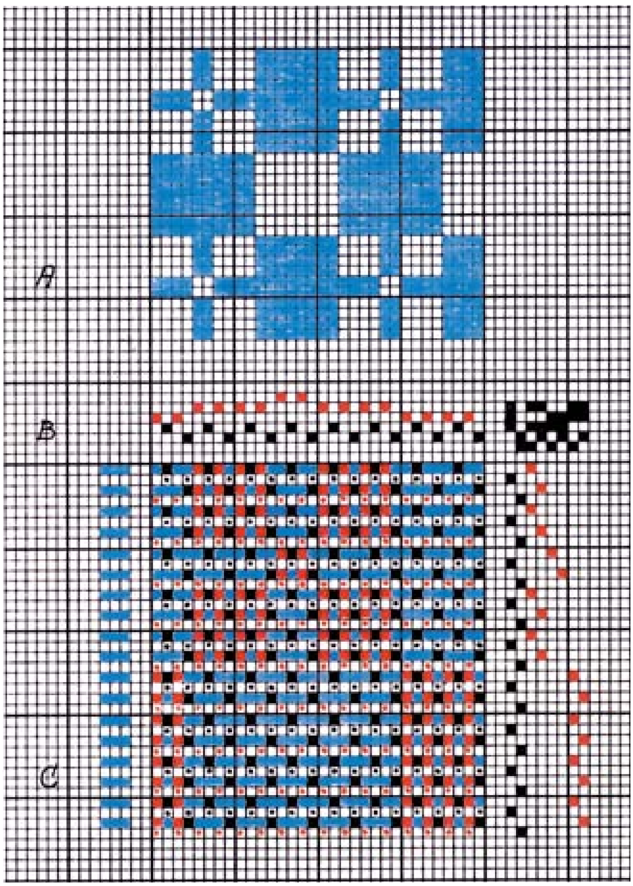


Figure 119 Draft for 'Summer and Winter' or Kuvikas with a three-block pattern (A). Binding threads, marked black, are entered into two shafts. Main-warp ends, marked red, are entered into one shaft for each block. Every other weft, marked white, is a tabby weft with two treadles, marked black. For clarity the lifted warp ends are shown by points: black for binding ends and red for main-warp ends respectively. For pattern weft, marked blue, two treadles (red) are needed for each block. To obtain the correct proportion of pattern the number of wefts in each block must be doubled; each treadling block is woven twice.

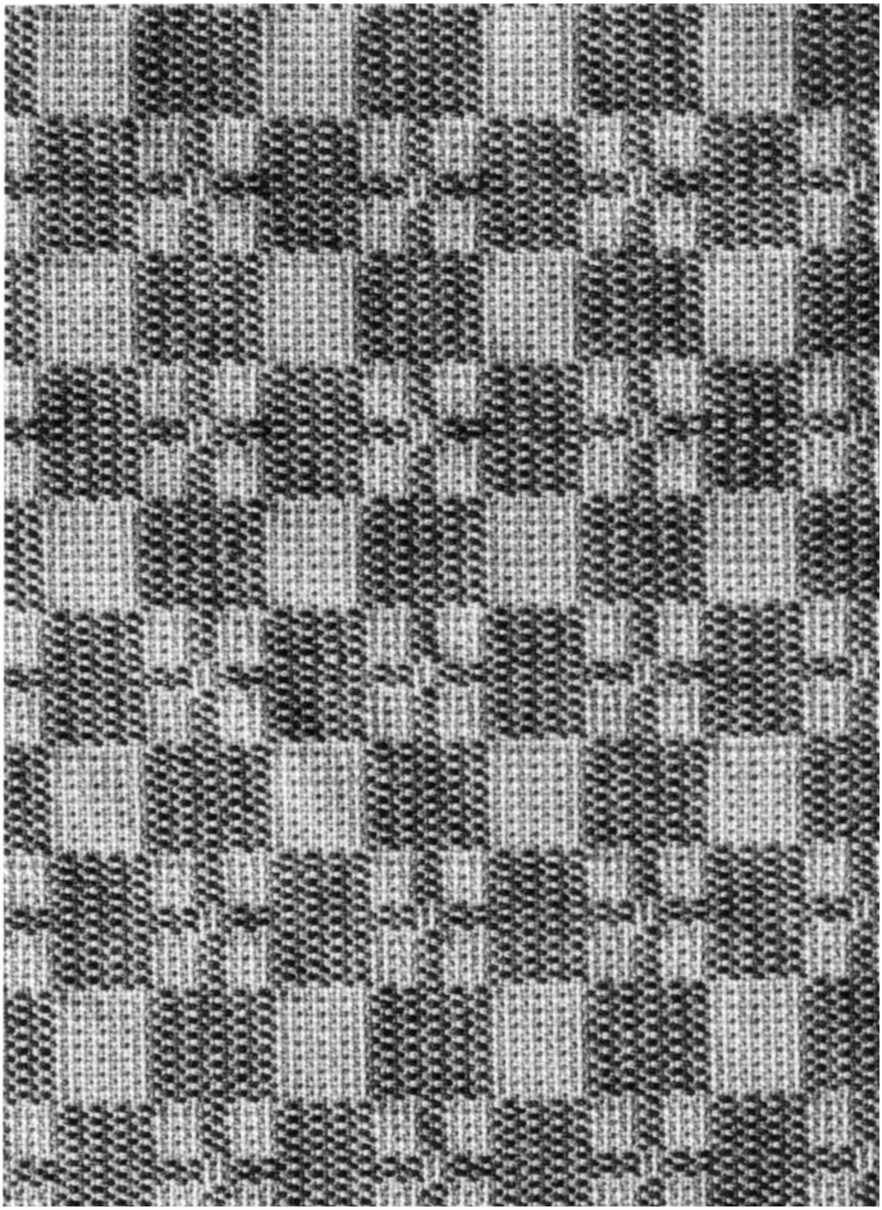


Figure 120 The sample of Kuvikas woven according to the draft, Figure 119.

Warp: spun silk Nm 10, 11 ends per cm.

Weft: Tabby: spun silk Nm 10, 11 per cm.

Pattern: spun silk Nm 10, dark grey, double spooled, 11 doubled wefts per cm. Total 22 wefts per cm.

are necessary for this three-block pattern, two for binding threads and three for pattern blocks. Two alternating wefts are used: one for tabby ground (white), one for pattern (blue). Two treadles, marked black, are used for tabby wefts. For clarity the binding threads (black) and the main-warp ends (red), when lifted for tabby, are shown by black and red points respectively. Each pattern block needs two treadles because a pattern weft uses alternately every other binding thread.

This uncomplicated and very flexible weave is apparently still widely used by handweavers in America and Canada. Frequently descriptions have appeared in the American journal *Handweaver and Craftsman:* for instance Klara Schoenfeld (1961) who, following a Finnish weaver's manual, calls this weave *kuvikas.* A woven sample of kuvikas is shown in Figure 120.

It is noteworthy that this weave was widely used in Finnish home craft, presumably for centuries. In the other Scandinavian countries it was not known until recent years (Cyrus-Zetterström 1977, pp. 79–81). Anna Henriksson in her manual on Finnish weaving (1948, pp. 231–239) describes many variations of this technique; for the ground weave not only tabby but also twill 1/2 and 1/3 was used.

True lampas

A short step from the Burgos silks now leads up to the true lampas. According to Geijer (1979, p. 61) the word *lampas* was adopted as a technical term in French silk weaving at a late date, probably not before 1900. English silk weavers have used the word *tissue* for nearly the same type of weave since the 18th century (Rothstein 1960). Von Falke (1913) introduced the old term *diasper*, from Latin *diasprum,* as a designation for the special type of weave produced in Italy in the 13th–14th centuries. The word *diasper* is still frequently used in connection with these Italian silks, presumably to classify them as a variety of lampas (see also King 1960, pp. 42–47). The definition of lampas as it appears in the CIETA vocabulary is:

> Term used exclusively for figured textiles in which a pattern, composed of weft floats bound by a binding warp, is added to a ground fabric formed by a main warp and a main weft. The ground may be tabby, twill, satin, damask . . . etc. The weft threads forming the pattern may be main, pattern, or brocading wefts; they float at the face as required by the pattern, and are bound by the ends of the binding warp in a bind-

> ing ordinarily tabby or twill and which is supplementary to the ground weave. (Burnham 1964, p. 28).

This is an excellent definition, and it will be followed here, but it must be noted that the term *lampas* has also been used in a much more vague sense. In many cases it seems simply to refer to the category 'everything else'; for example the pseudo-damask described in Chapter 5.

Presumably the development outlined above from tabby ground to true lampas took place in the Iranian world in the centuries before the year 1000. Iranian weavers carried on the traditions of craftmanship from the Sassanian period (AD 226–651); and obviously the art of silk weaving flourished for centuries (Geijer 1979, p. 123). Unfortunately we have found no dated material from Iran for the earliest primitive weaves. Therefore we have used samples from other countries.

Some silks from the Seljuk period (ca. AD 1100–1300) woven with lampas technique are extant (Pope and Ackerman 1938–39, pl. 994). From later periods, the Mongol-Timurid dynasty (1370–1500) and the Islamic Safavid dynasty (1503–1735), a considerable number of securely dated examples are preserved (Geijer 1979, pp. 124–26). Among marvellous silks woven with different techniques, such as samitum, double cloth (see Chapter 8), and velvet, the lampas technique is represented in many variations of the most intricate technical skill (see for example Geijer 1979, pl. 57 a).

For nearly four hundred years Italian weaving centres took the leading part in European silk weaving. Lampas (diasper) was a main technique for the famous silks from the 13th–14th centuries from which an astonishingly large number of perfectly preserved examples are still in existence, mainly in European churches. A large and varied collection is exhibited in the Cathedral of Uppsala, Sweden (Geijer 1964).

Italian cities near the eastern Mediterranean had for centuries been enterprising entrepôts for luxury goods from remote Eastern countries. Among these goods grège (unspun silk) and silk fabrics were of great importance. Before the final decline of the Eastern Roman Empire Italian merchants had been farsighted enough to start silk manufacture in their own cities. From the end of the 12th century many Italian cities became famous and prosperous as silk weaving centres, for example Lucca, Venice, Genoa, etc.

In the mid-seventeenth century French silk manufacture became a serious competitor and France from then on took over the leading part in

Europe. Nevertheless high-quality silks were produced in Italy as well as in other European countries, among others in England where the renowned Spitalfields silk manufacture flourished from the first part of the 18th century but was already in decline during the 19th century (Flanagan 1954; Rothstein 1975; King, Rothstein, and Levey 1980).

The lampas technique with its many possibilities for variation was developed to such heights of artistic and technical sophistication in Iran, in Italian workshops, and still more by French production during the 18th century, that it is far outside our competence to follow up the technical development in detail. We will show the principle of lampas and a number of variations, illustrated by woven samples. This we hope will be a sufficient foundation for further studies (Guicherd 1957 and courses offered by CIETA in Lyon under Gabriel Vial).

For our technical research we have found the Spanish-Moorish period (8th–15th century) to yield a number of instructive examples. Technically the weaves of the Spanish-Moorish period seem to be clearly continuous with those of Iran. There can be no doubt that the art of silk weaving, already at a high level within the Iranian world, was brought westward by Arabs or Moors from Western Asia through North Africa to Spain. Of course the style of ornamentation underwent alterations accordingly. But our main theme here is the weaving techniques, and we presume that Moorish weavers used their traditional craftsmanship and presumably also brought with them, perhaps not the looms, but at any rate their knowledge of looms and other implements traditionally utilized for silk weaving in their home countries.

For a practical description of an individual example of lampas it is necessary to specify the proportion of binding-warp ends to main-warp ends. The binding of main weave must be clearly shown and so must the method for binding the pattern weft. Possibly it will be useful here to emphasize that *main weave* means the weave formed by the main warp, marked red in our drafts, and the main weft, marked white; and the binding warp (black) together with the pattern weft (blue) produces the *pattern weave.* The word 'pattern weave' in this connection may be a little disconcerting: the pattern weave does not always form the design, and the background outside the design is not always formed by the main weave. In some cases the ground outside the design consists of the real pattern weft with the binding warp. Then the design is produced by the main weave. This is what is meant in the definition above that 'the weft threads forming

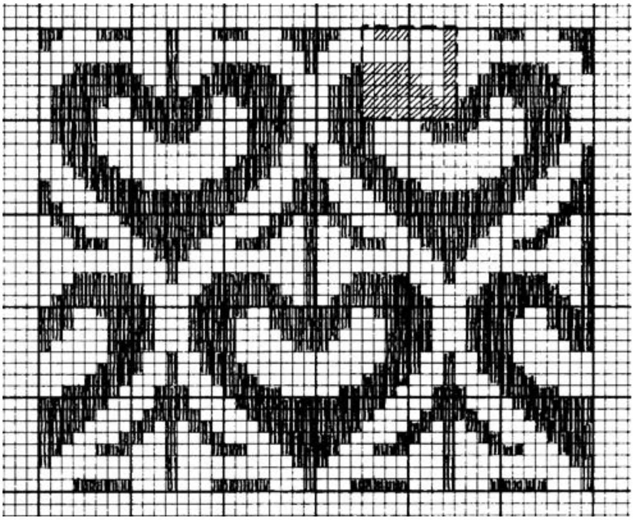


Figure 121 The pattern for our first experiment with a true lampas. One vertical column of squares means three main-warp ends and one binding-warp end. One horizontal row means four wefts, one découpure: two main wefts and two pattern wefts.

the pattern may be main wefts'. See our experiments, sample III, Figures 126 and 129.

Of course many different weaving methods have been utilized for this very flexible type of weave. It is now and then remarked in descriptions of lampas that the main weave is a 'double weave'. This does not refer to a true 'double cloth' (see Chapter 8), which consists of two layers throughout, the pattern coming from an alternation of the layers. In lampas only the main weave can be double-woven; the binding warp with the pattern weft is always tightly woven together with the main weave (see the drafts, Figure 122).

Geijer (1979, p. 61) mentions this in connection with the word *diasper.* This word may denote a variety of lampas, or more precisely the kind of lampas which has a ground in 'double weave', as in the silks from 13th century Italy. This is shown in detail in the drafts below, and some of our woven samples show both the 'double weave' and the two layers bound together all over the material.

From an Italian silk of the 14th century belonging to the Abegg Stiftung, Bern, we borrowed a detail of stylized leaves for our first experiment, Figure 121. The silk is illustrated by Lemberg (1973, pl. 29).

We used three main-warp ends for each binding-warp end. The main weave is tabby and the pattern weft is bound in tabby as well. In the draft, Figure 122 A, a detail of the pattern is shown. Each small square means three main-warp ends and one binding-warp end. In weft direction one

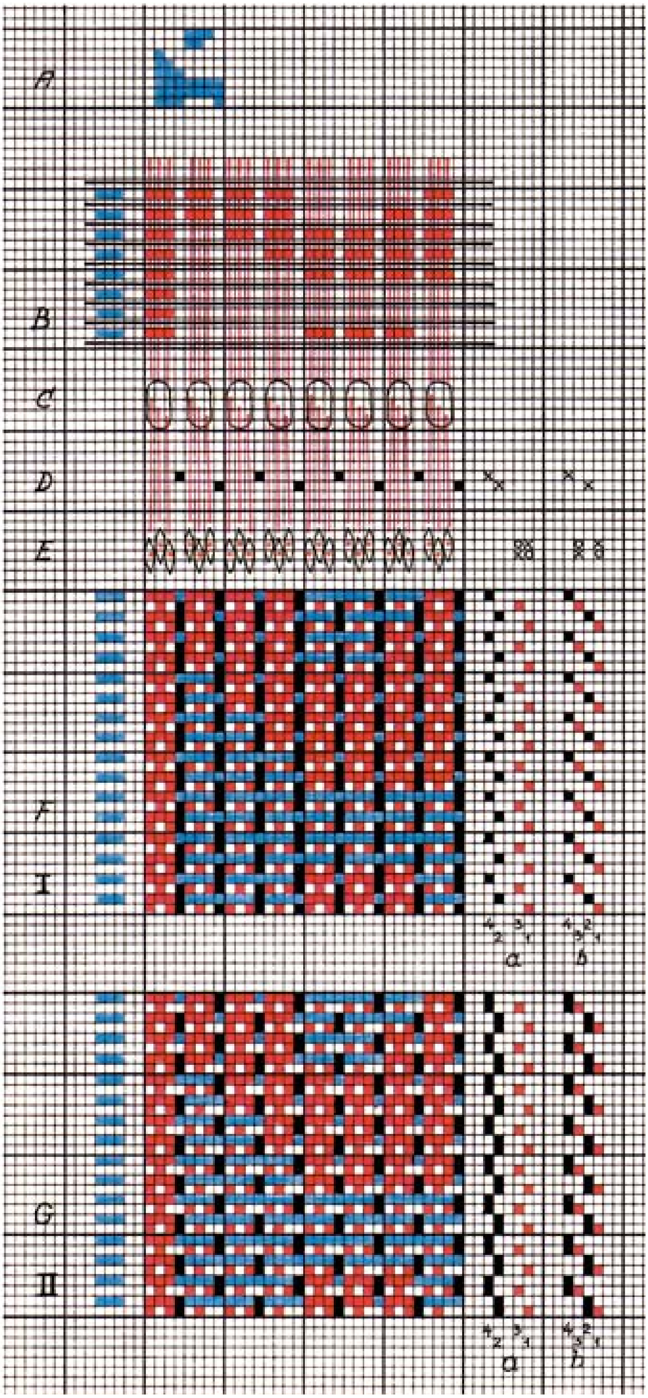


Figure 122 The draft for samples I and II is shown with the reverse side up. At A is shown a detail of the pattern; white squares mean three lifted main-warp ends. B shows the lifting plan, and at C are shown the leashes, each of which lifts three main-warp ends. Black squares at D show the two binding shafts, here adjusted to the upper shed face. At E two shafts with long-eyed heddles are shown for the main weave. The detailed draft F for sample I demonstrates the double weave of the ground (blue part of the draft).

At G is shown the draft for sample II with both weaves bound together.

Note in the red parts of both drafts that the binding warp (black), when it goes under a pattern weft (blue) and returns to the upper shed face, binds the two layers together.

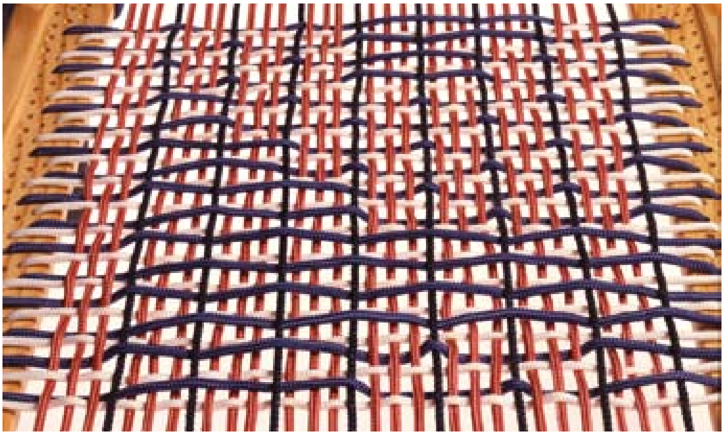


Figure 123 The draft Figure 122 F is here plaited in a frame to show the binding more clearly. Note, reverse-side up, that the binding warp is always adjusted to the upper shed face and is pulled down only to bind the pattern weft on the face side (below). In the blue part, lower left, the double weave can be seen clearly.

square means four wefts (two main and two pattern wefts). The lifting plan is shown at B. In this experiment we have demonstrated three variations with the same warp and the same pattern lift.

The drafts for samples I and II are shown in Figure 122. Both are woven reverse-side up. The binding shafts (black) shown at D are adjusted so that the heddle eyes are at the same height as the lifted main warp (upper shed face). This means that the binding warp is always above the main weave when the reverse side is up.

When tabby is used both for main weave and for pattern binding only four treadles are needed. We have shown two methods for placing the treadles, a and b. Method a is certainly the more theoretically correct but method b is more practical. Even-numbered treadles (black) for pattern weft are used alternately only to depress binding-warp ends denoted by x x in the tie-up. When the loom is set up as shown here a row of pattern can stay lifted for each of the wefts within one découpure.

Sample I

See Figure 122. When treadle 1 or 3 (red) is used for main weft, the long-eyed heddles lift every other main-warp end from the lower shed face and from the lifted groups of main warp the long-eyed heddles depress every other end. Thus a plain tabby is woven. When treadle 2 or 4 (black) is used for pattern weft (blue), every other binding-warp end is depressed. The pattern weft appears on the face side (downward) only where groups of main warp are lifted, see the red part of the draft at F. Outside the lifted pattern the pattern weft is bound by the binding warp and does not interfere with the plain tabby below (the blue part of the draft). This is the double weave mentioned above in connection with the Italian diasper silks. Lifted groups of pattern on the reverse side come out in tabby but the binding-warp ends utilized for pattern on the lower face side must return to their lifted position when a main weft is thrown in. Thus the pattern areas are bound solidly together. This draft is plaited in a frame in Figure 123.

When double weave is used as a background for pattern it is useful when the design is planned to take care that no large areas are left without pattern. The tightly woven tabby is apt to puff up if it is not bound by a detail of pattern. See for example the diasper silks in the Uppsala Cathedral (Geijer 1964): it is very seldom that a ground area is left without a strategically placed sprig of leaves. On the other hand the double weave when used with care gives a charming slight relief to the pattern.

Sample II

If it is desirable to avoid the double weave on account of the quality of the material, or because the design demands larger unpatterned areas, it is possible to bind the two layers together. In the draft Figure 122 G is shown how this can be done with the same tie-up. The binding treadles (black) are used for two consecutive wefts: first together with the treadle for main weave (red), then alone for the pattern weft, as in sample 1. Then the binding-warp ends tie down into the tabby weave. On the face side it can be seen that the binding points have an effect on the tabby: it is not absolutely regular. The fabric is more solid but the fine relief has disappeared. In Figure 124 the woven samples I and II are shown; note here the difference in the ground weaves.

Sample III

This sample is woven face-side up as shown in the draft, Figure 125. In this case the binding warp works on the lower reverse side; the binding shafts,

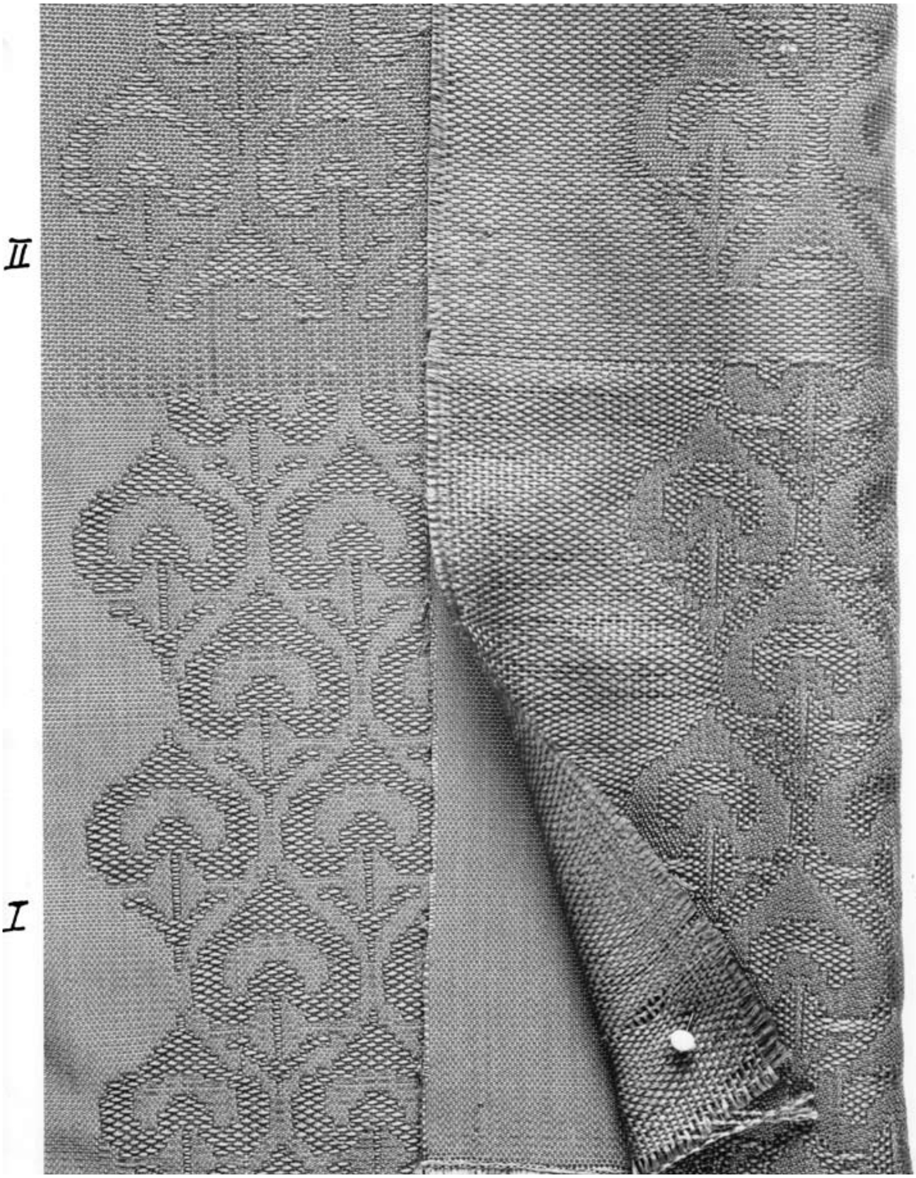


Figure 124 The woven samples I and II are shown with the face side up at the left and folded over to show the reverse side at the right. Note in sample I (lower left) the plain tabby ground and compare this with the ground in sample II.

Warp: organzine silk Nm 12.5 red, three main-warp ends, one binding-warp end. 24 ends per cm.

Weft: organzine silk Nm 12.5, main weft: brick-red, pattern weft: red. Six découpures per cm, each découpure four wefts (two main and two pattern wefts), 24 wefts per cm.

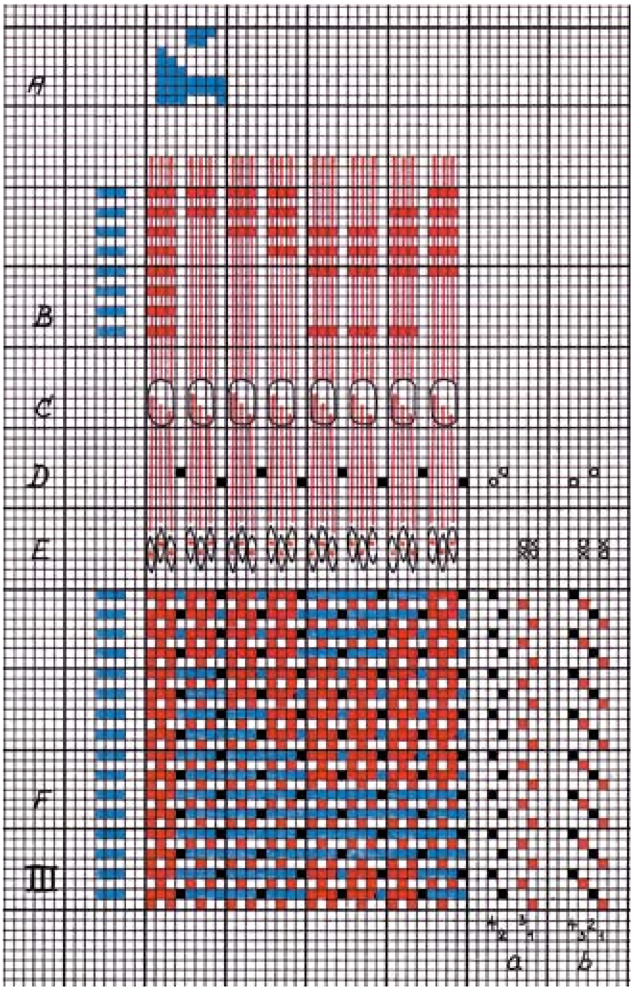


Figure 125 The draft for sample III is shown face-side up. The same entering and pattern lift is used here as in Figure 122. The binding shafts, shown at D, are here adjusted to the lower shed face and are tied up to be lifted.

at D, are adjusted to the lower shed face and supplied with weights to keep them in place. The treadles are now tied up only to lift; this is marked by o o in the tie-up. Lifted groups of pattern appear on the upper face side in tabby weave, the main weave. The double weave is used in this sample in order to give the faint effect of relief to the figures. The pattern wefts here appear as a background for the figures.

The woven sample III is shown in Figure 126.

For our next experiment with lampas we made the pattern shown in Figure 127. The draft is shown in Figure 128. Three main-warp ends are used for each binding-warp end. The main weave is tabby and the pattern

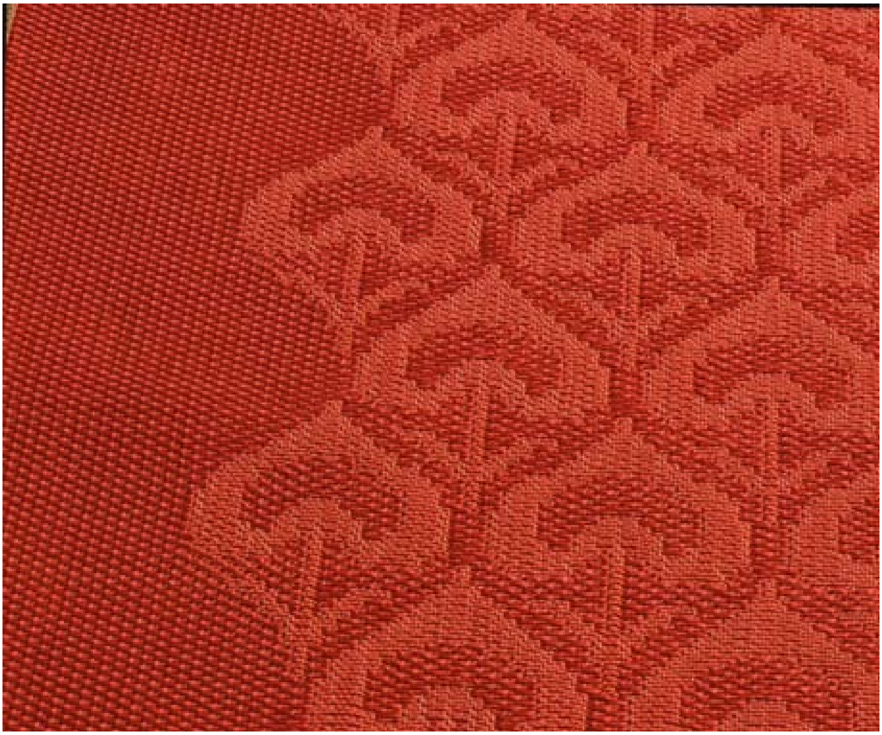


Figure 126 The woven sample III.

Warp: organzine silk Nm 12.5 red. Three main-warp ends, one binding-warp end, 24 ends per cm.

Weft: organzine silk Nm 12.5, main weft: brick-red, pattern weft: red.

Six découpures per cm, each découpure four wefts (two main and two pattern wefts), 24 wefts per cm. Note that the main weave in tabby comes out in the figures as a double weave.

weave is twill 1/2. The sample is woven face-side up; therefore the draft is shown this way as well. A detail of the pattern is shown at A; white squares mean three lifted main-warp ends. The three binding shafts at D are adjusted to the lower shed face, supplied with weights and tied up only to lift. In the detailed draft F the lifted pattern (red part) comes out as tabby in double weave above the pattern weave in twill.

In the draft Figure 128 G is shown the variation with both weaves bound together throughout. Note that the binding warp is also lifted when the main wefts are woven. The binding treadles, marked black, are used for two consecutive wefts, first together with a treadle for main weft (red), then alone for a pattern weft (see sample II, Figure 122 G). In our rough

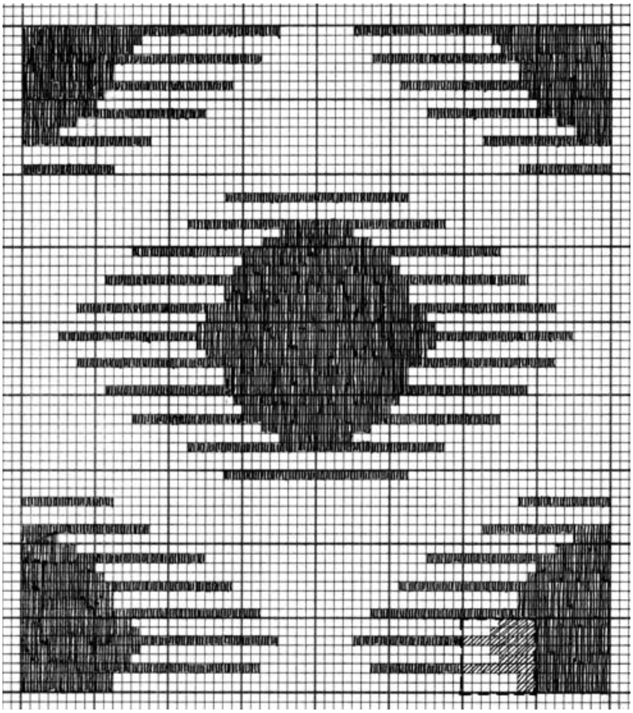


Figure 127 This pattern was drawn for the sample woven with main weave in tabby and pattern weave in twill 1/2. One square means three main-warp ends and one binding-warp end. In weft direction one square means two main wefts and two pattern wefts.

sample it can easily be seen that the binding points of the twill weave are disturbing to the tabby weave in the figures.

Woven samples of both variations are shown in Figures 129 and 130.

Lampas with main weave in satin

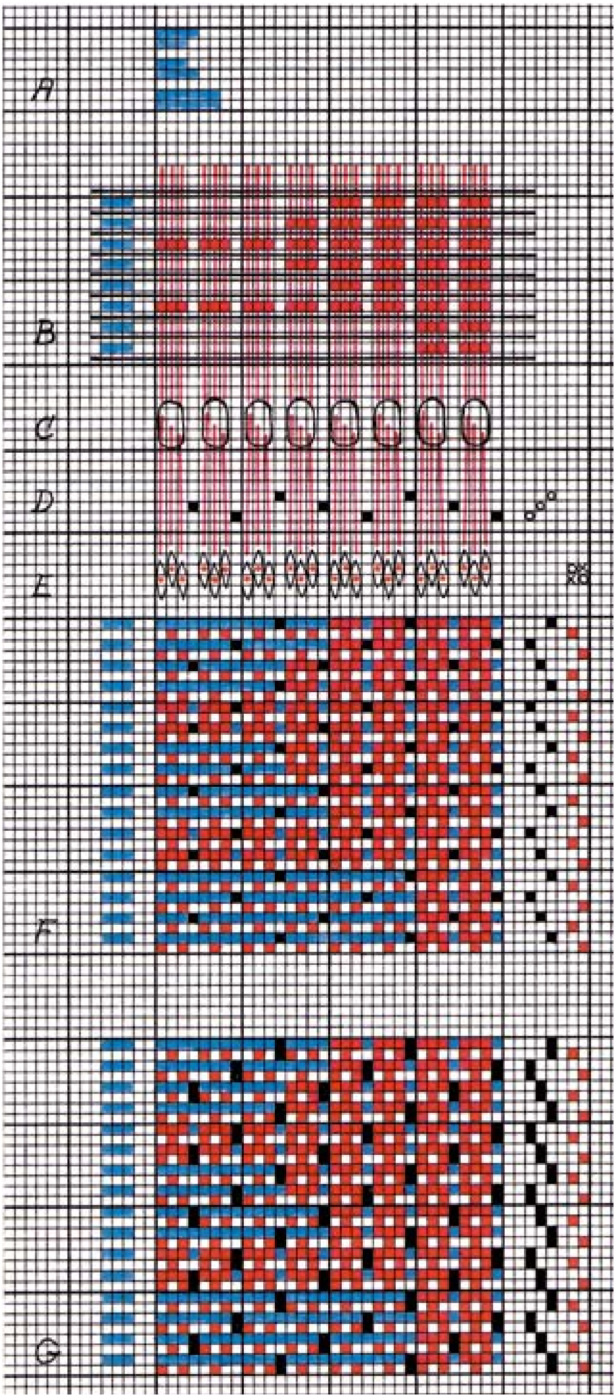
For the sake of weaving techniques we have deferred Chinese weaving from the centuries after the Han to a later chapter. During the Tang period some techniques appear which seem to have been developed in Western Asia. To avoid repetition we prefer to discuss these techniques in connection with their first appearance, and in Chapter 10 samples from the Tang are shown and the 'Chinese' way of using them.

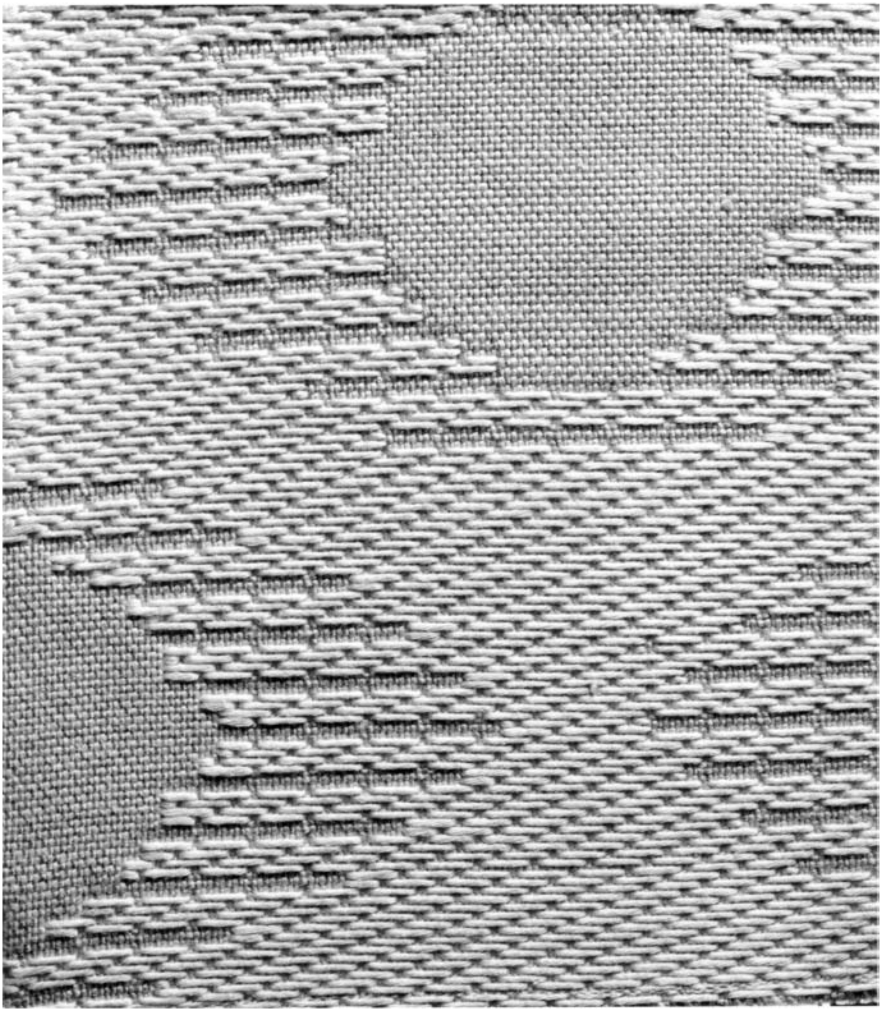
However an important group of richly varied lampas weaves showing Chinese influence has been preserved, mostly in European church treasuries. An example from this group will be discussed here.

The Mongol invasion in the 13th century resulted in a westward dissemination of Chinese designs and techniques (Geijer 1979, p. 124). It is

Figure 128 A fraction of the pattern in Figure 127 is drawn in detail in the draft, shown face side up.

The three binding shafts for twill 1/2 at D are adjusted to the lower shed face. The detailed draft F shows that the lifted pattern (red part) comes out in main weave, tabby in double weave. In the draft G the binding treadles are used not only for pattern weft but also together with the treadles for main weave. This causes the two layers to be bound together.





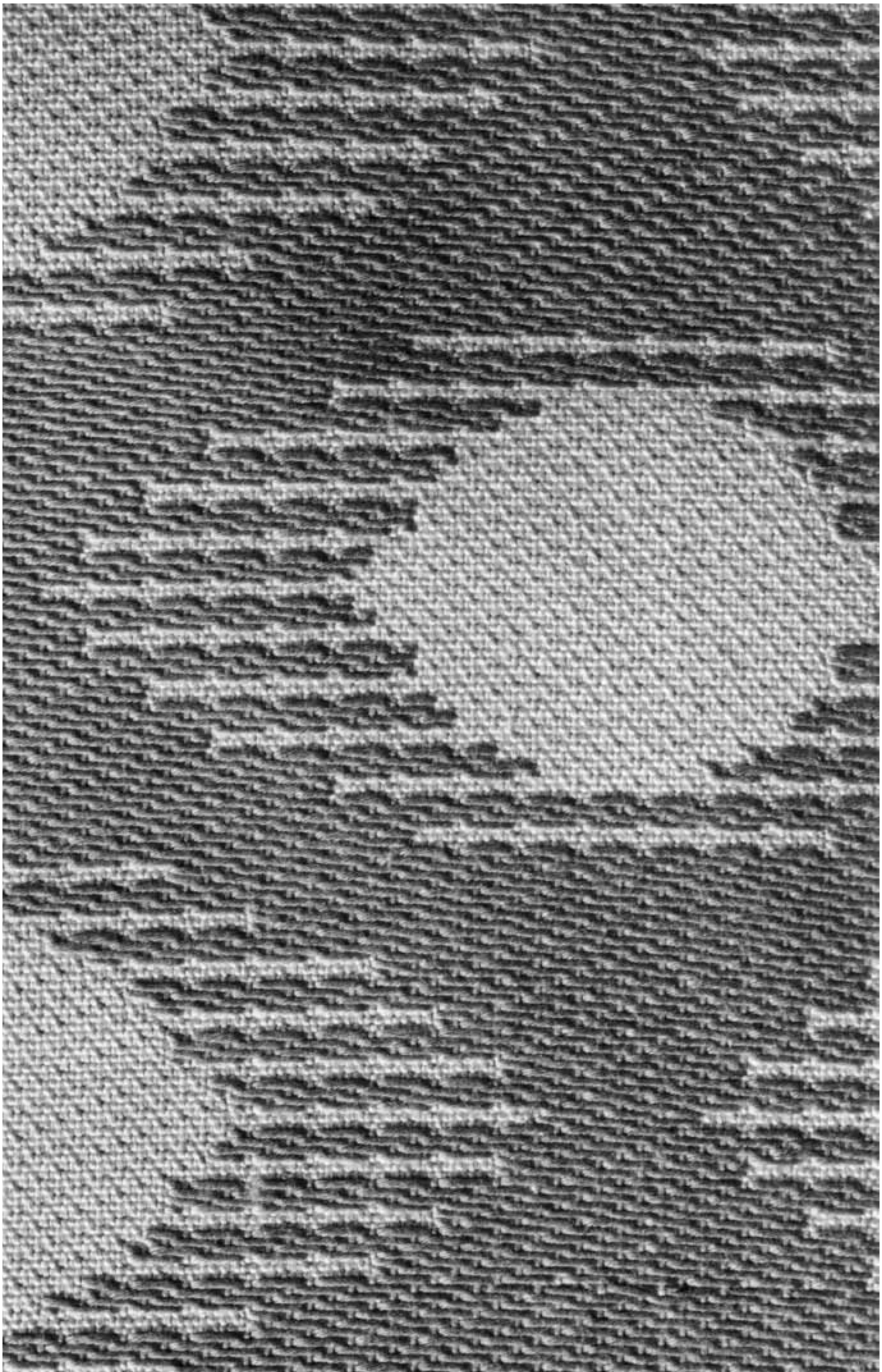
↑ **Figure 129** Sample woven after the draft, Figure 128, with figures in double weave.

Main weave: tabby, pattern weave: twill 1/2.

Warp: spun silk Nm 10 white, three main-warp ends, one binding-warp end, 16 ends per cm.

Weft: spun silk Nm 10, grey for main weft, white for pattern weft, ten main and ten pattern wefts, 20 wefts per cm.

→ **Figure 130** Woven sample of the same pattern and the same material as in Figure 129. In this case the tabby parts are bound by the binding warp as shown in Figure 128 G. The disturbing effect of the binding points in twill can easily be seen in the figures.



characteristic for this group of lampas weaves that Chinese dragons and other Chinese motifs appear in connection with Arabic inscriptions in stylized Cufic script.

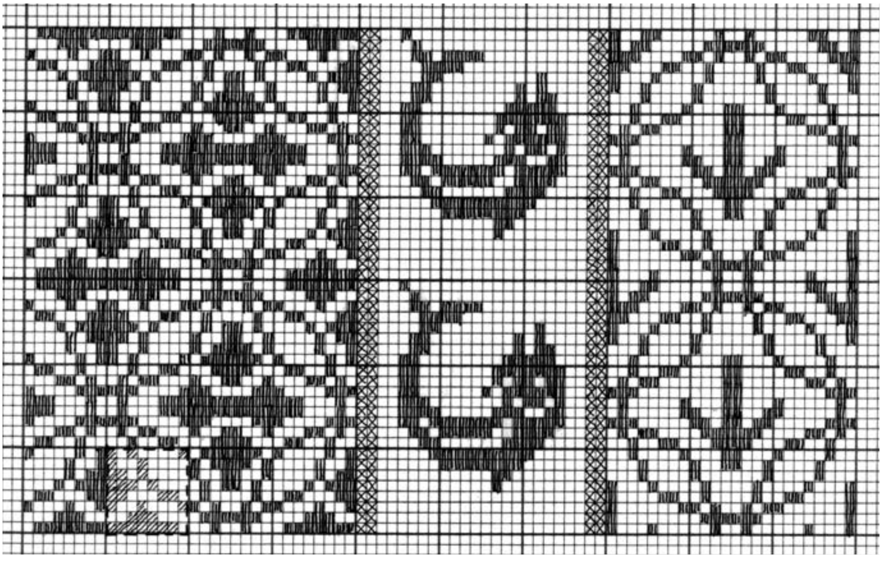
The use of flat membrane gold was the Chinese method for introducing gold into textiles. Presumably also the satin binding points to China. Müller-Christensen (1955, p. 30), referring to a personal communication from Ernst Kühnel, presumes this extensive production to have originated somewhere in Turkestan during the 13th and 14th centuries where techniques of Chinese and Persian origin met.

For our experiment we made a simplified pattern from details of the silk illustrated by Müller-Christensen (1955, pl. 74), shown in Figure 131.

Our sample is woven reverse up as can be seen in the draft Figure 132. Four main-warp ends are used for each binding-warp end. In the detail shown at A one white square means four lifted main-warp ends and one binding-warp end. In weft direction one square means two main wefts with 5-end satin and two alternating wefts in tabby.

At Figure 132 C are shown the leashes, each of which lifts four main-warp ends. The binding shafts for tabby (black) shown at D are adjusted to the upper shed face and depressed when needed to bind the pattern weft. At E five shafts for satin are supplied with long-eyed heddles. We tied up

Figure 131 Our pattern for the experiment with a 5-end satin for the main weave. The details of pattern are derived from the Regensburg dalmatica illustrated by Müller-Christensen (1955, pl. 74).



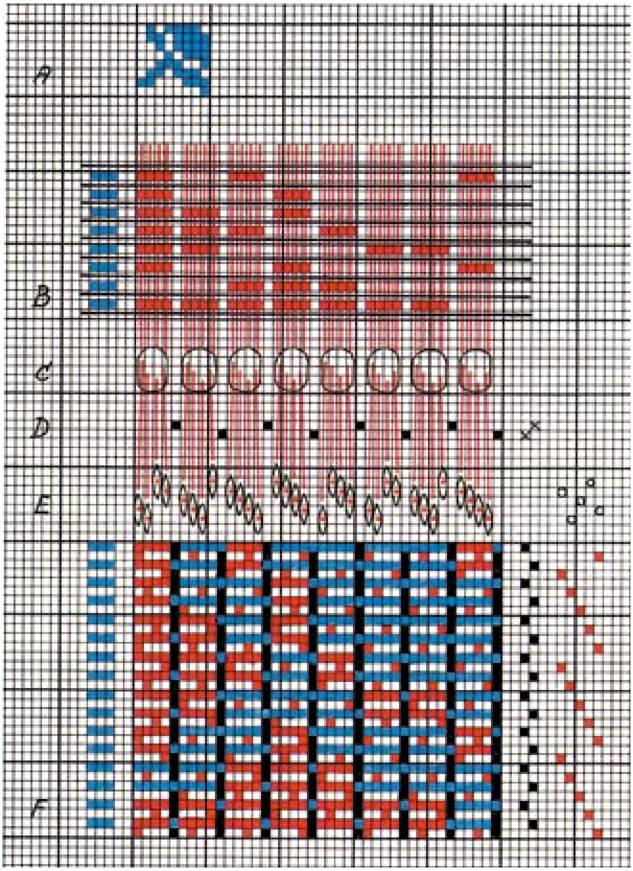


Figure 132 The draft for our experiment is shown here reverse-side up. For the detail shown at A the lifting plan is shown at B. The binding shafts for tabby (black) at D are adjusted to the upper shed face and depressed alternately to bind the pattern weft. The entering into five shafts for satin shown at E was rather troublesome because each of the leashes lifts only four threads. In the detailed draft F, seen from the reverse side, the blue parts show the pattern wefts bound by the binding warp in a separate layer above the satin weave.

only the lifting for satin, marked by o o in the tie-up; therefore a lifted row of pattern had to be released while a satin weft was thrown in. Certainly it would have been more efficient to tie up the depression of four shafts for each treadle as well; then we could have woven continuously with the pattern lifted as in the samples described above. The satin ground in warp effect is a double weave. The yellow pattern weft is bound on the reverse side only by the binding-warp ends.

The woven replica is shown face-side up in Figure 133.

Lampas with two pattern wefts

As a motif for this experiment we used a silk from the pelisse of Fernando in the Burgos collection (13th century). As can be seen in the illustrations

Figure 133 The woven sample seen from the face side.

Warp: organzine silk Nm 12.5, white with narrow green stripes; four main-warp ends to one binding-warp end. Main weave: 5-end satin. Pattern weave: tabby.

Weft: organzine silk Nm 36, doubled for main weft; spun silk Nm 10, yellow for pattern weft. Twelve main and twelve pattern wefts, 24 wefts per cm.

of Burgos textiles (Gómez-Moreno 1946) a pelisse was a sleeveless fur-lined coat worn by both men and women. From Fernando's pelisse only the upper bodice is preserved. Florence May (1957, p. 83) describes this silk:

> Simple as is the lozenge design for a pelisse (figs. 56 and 57) worn by a son of Alfonso X, it owes much of its beauty to a master weaver who used an individual technique so that the white and gold diamond motifs with dark grey outlines and measuring less than one centimeter across and a trifle over a centimeter in height are combined in one gleaming fabric.

For our replica we followed Gómez-Moreno's description of the technique as far as possible. Four main-warp ends were used for each binding-warp end. The main weave is tabby and the pattern is bound in tabby as well. White silk is used for the entire warp and is also used for the main weft. Grey silk and gold thread are used for the pattern wefts.

The weaving was done face-side up and the draft, Figure 134, is also shown in this way. Main warp is lifted in groups of two, see the leashes at B. At C two binding shafts (black) are adjusted to the lower shed face.

Long-eyed heddles are used for the main weave, see D; they are tied up only to lift.

The diamonds in white tabby are woven as a double weave. The two pattern wefts, grey and gold, are bound on the reverse side by the binding warp.

The grey pattern weft appears on the face side in the outlines only. Behind the gold diamond the grey weft is bound by the binding warp. The white main warp and the white main weft are not bound in tabby behind

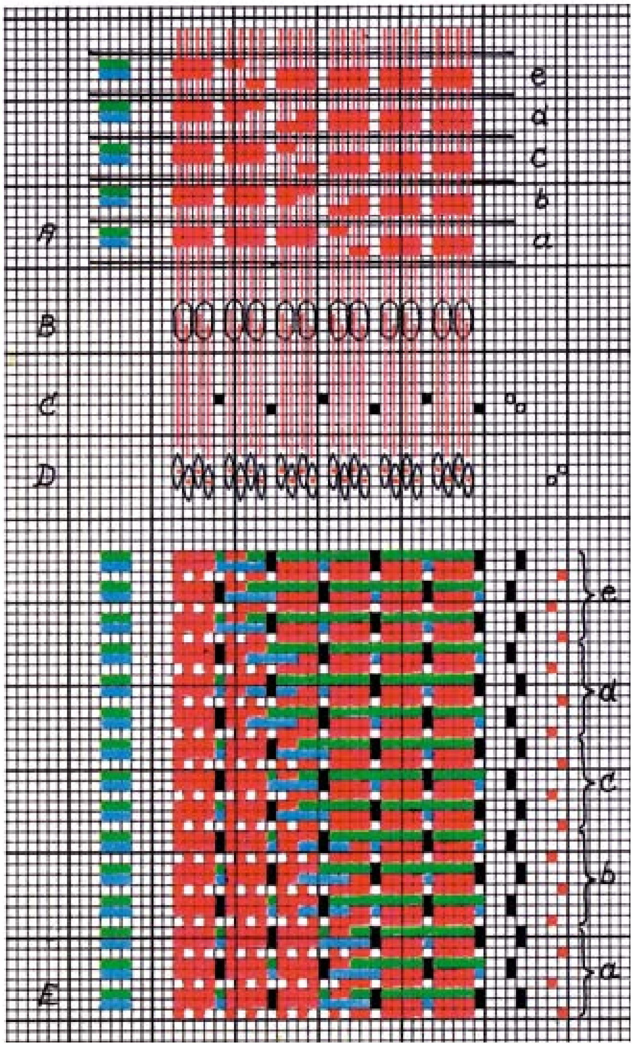


Figure 134 The draft for Fernando's pelisse shown face side up. Pattern lifts for passées a–e are shown at A. Main warp is lifted in groups of two, as shown at B. Binding warp (black) is adjusted to the lower shed face at C. Two shafts with long-eyed heddles are shown at D; they are tied up only to lift; no depression is needed because no tabby weave is used under the gold diamonds.

The order of wefts is shown at the left: white squares mean main weft, blue squares mean grey pattern weft, and green squares mean wefts of gold thread.

Each découpure consists of three passées (nine wefts); see braces a–c.

the gold but are pressed in between the two layers of pattern weave. These layers are bound together by the binding-warp ends and cannot be separated as the white diamonds can be. Where the angles of diamonds meet no white main wefts are thrown in. This gives the impression of a tighter line of gold across the fabric.

These are the specific features described by Gómez-Moreno as far as we have been able to understand them. The reason why the weaver made it in this way is a matter of conjecture. Presumably he intended to give a

Figure 135 Our replica of Fernando's pelisse.

Warp: organzine silk Nm 12.5 white. Four main-warp ends to one binding-warp end, 15 threads per cm.

Weft: main weft: spun silk Nm 10, white. Pattern wefts: spun silk Nm 10, grey and gold thread. 14 main and 28 pattern wefts, 42 wefts per cm.

little extra relief to the white diamonds on the face side when no tabby binding tightened the threads on the reverse side.

Our woven replica of Fernando's pelisse is shown in Figure 135.

Beiderwand

In the former Danish province Schleswig-Holstein, in northwestern Germany, a distinctive sort of textile was used for bed curtains during the 18th–19th centuries. They may have been used earlier, but no securely dated examples are found from before the year 1700. Built-in beds were generally used in cottages and farmhouses at this time. To hide the open beds in the daytime these curtains made from linen and wool were very useful; their patterns and colours also added a decoration to the rooms.

It is uncertain when the name, presumably meaning 'both sides', was applied to this sort of weave. The word *Beiderwand is* known from written sources from the 14th century, but there it means a narrowly striped half-woollen material for coats (Sauermann 1923). In this sense the word has continued till our day. In Danish the bed curtains were called *riflaken* or *rylaken: rif* or *ry* meaning 'rugged' (woollen), and *laken* meaning 'sheet'.

Beiderwand can be considered a sort of double weave; it is actually a true lampas (diasper) similar to our sample III, Figures 125–126; but the Beiderwand has always four main-warp ends to one binding-warp end. The material is generally linen for the warp and for the main weft, and a double-spooled wool thread for the pattern weft. Tabby is used both for main weave and for pattern weave. The pattern comes out in linen tabby on a ground of woollen pattern wefts dyed in a clear strong colour. This is the face side used in Schleswig.

It is remarkable that this rich and varied production apparently was almost unknown outside Schleswig-Holstein. The only other place where bed curtains of the same weave were generally used is the island of Amager outside Copenhagen.

In the year 1516 the Danish king, Christian II, introduced families of gardeners and farmers from Holland to Amager to cultivate fruits and vegetables for the royal household. Apparently the Dutch families were happy in their new surroundings; many more Dutchmen settled down on Amager in the following centuries. Nearly up to our time these people kept up their distinctive character in language, garments, and furniture.

Their textiles are preserved in large quantities in museums and private families. A variety of bed curtains woven with the Beiderwand technique is preserved. But here the other side was meant to be the face side: patterns come out in coloured wool and the ground consists of the tightly woven linen tabby, here showing up the striped effect from the binding warp. The designs are generally reminiscences of 17th–18th century silks and show a specific character of flourishing ornaments. Presumably the bed curtains are of local production.

Even though a large number of bed curtains is preserved, unfortunately nothing is left of looms or workshops on Amager. The bed curtains must have been woven by professional weavers, but in inventories they are often described as home made. Presumably the materials, linen and wool, were produced as home craft, but the weaving of the richly patterned textiles required a drawloom and only a professional weaver could afford this (Mygdal 1932). If only some real facts were available a connection to Holland could be established.

From Schleswig-Holstein the extensive and varied Beiderwand weavings have been described and reproduced by Sauermann (1923). The types of designs are so richly represented that they can be placed in three characteristic groups.

One group is woven with block patterning. This means that they were woven on a shaft loom with several shafts and they could have been made as home craft, at any rate by experienced village weavers; see our sample, Figure 139 below. The endless variations were certainly obtained from copper-engraved books widely circulated in the 18th century;* or they were copied by hand and altered as required.

Some patterns were more suitable for vertical hangings, for example the very common pattern of stylized trees. Others were decorative all-over patterns of chequers or stars. These block patterns circulated among European weavers, also for use with other sorts of weave, for example for the simple form of damask called 'damask diaper' for linen table-cloths.

* a) *Neu-hervorkommendes Weber Kunst und Bild Buch*. 4 Teile, Culmbach: in Verlegung Nathanael Lumscher, 1720. b) *Nützliches Weber Bild Buch*, von Johann Michael Frickinger. Schwabach und Leipzig: zu finden bei Johann Jakob Enderes, 1740. c) *Neues Bild und Muster Buch zur Beförderung der edlen Leinen und Bild Weberkunst*, von Johann Michael Kirschbaum. Heilbronn und Rotheburg ob der Tauber: zu finden bei Johann Daniel Class, 1793 (The Library of the Museum of Decorative Art, Copenhagen).

The clear geometrical construction gives a strongly proportioned balance and a timeless charm to this type of pattern; they were used with happy result in many connections for centuries.

Contrary to the first group of block patterns the next two groups, with rounded lines and much detail, needed to be 'drawn' i.e. they had to be woven on a drawloom. Fortunately drawlooms for Beiderwand are preserved in Schleswig; one loom is exhibited in the Museum of Altona (Sauermann 1923, p. 9). In this simplified drawloom the harness cords are placed horizontally uppermost in the loom and fastened over the head of the weaver. Thus he was able to draw the lashes for pattern himself without the assistance of a drawboy. One example of a similar loom is shown and described in Chapter 9. Presumably discarded damask looms were also used for Beiderwand (Sauermann 1923 p. 7).

Another group of Beiderwand curtains, certainly the largest, is decorated with ornaments of plants. Some of them show only plants, but most are adorned with birds, animals, certain symbols, etc., and nearly the whole repertoire of ornamentation from the 16th–17th centuries is represented, see Figure 136. This group is evidently inspired by silks from southern countries and from linen damask of Saxon origin.

The third group of Belderwand hangings is characterized by figurative scenes, sometimes derived from the Bible: the good Samaritan, the sacrifice of Isaac, Christ's entry into Jerusalem (see Figure 137), etc. Other motifs are from Greek mythology: the Pyramus and Thisbe motif is frequently seen. Another popular motif was the four continents (Australia not being known at that time). Some of these motifs are also found in linen damask from Holland. Certain motifs are recognizable in illustrated works; presumably skilled artists had drawn the motifs onto ruled paper ready for the weavers to count in onto their harness. Patterns of this type are found in Schleswig, and the ruled paper generally has the notation 'Printed in Amsterdam.'* Certainly such printed patterns were not exclusively intended for Beiderwand; they were used by weavers for other textiles as well. Still a connection to Holland appears, and furthermore the fact that Beiderwand curtains with figurative scenes were most frequently used near the coast of Friesland points in the same direction.

How the lampas technique came into use in this locality can only be a matter of conjecture. Presumably some weavers from a silk-weaving

* Dutch: 'gedruckt tot Amsterdam by Joachim Ottens op de Nieuwendyk in de Wereltcoart tussen den Dam en de Sout Strat.'

Figure 136 Beiderwand from Schleswig, 18th century. The Museum of Decorative Art, Copenhagen, no. A 119/1915. Pattern unit: width 33.5 cm, height 93 cm.

Warp: unbleached linen, 16 main-warp ends, 4 binding-warp ends; 20 ends per cm.

Weft: ca. 10 main wefts, ca. 10 doubled blue-green wool wefts; ca. 20 wefts per cm. This is a typical example from the second group of patterns with plants and animals. Note in the large flowers the decorative details used to bind the larger double-woven parts.

Photo: Ole Voldbye.

Figure 137 Beiderwand from Schleswig, 18th century. Christ's entry into Jerusalem. The Museum of Decorative Art, Copenhagen, no. 21/1948.

Warp: unbleached linen, 16 main-warp ends, 4 binding-warp ends; 20 ends per cm.

Weft: 15 linen main wefts, 15 doubled red wool wefts, 30 wefts per cm.

This is an early example of the figurative scenes from the third group. The weft is uncommonly tight in this weave.

Photo: Ole Woldbye.

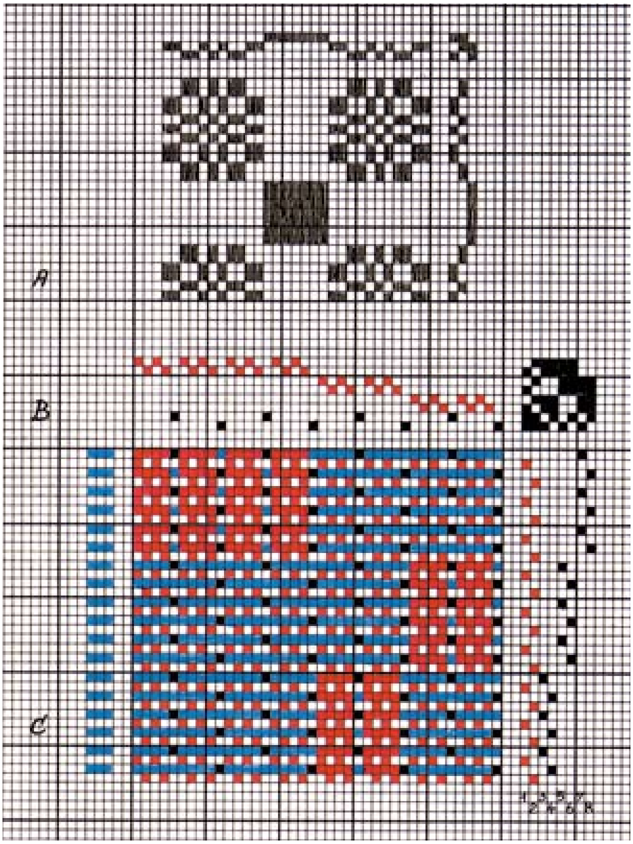


Figure 138 Draft for a Beiderwand in three-block pattern. In the pattern, A, each square means ten warp ends and twelve wefts. At B the entering of shafts is shown, two shafts (black) for binding warp and two shafts for each block of pattern, marked red. In the detailed draft C it can be noted that the binding warp (black) is always below the main weft (white). The red parts show the pattern in double weave, linen tabby on the face side.

centre moved to the region of Friesland and tried out their skill with the local materials, linen and wool. It is noteworthy that the tabby binding and the proportion of four main-warp ends to one binding-warp end is always maintained in Beiderwand. Also the materials, linen and wool, are nearly always used. Generally the linen is unbleached, though in some cases the linen for the binding warp was dyed in a colour corresponding to the wool weft in order to hide the binding points.

Block-patterned Beiderwand

For our experiment we used a three-block pattern, see Figure 138 A. As mentioned above, the Beiderwand weave has always four main-warp ends to one binding-warp end, i.e. one warp découpure consists of five threads.

In the pattern, Figure 138 A, each vertical column of squares means two découpures, ten warp ends. In weft direction each row of squares means twelve wefts, alternately linen and wool. The woven sample is shown in Figure 139.

An ordinary shaft loom was used; no draw arrangement is necessary for block patterns. The binding warp (black) was entered into two shafts in tabby for the pattern weave, see Figure 138 B. To bring out the tabby weave in the main warp two shafts are needed for each new block in the pattern, see the entering at B. The tie-up is shown by black squares for depression shafts and empty squares for lifted shafts. Alternating wefts of linen and wool are used throughout, marked respectively by white and blue in the draft.

For block patterning on a shaft loom the treadles are used for both the binding and the patterning, contrary to a loom supplied with a draw arrangement where treadles function only for the binding. Therefore treadles 1 and 2 are here marked red because they are used throughout for main weave. The other treadles, marked black, are used for the binding warp (black), and at the same time they lift the groups of main warp for pattern. Two treadles are therefore needed for each new pattern block. Each treadle block can be used for any height needed for the pattern.

Only this three-block pattern is shown here. Any block pattern can be woven with this method.

Beiderwand woven on a drawloom

The method for weaving Beiderwand on a drawloom is demonstrated in Figure 140. Main warp, marked red, is entered in groups of four into the leashes at C. Between each group of main warp one binding-warp end (black) is taken past the leashes and entered alternately into small-eyed heddles on two shafts at D; these shafts are adjusted to the lower shed face and lifted alternately for the binding of pattern weft. Main warp is entered once more into long-eyed heddles on two shafts to bring out the tabby weave with the main warp (red) and the main weft (white). Four treadles are needed, treadles 1 and 3 for main weft (white) alternating with treadles 2 and 4 for pattern weft (blue) in combination with the current pattern lift. The long-eyed heddles allow a pattern lift to stay open while a découpure is woven.

This is the method used for the Beiderwand bed-curtains apart from the first group of block-patterned weaves.

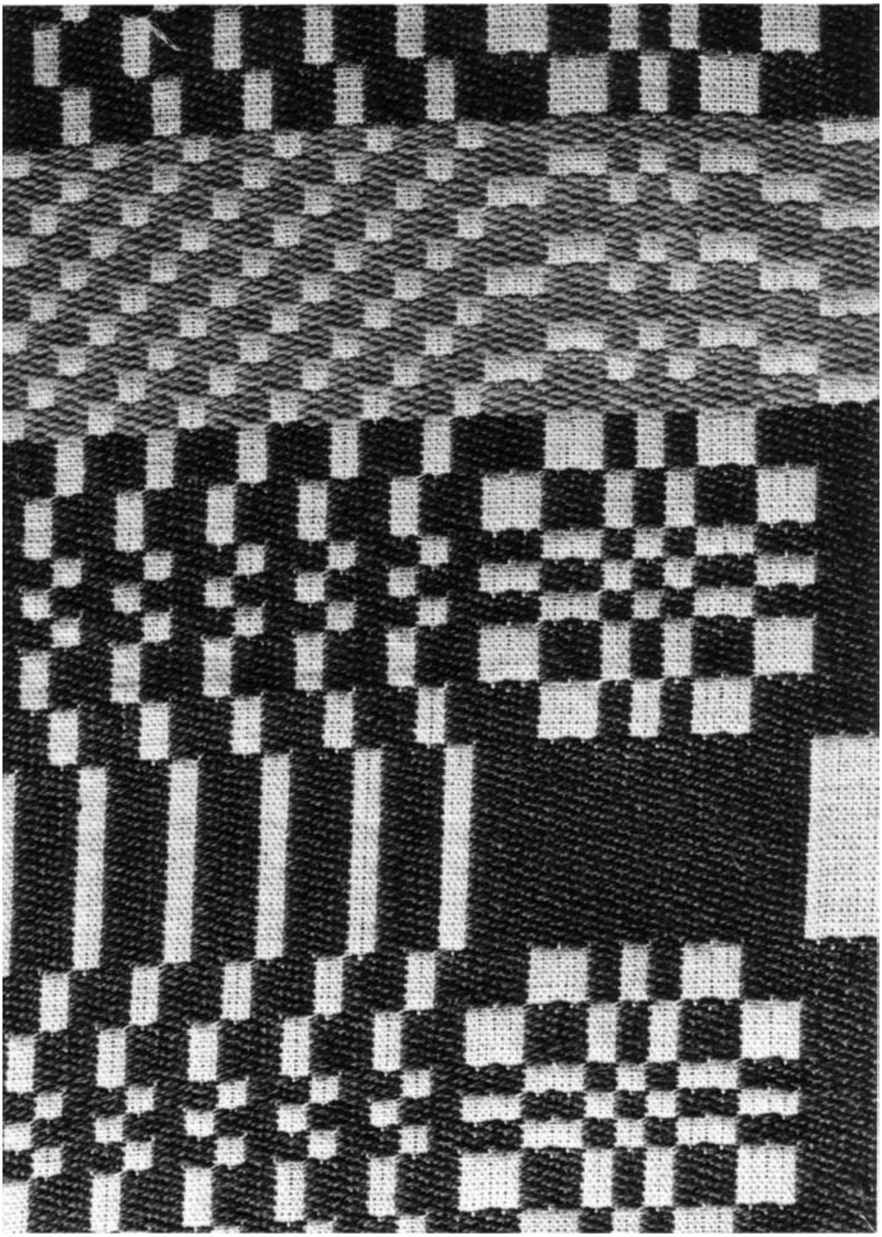


Figure 139 Sample with block patterning woven after the draft, Figure 138.
Warp: unbleached linen 25 lea, 12 doubled threads per cm.
Weft: main weft: linen 25 lea, 7 doubled wefts per cm. Pattern weft: 2-ply wool, 7 per cm.

For our experiments, shown in Figure 141, we used a detail from the bed-curtain belonging to The Museum of Decorative Art, Copenhagen, dated to Schleswig 18th century, Figure 136. We succeeded in weaving nearly the same quality as in the original example.

Lampas (and Beiderwand) as a pick-up weave

A third method for weaving Beiderwand and other sorts of lampas has lately been tried out. The method is most useful for a unique textile with freely designed figures. The outlines of the motif are first drawn with a

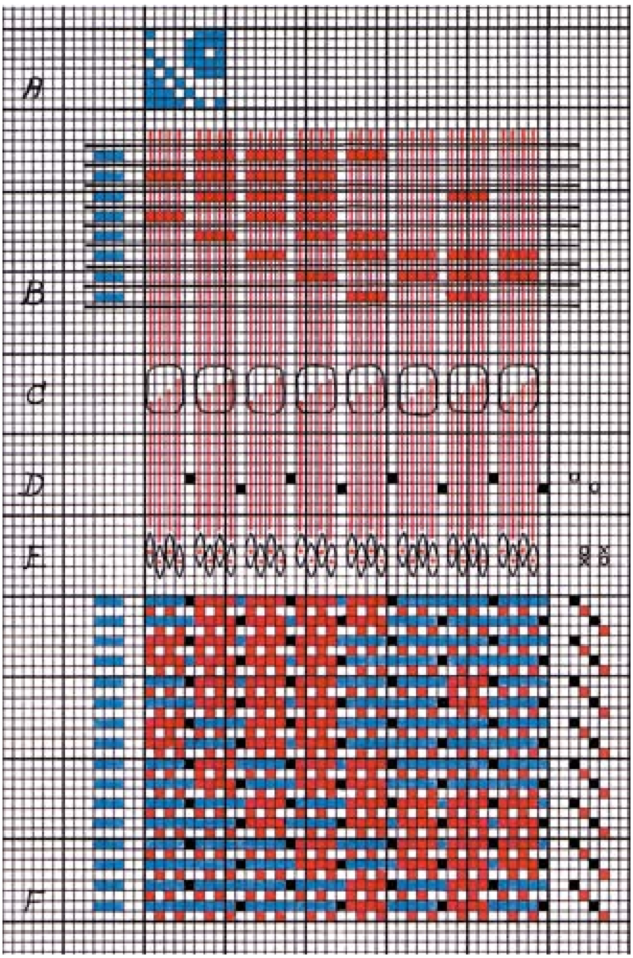


Figure 140 The draft for a Beiderwand woven on a drawloom. A is the detail of the pattern used for the draft. One square means four main-warp ends and one binding-warp end. Horizontally it means four wefts, two main and two pattern wefts. At B is shown the lifting of pattern. Each of the leashes at C lifts four main-warp ends. Binding warp (black) is entered into small-eyed heddles on two shafts at D; the shafts are adjusted to the lower shed face and lifted alternately by the treadles, marked black, for weaving tabby with the pattern weft. The main warp is entered again into long-eyed heddles on two shafts E to produce the main weave in tabby. The detailed draft F shows the individual threads; compare this draft with the draft for lampas in Figure 125.

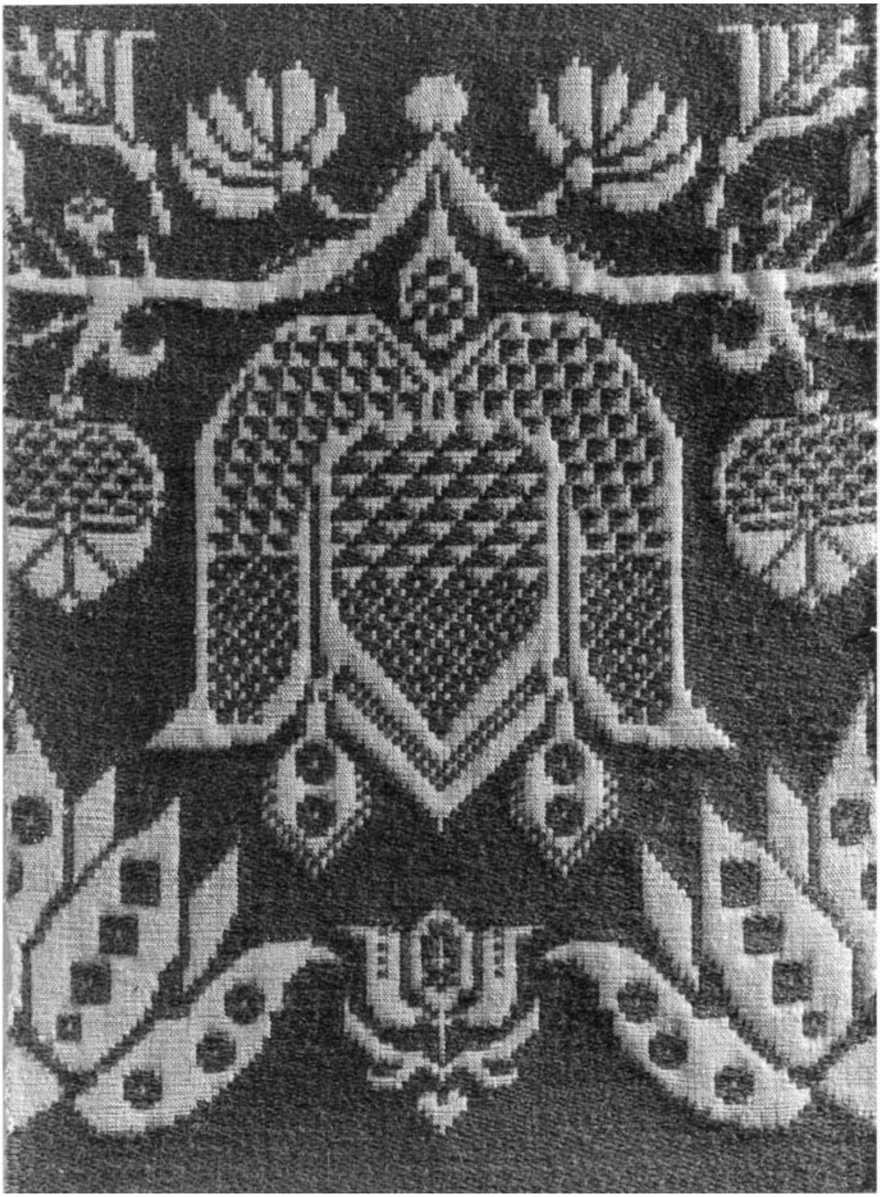


Figure 141 A detail from the bed-curtain shown in Figure 136 was used for our sample of Beiderwand woven on a drawloom.

Warp: unbleached linen 16 lea, ca. 18 ends per cm.

Weft: main weft: linen 16 lea, ca. 11 per cm. Pattern weft: doubled blue wool, ca. 11 per cm; ca. 22 wefts per cm.

This is nearly the same thread count as in the original example from Schleswig.

clear black line in real size onto a sheet of sturdy white paper. This working drawing is fastened below the warp ahead of the reed, and the lifting of pattern follows the outlines exactly.

For this system a common shaft loom is sufficient. The setup of the warp is shown in the draft, Figure 142. Main warp, marked red, is entered into two shafts and binding warp, marked black, is entered into two other shafts, nearest to the weaver, as shown in the draft.

For a Beiderwand weave it is useful to note in the sleying of the reed: if the main warp is sleyed two to a dent, the binding-warp ends must go into every other dent. This way the dents contain alternately two and three threads, and the tabby is distributed evenly throughout the main weave.

Four treadles are needed for the weave: treadles 1 and 3 (red) for the main weave in tabby, treadles 2 and 4 (black) for the pattern wefts. In the tie-up black squares mean depression shafts and empty squares mean lifted shafts. At the right an extra treadle, marked by red points, is tied up to lift the whole of the main warp and is used only in picking up pattern; this treadle is not used for weaving.

If an unpatterned part is wanted, then wefts of linen and wool are woven alternately with the four treadles as can be seen from the four wefts in the lower part of the draft, Figure 142.

When pattern turns up at the fell of the weave the whole of the main warp is lifted with the extra treadle at the right. A pointed stick, ca. 3.5 cm

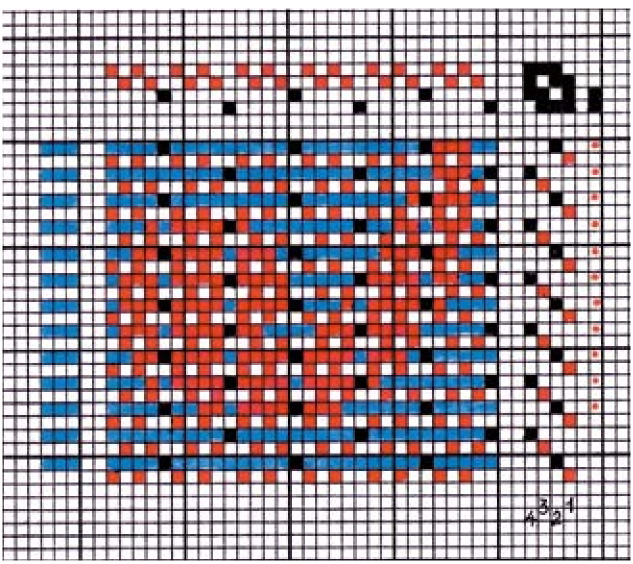


Figure 142 The draft for a Beiderwand woven with the pick-up method. The main warp and the binding warp are entered into four shafts as shown here. Four treadles are needed for the weaving. At the right is shown with red points the extra treadle used only for picking up pattern. A working drawing, with the outlines of the motif is placed below the warp threads for patterning.

wide, is used to pick up the threads needed for the pattern according to the outlines in the drawing below. Note here, contrary to the Beiderwand weaves described above, it is not necessary always to take up groups of four. With this method any number of main-warp ends can be lifted, corresponding exactly to the current outlines. When the lifts needed in the entire width have been picked up the shed stick is pressed flat against the reed; it is kept here with the left thumb while treadle 2 lifts every other binding-warp end. A new shed stick with a width of ca. 6 cm is now put in behind the reed under the groups of lifted main warp and at the same time under the binding-warp ends lifted by treadle 2. The broad shed stick is raised on edge and the first stick is drawn out. Into this shed the first pattern weft is thrown in, the broad shed stick is pulled out, a main weft

Figure 143 A fragment of an altar frontal woven with pick-up Beiderwand. Warp direction is shown horizontally.

Warp: doubled linen 14/2 lea, 6 doubled ends per cm.

Weft: main weft: doubled linen 14/2 lea, 6 per cm. Pattern weft: gold cordonnet, 6 per cm, 12 wefts per cm.

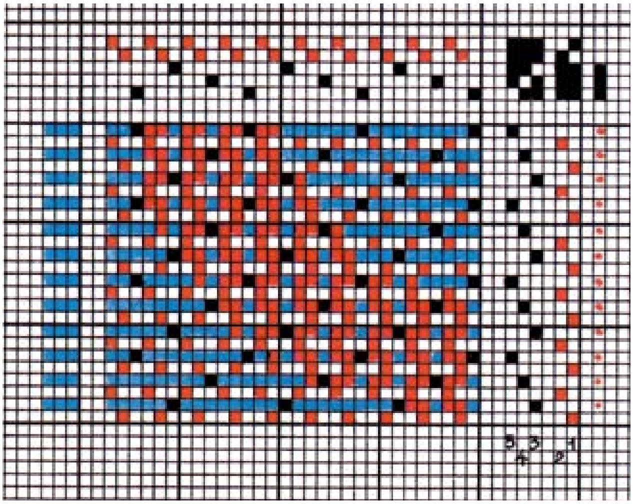


Figure 144 The pick-up method shown for a lampas with twill 1/2 for pattern weave. Note that three shafts and three treadles are needed for the pattern weave. The extra treadle to lift the whole of the main warp is shown by red points at the right. A working drawing fastened beneath the warp threads is needed for the pattern. Compare this draft with the draft shown above in Figure 128.

is woven with treadle 3, a new row of pattern is counted up, this time connected with the opposite number of binding warp lifted by treadle 4, then again tabby weft with treadle 1, and so on.

Figure 143 shows a fragment of an altar frontal in Beiderwand weave made with the pick-up method. Even though the quality is very coarse it was possible to form the rounded lines of different widths rather evenly.

The method is demonstrated in Figure 144 for an example of a lampas with twill weave 1/2 used to bind the pattern weft. Three shafts and three treadles are needed for the binding warp and the pattern weft in this case. Compare this draft with the sample shown above in Figure 128. In Figure 144 only two main-warp ends are used between binding-warp ends. This depends on how long the weft floats are wanted in the pattern weave.

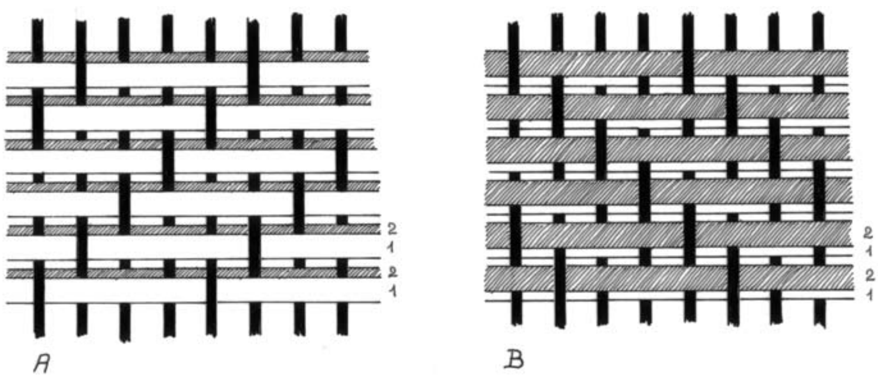
For the weaving of longer lengths with repeated pattern units the draw-loom is preferable, but for a unique textile which is not too fine in quality the pick-up method is not very time-consuming. For each pattern weft it is necessary to pick up only once, contrary to the pick-up method for true double cloth, see Chapter 8.

Chapter 7
Double-faced weft weaves

In about the twelfth century a new type of patterned weft-faced weave appeared. Both sides of these textiles have a predominant weft. Many examples are preserved in churches and museums, most of them considered to be of Spanish production from the thirteenth century. Undoubtedly these double-faced weft weaves originated among Spanish weavers, perhaps during the twelfth century.

The term 'double-faced weft weave' means that the two sides are equally finished in appearance, and the choice of which to call the face and which the reverse is, from a technical point of view, arbitrary. In Figure 145 two diagrams show both sides of an unpatterned double-faced weft weave. Two wefts of different colours alternate, and it is convenient to consider these separately. The white weft 1 forms the upper side in diagram A with a *weft-faced* twill 3/1 while the darker weft 2 forms the other side with a *warp-faced* twill 1/3; diagram B shows the opposite side. When these bindings are combined, an important rule is that binding points of the one weft must be hidden by weft-floats of the other. See the draft, Figure 146:

Figure 145 The principle of the double-faced weft weave. In this sample twill 1/3 and 3/1 are used. Warp ends are marked black; two wefts, white and hatched, are used throughout. In diagram A the white weft appears on the upper side and the dark weft on the lower side. At B the same diagram is turned over to show the dark side. The binding points are placed in such a way that they are always concealed by the weft floats of the other colour



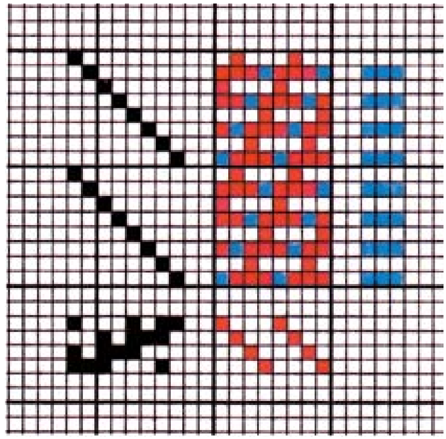


Figure 146 The draft for an unpatterned double-faced weave corresponding to diagram A in Figure 145. Note that blue binding points on the blue weft always have a white weft above and below and red binding points on the white weft always have a red warp above and below; with this arrangement, binding points on one side are covered by weft floats on the other side.

a blue binding point on weft 2 has always a white weft above and below, and a red binding point on the white weft 1 has always a red warp above and below; therefore the weft-floats slide over the binding point from the other side when the material is properly beaten in.

For patterning the two differently coloured wefts change places as required by the pattern. In the diagram, Figure 147, a change of colour is shown; patterns come out in reversed colours on the other side. A drawloom is needed for patterning. We have never seen more than two wefts used in this weave; for gold or any extra colour brocading is utilized.

Unlike the earlier compound weft weaves, taqueté and samitum, only one warp is used for this weave. Presumably this was one reason why the Spanish weavers developed this specific weave. The high-quality silk weaves woven with this technique always have each warp end lifted individually by one harness cord. Possibly some Spanish weavers had at their disposal a type of drawloom well suited for this method; for instance the Persian type of drawloom would be very suitable.

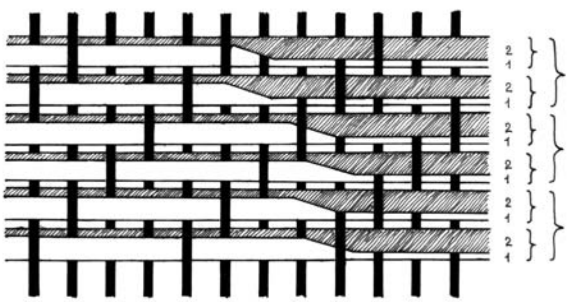


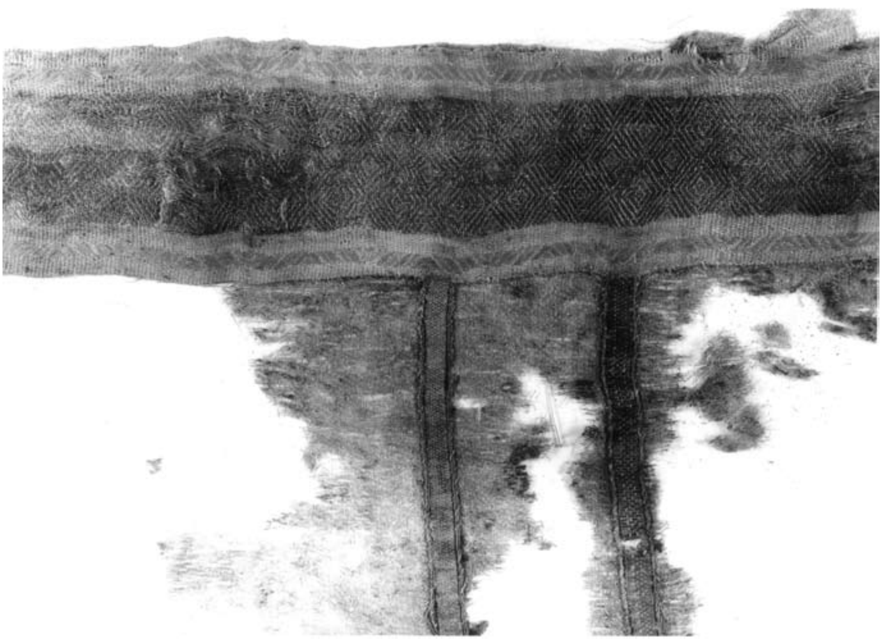
Figure 147 For patterning the two wefts the two wefts change places according to the pattern. The diagram shows such a change of colours. Each of the smaller braces indicates one passée while the larger braces indicate découpures. See the lower right corner of the draft Figure 161. A drawloom is needed for the patterning.

Archaeological material

The Burgos collection includes a large number of silks woven with the double-faced technique. Gómez-Moreno (1946) illustrates these weaves in a variety so amply represented that almost the entire development of the double-faced weft weaves appears. Some samples of lozenge-patterned twill weaves are shown, some with different colours on each side. One example, no. 26, pl. LXVIII, woven on a white warp with blue weft, has in each lozenge a little diamond of gold. A characteristic of the Spanish silks woven with this technique is that the ground always has a lozenge pattern.

Absalon's gold border

We have had the opportunity to make a detailed study of a very similar sample from the same time. The Danish Archbishop Absalon died in 1201 and was buried in the monastery church in Sorø, which was founded by Absalon himself. During recent years the scanty textile remnants from his tomb have been carefully conserved. Among these is the double-faced weave in gold and silk shown in Figure 148. This golden trimming must have been cut from a larger piece of material: it is hemmed on all sides.



The weft direction is along the length (horizontally in the figure). The two wefts are respectively gold and slightly twisted silk. The gold thread dominates the front side, while the silk weft from the other side comes up only as small diamonds. An enlarged detail is shown in Figure 149.

We made a draft, Figure 150, to show how we think it possible to weave this double-faced weave. At A is shown the lifting plan for half of the diamond. Each harness cord lifts a single warp end: see the leashes at B. Presumably the harness cords were arranged in point repeat. Figure 150 C shows five shafts with long-eyed heddles entered in point repeat for the lozenge pattern.

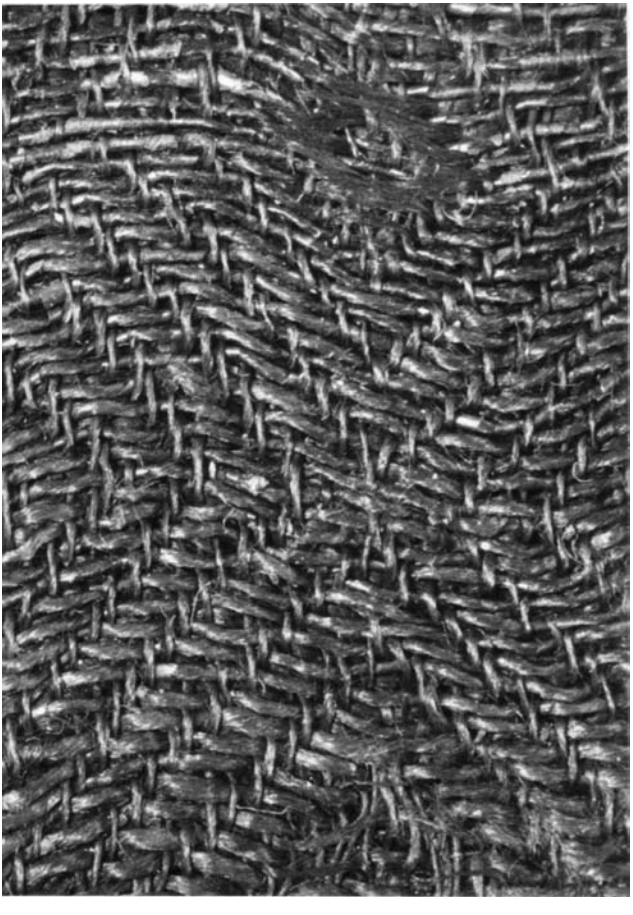
The gold thread (blue in the draft) goes under two warp ends and over three, twill 2/3. The silk weft (white) on the other side goes under four and over one warp end, twill 4/1.

↙ **Figure 148** A gold border from Archbishop Absalon's vestments. Two tablet-woven bands are normally placed in this way on a dalmatica; therefore this is presumed to be part of his dalmatica. The width of the lozenge border is 4.5 cm.

Warp: silk Z-twisted, 36 ends per cm.

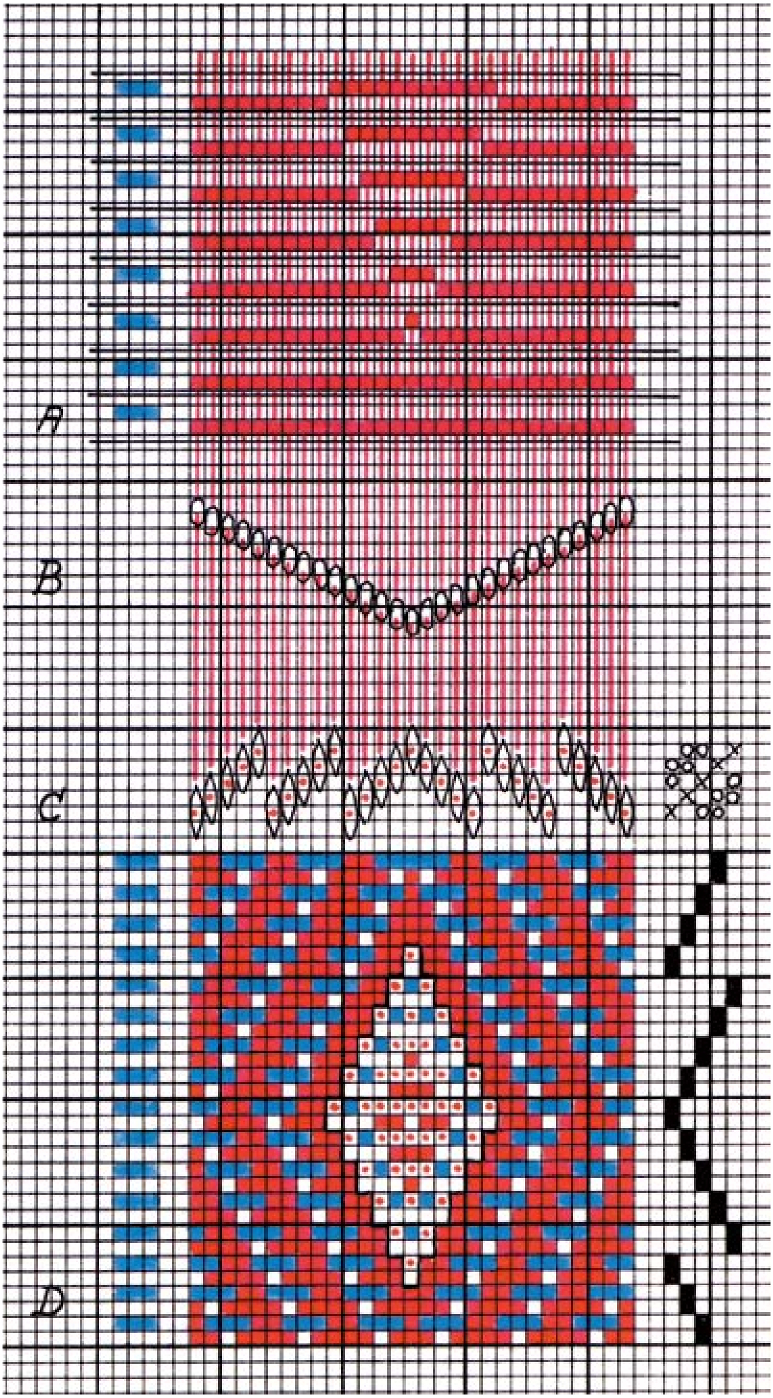
Weft: gilt silver wound on silk alternating with untwisted silk, 60 wefts per cm.

Photo: The National Museum of Denmark.



→ **Figure 149** Enlarged detail of Absalon's gold border showing the front side of gold with diamonds of silk appearing from the other side.

Photo: The National Museum of Denmark.


A
B
C
D

For white weft 1 (silk) the whole of the warp is lifted by the harness cords and the binding is brought about by depression shafts. For the blue weft 2 (gold) the warp is left down; the twill weave is brought out by lifting shafts only.

For clarity the diamond figure is outlined in the draft, Figure 150 D. Each warp end within the diamond lifted by the harness cords is marked by a red point. Warp ends lifted by shafts and treadles are marked by filled red squares.

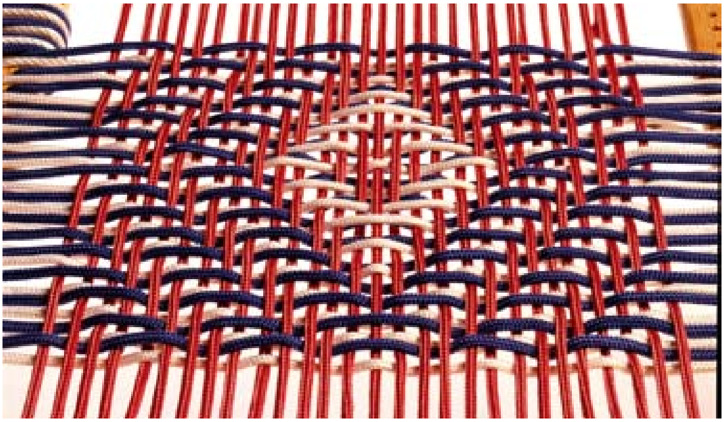
In order to show more clearly how white and blue wefts work across the warp the same draft is plaited in a frame, Figure 151.

To continue the development shown by Gómez-Moreno (1946), he tells us that later on noble families demanded their coats of arms woven into these double-faced lozenge weaves and that it then became a very intricate technique. Below we shall see how true this remark was.

Exquisite examples of this type are preserved in the Burgos collection (Gómez-Moreno 1946, pl. LXX–LXXIV); Florence May (1957, figs. 59–62) also reproduces these silks. A number of samples are found in other European museums. One example, shown in Figure 152, is preserved in the History Museum at the University of Bergen, Norway, from the Selje Convent.

← **Figure 150** Our draft for Absalon's gold border. At A is shown the lifting plan for half of the diamond. Note at B that warp ends are entered individually into the leashes, arranged in point repeat. Five shafts with long-eyed heddles are used for the two twill bindings. The diamond is outlined in the draft D; here each warp end lifted by the leashes is shown by a red point. Warp ends lifted by the shafts are shown by filled red squares.

↓ **Figure 151** To show more clearly how the two wefts work across the warp the draft D is plaited with coloured strings in a frame.



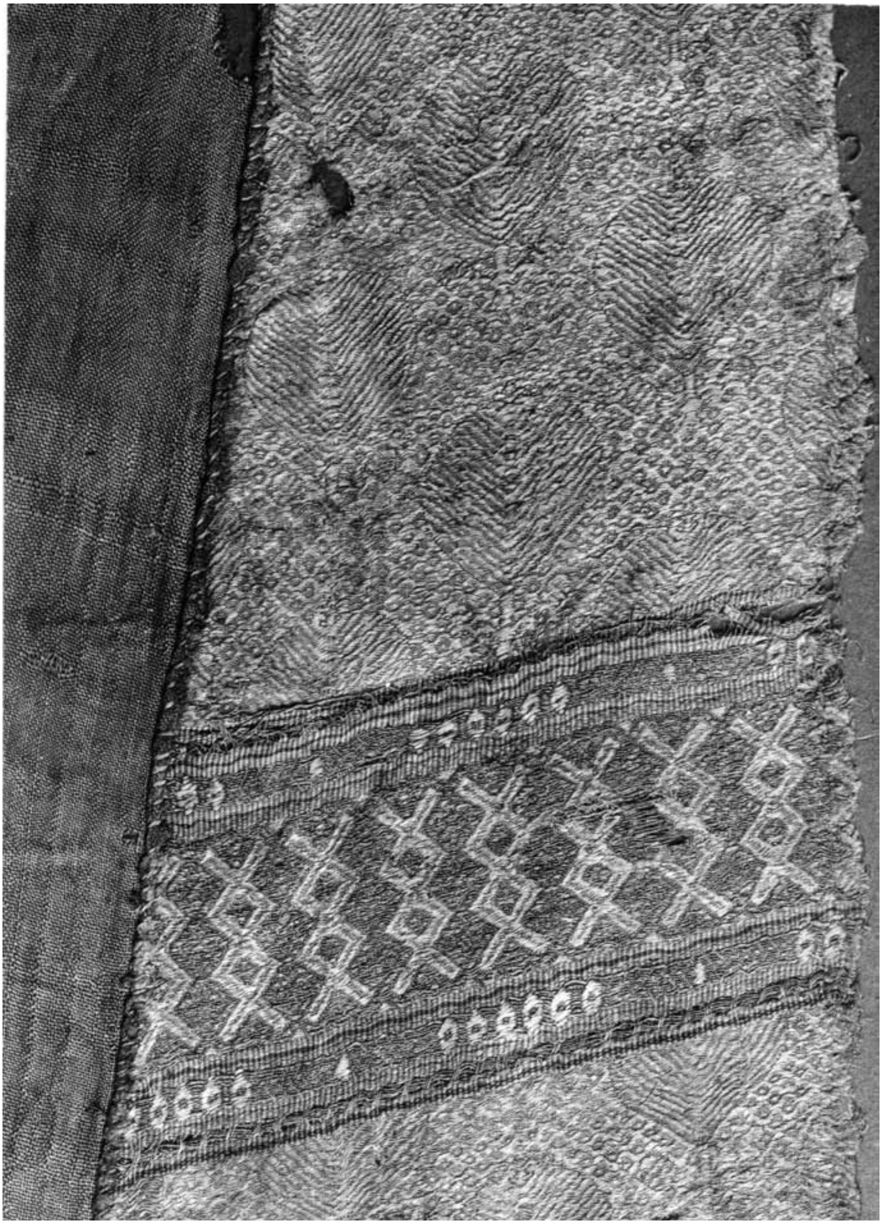


Figure 152 An example of a *drap de l'arrest* belonging to the History Museum at the University of Bergen, Norway, no. 178 BM.

Warp: ca. 45 ends per cm.

Weft: ca. 98–100 per cm.

Photo: The Bergen Museum.

The specimen from Aarhus

In the years 1963–64 an excavation on the site of an old hotel in the city of Aarhus, Denmark, revealed some strata of archaeological interest. Building foundations, ceramics, and various types of textiles were found. A thorough description of the excavation appeared in 1971: *Aarhus Søndervold* (Andersen et al. 1971). The garments and textile fragments were described in this report by Erna Lorenzen.

Among the finds was a tiny piece of silk, the length 13 cm, the largest width 2.5 cm tapering at one end. Warp: twisted silk, ca. 26 ends per cm; weft: untwisted silk in two series, ca. 28 in each, i.e. ca. 56 wefts per cm. The material now has a pale brownish tint; no traces of the original colour can be seen. The silk fragment is preserved in the Prehistoric Museum, Moesgaard, near Aarhus. Here Flemming Bau by means of a microscope succeeded in drawing an exact diagram from part of the silk, see Figure 153. Obviously the fragment is too small for any comment on the design.

It appears from the diagram that two wefts work alternately as discussed above. Therefore we made two drafts, Figure 154 A and B, one from even-numbered wefts, the other from odd-numbered wefts. Certainly faults occur and some threads are missing; still we could clearly trace the four twill bindings used. Bindings C and D, Figure 154, are used for the lozenge ground on each side; the binding unit is five. The twill bindings E and F are used for what we presume to be the figured part; the binding unit here is six. The differently numbered binding units were just the stumbling point which we, in common with Gómez-Moreno, found to be terribly intricate.

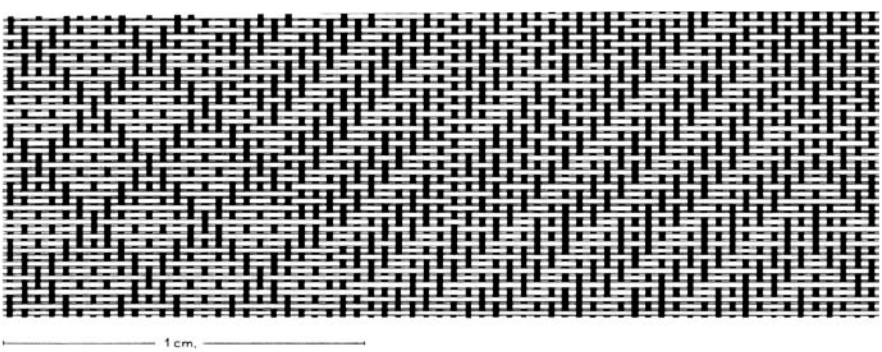
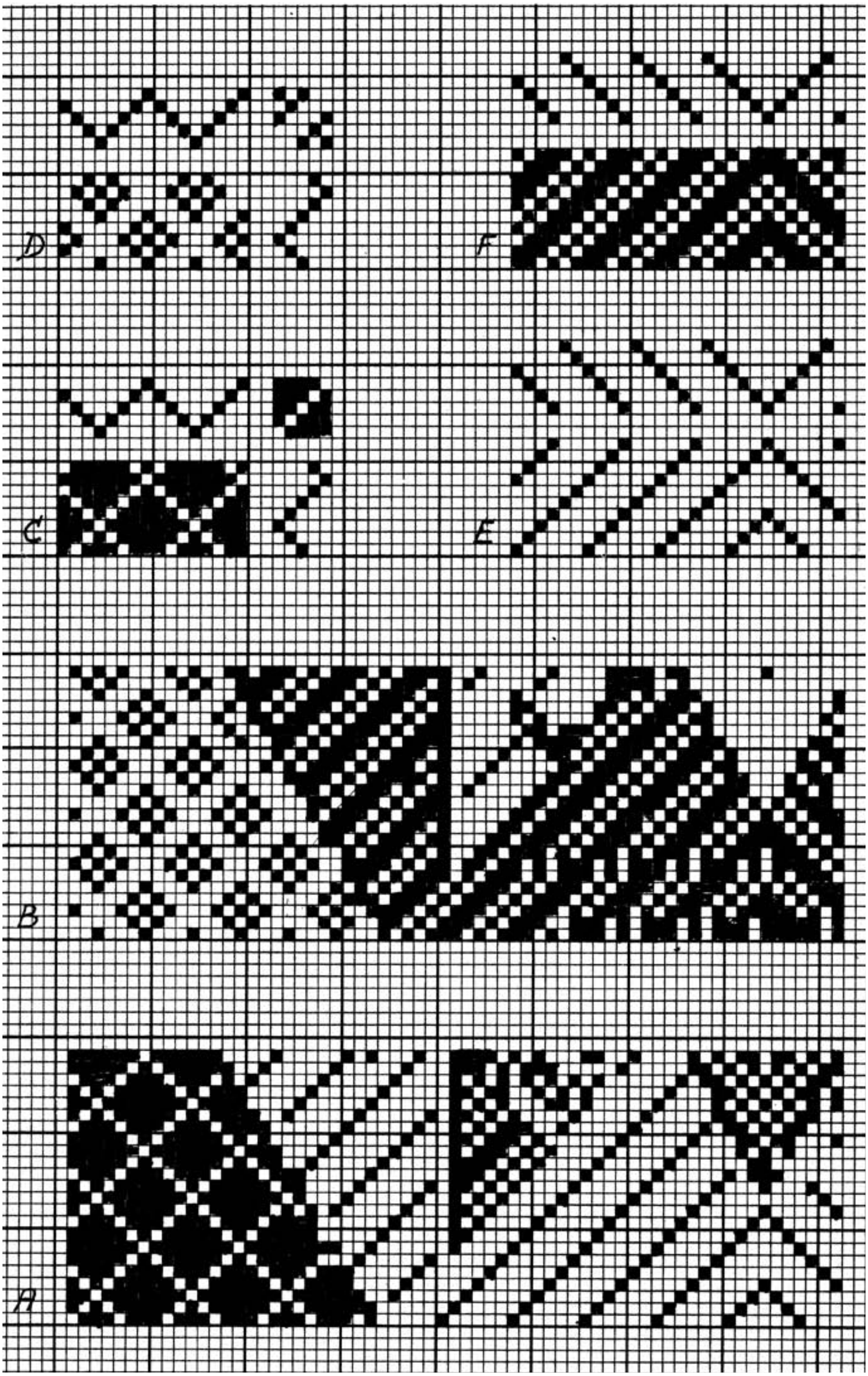


Figure 153 Diagram from the silk found in Aarhus, Denmark. Warp ends are marked black. It can be seen that every other weft dominates the upper side (Andersen et al. 1971, p. 238).


D
F
C
E
B
A

How was it possible on a ground woven with five shafts to use for pattern a binding with a unit of six?

In order to clear up the weaving of the silk our drafts were sent to the Victoria and Albert Museum, London. In a kind letter Donald King told us of similar textiles in European museums and also referred us to Gómez-Moreno (1946, pl. LXXI–LXXIV) as well as his own article, 'Two medieval textile terms' (1968a). This article is of great interest in this connection; it discusses the medieval term *drap de l'arrest* and concludes that the Latin word for an ear of corn, *arista*, was applied in Mediaeval times to a fish bone. Cloths of *areste* are 'fishbone', or what is now called herringbone (or chevron) twill, in which the diagonal lines of the twill are reversed about a central axis. This is a characteristic of all known *drap de l'arrest* textiles.

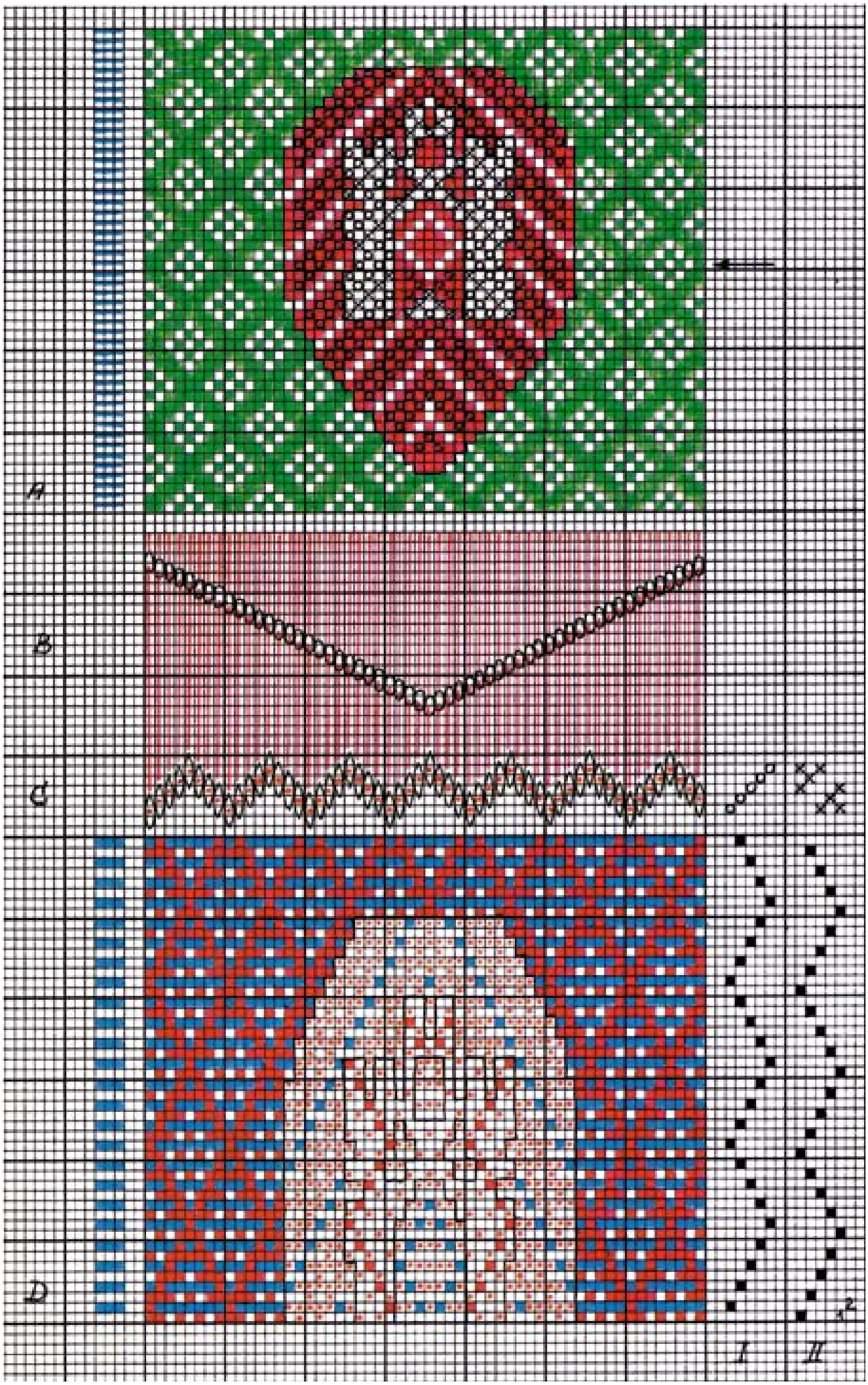
Pattern units in the known examples are never very wide and the twill direction is turned over in the middle of each motif. Luckily such a 'turn-over' is visible in the draft of our little piece of silk; see Figure 154 A at the right. From this it became evident that the lozenge ground was woven with shafts and treadles, while the motifs were woven entirely by means of the harness cords, each cord lifting one single warp thread. By this method the harness can be used for any thinkable variation of twill as long as the rule for double-faced weaves is maintained: the weft floats on one side must conceal the binding points from the other side. In the sophisticated Spanish silks two different twill weaves are employed to bring out the pattern.

In one example (Gómez-Moreno 1946, pl. LXXIII) the twill lines are employed to draw the rounded lines in the wings of birds. Still the main twill direction is reversed in the middle of each motif.

Our experiment with a drap de l'arrest

As a motif for our experiment we used a silk from Burgos (Gómez-Moreno 1946, pl. LXXI and Florence May 1957, fig. 57). We made a simplified design, shown in Figure 155 A. Unfortunately Gómez-Moreno does not give the thread count or any dimensions for this silk. In the illustrations the number of lozenges could be counted, and this number multiplied by the number of threads in a binding unit gave the result of about 56 warp ends in each half of the symmetrical pattern unit.

← **Figure 154** Drafts made from the diagram in Figure 153. Note that wefts are marked by filled squares. A shows the wefts which appear on the upper side. B shows the wefts which appear between the wefts shown at A. C and D are the bindings used for the lozenge ground, binding unit five. E and F are the bindings used for chevron twill in the figures, binding unit six.


A
B
C
D
I
II

In the original silk the rows of emblems are staggered, i.e. the emblems in one row come under the intervals in the previous row. The pattern unit is reckoned from the middle of one emblem to the middle of the next emblem below, see Figure 156. In the 13th century drawlooms in Spain were apparently equipped with harness arranged in point repeat as shown here. In our simplified drawloom, the harness is arranged straight over without any repeat, so we counted up four emblems in one row; see the woven sample, Figure 157.

In the design, Figure 155 A, the emblem is outlined for better clarity. The colours, red and green, in this design represent the real colours of the silk; they do not have the technical significance which is usual in our drafts. The gold brocaded castle within the red coat of arms is for better clarity shown white and outlined with black. Although this textile is a double-faced weave, when brocading is used one side must be the face side. The design represents this side.

Twill bindings E and F from Figure 154 are shown as follows: binding E by white squares and binding F by black circles. Within the brocaded castle both twill E and twill F are shown; here twill E is shown by x's. It is interesting to note that tabby appears when both bindings are used simultaneously. Tabby below the brocaded gold is useful because longer weft floats in the ground material would compete with the weft floats of the brocaded gold thread; the surface of gold would be speckled with the colour of the ground weft. Therefore it is necessary to use tabby weave below the brocading to obtain an even surface of gold. In our sample two emblems are woven without brocading to show the tabby weave; see the detail in Figure 158. In the draft Figure 154 A a triangle with tabby appears in the upper right corner. This undoubtedly indicates that a brocading, now disintegrated, was worked in here.

Our sample was woven reverse-side up because of the gold brocading. The draft, Figure 155 D, is shown this way as well, contrary to the design at A.

← **Figure 155** Design and draft for our experiment with the Burgos silk in double-faced weft weave, the *drap de l'arrest*. Our simplified design is illustrated at A. Here we have momentarily departed from our usual colour code and used the actual colours of the silk. Each row of squares means two wefts, shown by white and blue at the left. At B is shown the entering of the warp, one end in each leash. At C the warp is entered again into five shafts with long-eyed heddles in point entering,. the shafts are used for the lozenge ground. The upper half of the design is shown at D in detailed draft, reverse side up. Two groups of treadles are used, group I for lifting and group II for depression shafts. Within the outlined coat of arms every warp end lifted by the leashes is marked by a red point. Within the brocaded castle filled red squares denote the binding C of Figure 154 lifted by treadle group I. Wefts 1 and 2 in the lower part of the draft D represent the row of squares marked by an arrow at the right of the design A.

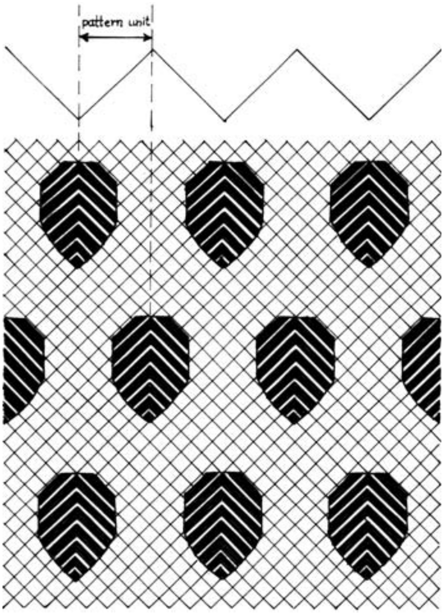


Figure 156 This simplified outline of the pattern in Figure 155 illustrates the point repeat. Note the illusion of a much larger pattern unit obtained by staggering the rows of emblems.

Certainly we can now agree with Gómez-Moreno that this technique is very intricate and troublesome to work out. Therefore it is presumably useful to sum up a short description on the counting up and the weaving of a pattern.

The design of Figure 155 A is used for counting up; note that one horizontal row of squares is used for weft 1 as well as for weft 2 (and for brocading).

Weft 1, white (green silk):
All of the warp ends in the lozenge ground are lifted; within the red emblem black o's are lifted. When brocading is used both o's and x's are lifted to give the tabby weave. One treadle from group 11 is used for depressing the twill weave in the lozenge ground, binding D in Figure 154.

Weft 2, blue (red silk):
Warp ends in the lozenge ground are left down. Within the red emblems every red square is lifted, while white squares for twill E are left down (see

→ **Figure 157** Our woven sample of a *drap de l'arrest*. Note in the coat of arms the chevron twill from which the name is derived.

Warp: cotton no. 12/2, 9 ends per cm.

Weft: spun silk Nm 10, alternating red and green, and gold for brocading.

Red and green each 24 wefts per cm, total 48 wefts per cm.

the blue squares in the draft, Figure 155 D). Within the brocaded part every thread is left down. One treadle from group 1 is used to lift for twill weave in the lozenge ground, binding C in Figure 154. In the brocaded part binding C functions automatically above the tabby weave; see the red squares in the brocaded part, Figure 155 D.

Brocading weft is then laid in according to the design.

Figure 158 A detail of the woven sample shown in Figure 157. In one of the emblems the brocading is left out to show the underlying tabby weave. At the top the bindings C and D of Figure 154 are woven separately to show the bindings clearly. When these bindings are woven alternately according to the general rule only one binding can be seen from each side.

Half-woollen cloths preserved in Scandinavia

About ten rather large textiles woven with the double-faced weave are preserved in Finland, Norway, and Sweden. For warp is used a thread of linen or hemp; for weft S-spun wool in two or more colours (Sylwan 1928; Kielland 1941; Engelstad 1952 and 1958).

These textiles are tentatively dated to the 15th century but it is not known where they were produced. Although the materials, linen and wool, are similar to those normally used in Scandinavian home craft, these textiles were certainly imported. The width of the weaves, in some of them up to 150 cm, makes a local production improbable. A very wide and strong drawloom would have been needed, and only large and well-equipped workshops could afford such looms.

The extant examples are mostly found in churches; they were presumably intended for some specific use in the church. They are finished with an ornamental trimming at each end, the lengths being about 2 metres. One example, belonging to the Oslo Museum of Applied Art, Oslo, Norway, is shown in Figure 159.

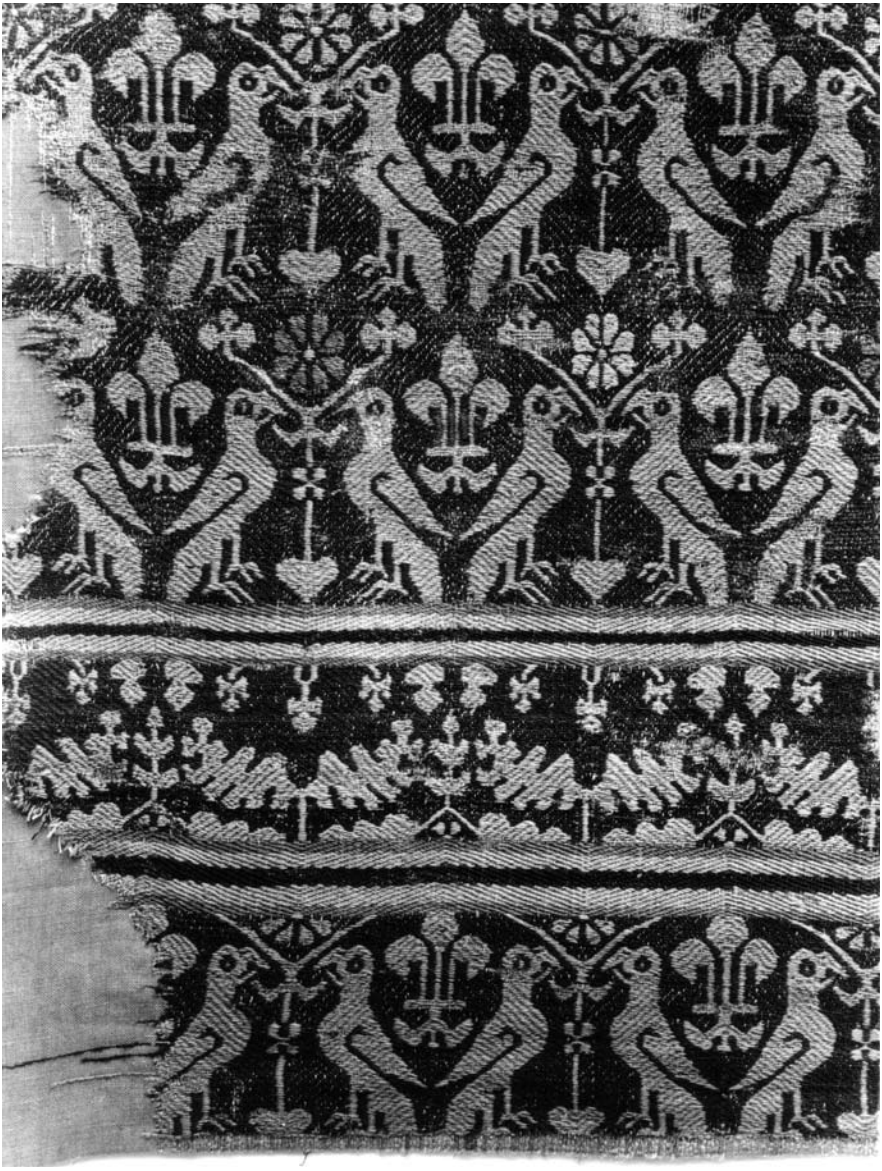


Figure 159 'The Heiberg Cloth' (Heibergteppet). Double-faced weft weave in linen and wool belonging to the Oslo Museum of Applied Art, Oslo, Norway, no. D 127-L12832.

Warp: linen thread, 10 ends per cm.

Weft: blue and yellow wool, ca. 16 wefts per cm.

Width: 150 cm, length: 206 cm. Half of the symmetric pattern unit: 7.5 cm. Height of pattern unit: 16 cm.

Photo: Teigen Fotoatelier A/S, Oslo.

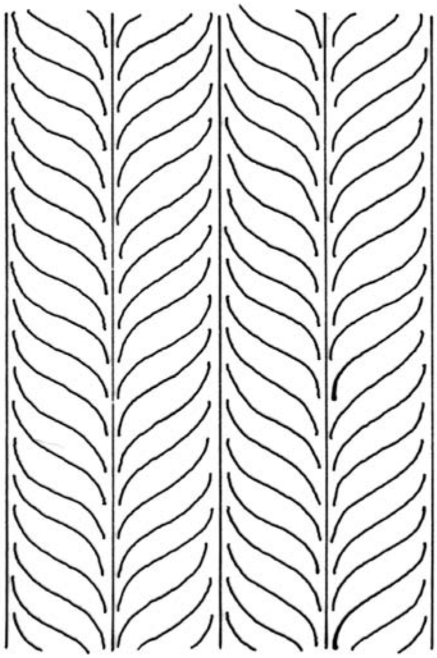


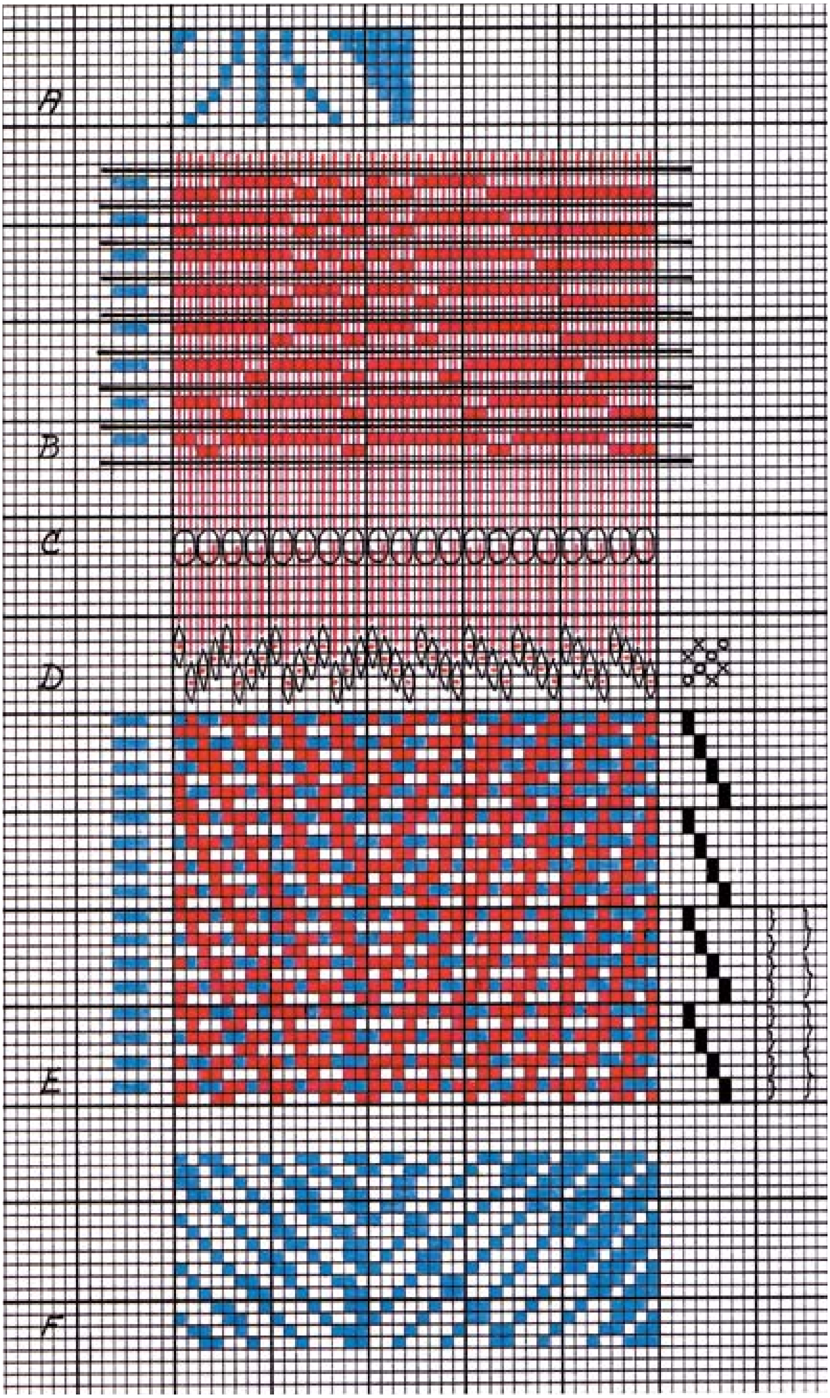
Figure 160 The simplified outline of our design for a double-faced weave in linen and wool. This design was drawn in real size, the width 48 cm, and fastened below the warp. Then it was easy to lift for pattern according to the drawing. Compare the design with the woven sample Figure 162.

The patterns are reminiscent of the Spanish silks discussed above and other contemporary silks from the Mediterranean area. Birds, flowers, and other details of ornament are always arranged in point repeat as shown above in Figure 156. The pattern unit, half of the. symmetrical motif, seldom exceeds 50–60 warp ends. The warp has a thread count of 8–10 ends per cm.

The binding is a four-shaft twill, 1/3 for one side and 3/1 for the other side. The shafts are entered in point repeat (point entering), the turning points corresponding with the pattern units; therefore the twill directions follow the point repeat of the pattern.

The experiment with the Burgos silk (see Figure 157 above) was slightly irregular, since point repeat was not used. It has been included here primarily to show the divergent possibilities of a drawloom. The same can be said of the next experiment to be described.

→ **Figure 161** The draft for our sample of double-faced weave. A fragment of the design is shown at A. The lifting plan at B indicates the opposed lifts within each passée. Two warp ends are entered into each of the leashes at G. Four shafts with long-eyed heddles are entered in point entering D. In the detailed draft E is shown that two passées are used for each découpure; note the brackets at the right. The diagram Figure 147 is drawn according to the lower right-hand corner of this draft. For clarity only blue wefts are drawn at F.


A
B
C
D
E
F

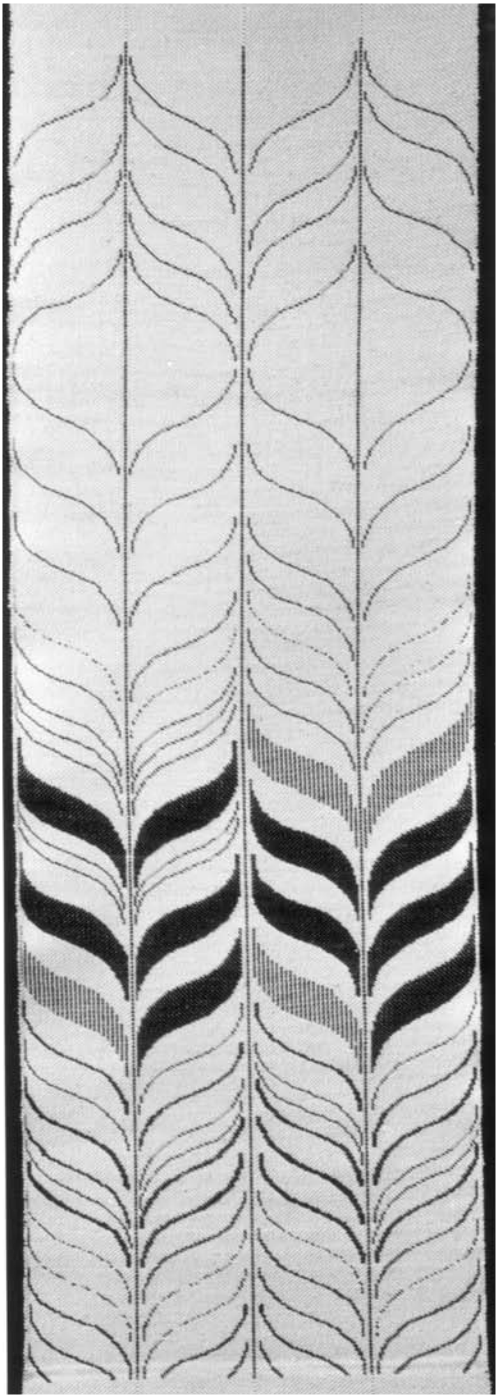


Figure 162 Woven sample of a double-faced weave with linen and wool. Note the diversity of the lines: in some of the filled intervals only every other harness cord was lifted, giving a lighter striped effect against the solid black.

Warp: unbleached linen 16/2 lea, 8 ends per cm.

Weft: alternately 2-ply white wool and black linen 14/2 lea, 20 wefts per cm.

For this experiment we used the same material as the Scandinavian textiles, linen and wool. As mentioned above our drawloom has no point repeat and we could work more freely with our design. We made a simple outline, see Figure 160, in real size and fastened it below the warp. The outline was drawn intentionally in four parts in a sort of point repeat to give our experiment the appearance of a true point repeat. Warp ends in this weave are always entered one into each leash; but our quality with eight ends per cm corresponded perfectly with the harness in our loom when two warp ends were entered into each leash, see the draft, Figure 161 C. Of course some irregularity appears in the detailed draft at E because two warp ends are lifted simultaneously, but in the woven textile no ill effect is to be seen. On the contrary, the slight irregularity gives a certain charm to the otherwise rather dry surface.

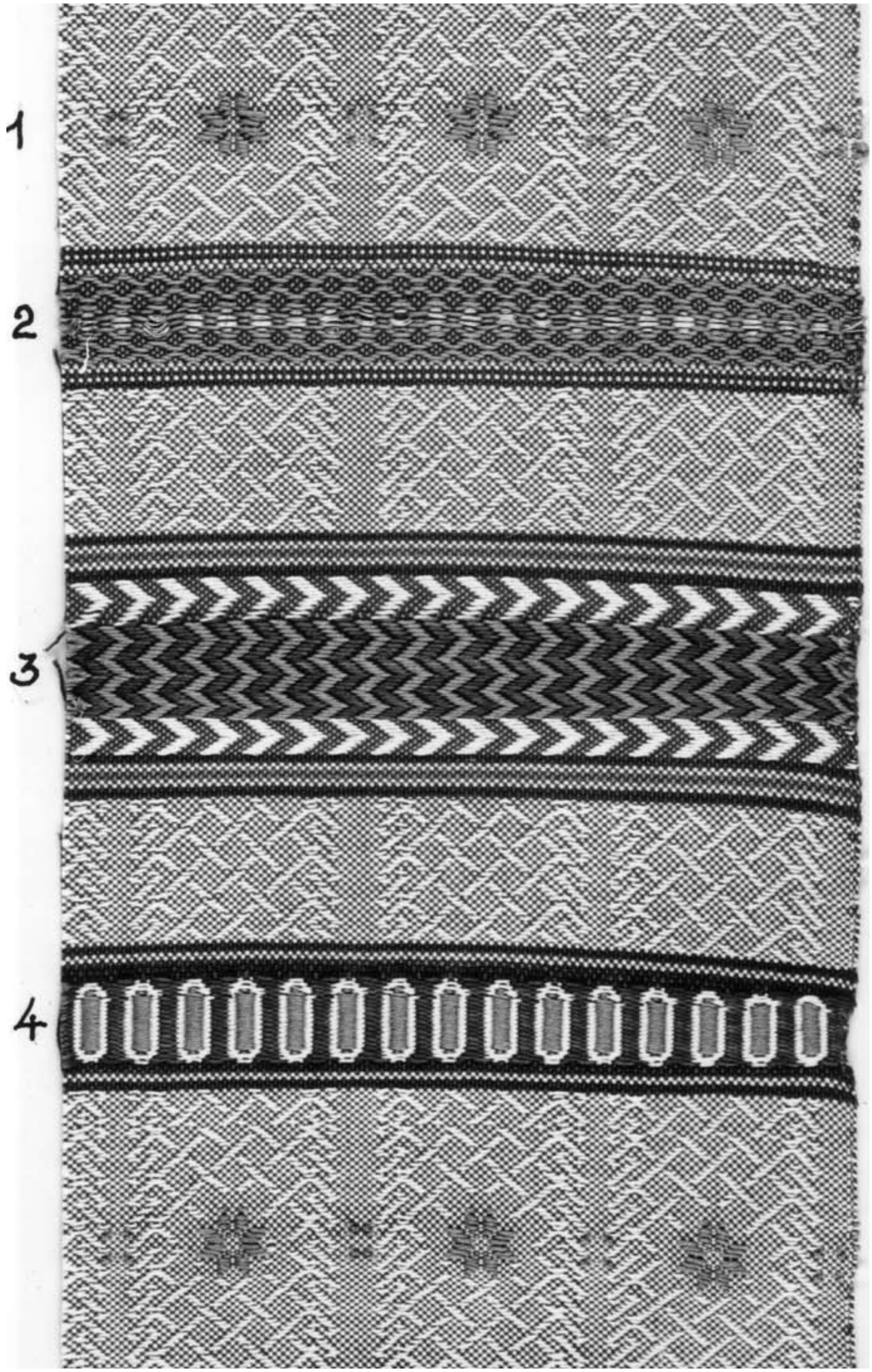
Four shafts with long-eyed heddles (see D) were entered in point entering, the turning points corresponding to the vertical lines in the outlined drawing. Then we could, against every rule of pattern repeat in the ancient weaves, pick up lines ad libitum, thin or thick, sometimes the whole of the intervals as can be seen from the woven sample, Figure 162.

Richly ornamented silks from Burgos

Another specific group of silks from the 13th century is represented in the Burgos collection (Gómez-Moreno 1946, pl. 61–67). They do not belong to the double-faced weave; but we found that it was possible to experiment with some details on the rest of our warp set up for the *drap de l'arrest,* Figure 155. These textiles were used for covers for the tombs or as parts of garments. They are characterized by richly ornamented bands, stylized Cufic scriptures, brocaded stars, and a variety of ornaments. The ground between bands is woven with tabby decorated with interlaced lines.

Nearly every technique known at that time seems to be represented; so much so that one is apt to look at them as a demonstration of virtuosity.

In the photograph, Figure 163, our few experiments are shown. As with the *drap de l'arrest* the weaving is done reverse-side up.


1
2
3
4

Uppermost at 1 tabby with interlacing lines is shown. This weave was used as ground between borders and also some pieces were woven entirely with this technique; for example a green pillow from the tomb of queen Berenguela (Gómez-Moreno 1946, pl. 62 and pl. 132) the silk afterwards embroidered with an extremely rough silk thread.

The lines of pattern, always running diagonally, consist of weft floats over three warp ends. One weft is woven as a normal tabby weft; while the shed is kept open single ends from the lower shed face are lifted by means of harness cords to form the pattern. In Figure 164 one pattern unit is shown, marked 1, and the detailed draft is shown at C 1. Warp ends lifted by harness cords are marked by black points. Two wefts are used for each tabby shed, one for tabby and one for pattern. On the reverse side pattern is only faintly to be seen. With this method it is easy to improvise linear patterns. From Gómez-Moreno's illustrations it is evident that Spanish weavers improvised freely. The patterns gained a certain firmness from the point repeat of the harness.

Stars and similar small motifs were easily lifted by the cords and woven in or brocaded with another colour.

The band marked 2 in our replica, Figure 163, used only a number of tabby wefts and some rows of lozenges woven with the treadles similar to the ground in the *drap de l'arrest*. A few gold threads are used in the middle of the border.

For the zig-zag band marked 3 in our replica we made the draft marked D 3 in Figure 164. Some tabby wefts of different colours are woven; then a white pattern weft is thrown in alternating with a dark tabby weft. In the middle part two colours go alternately over and under five warp ends without any tabby wefts in between, see the draft D3 and the pattern unit marked 3.

The band marked 4 is our simplified version of the Cufic scripture. The very much simplified design is shown in Figure 164, marked 4, face-side up. The detailed draft E4 is shown reverse-side up. Pattern is lifted by harness cords respectively for two or for three colours. When a weft float is too long on the face side, depression treadle 1 or 5 is used for a sort of

← **Figure 163** The woven sample shows our experiments with ornamented bands.
Warp: cotton no. 12/2, 9 ends per cm.
Weft: spun silk Nm 10 in a number of colours.

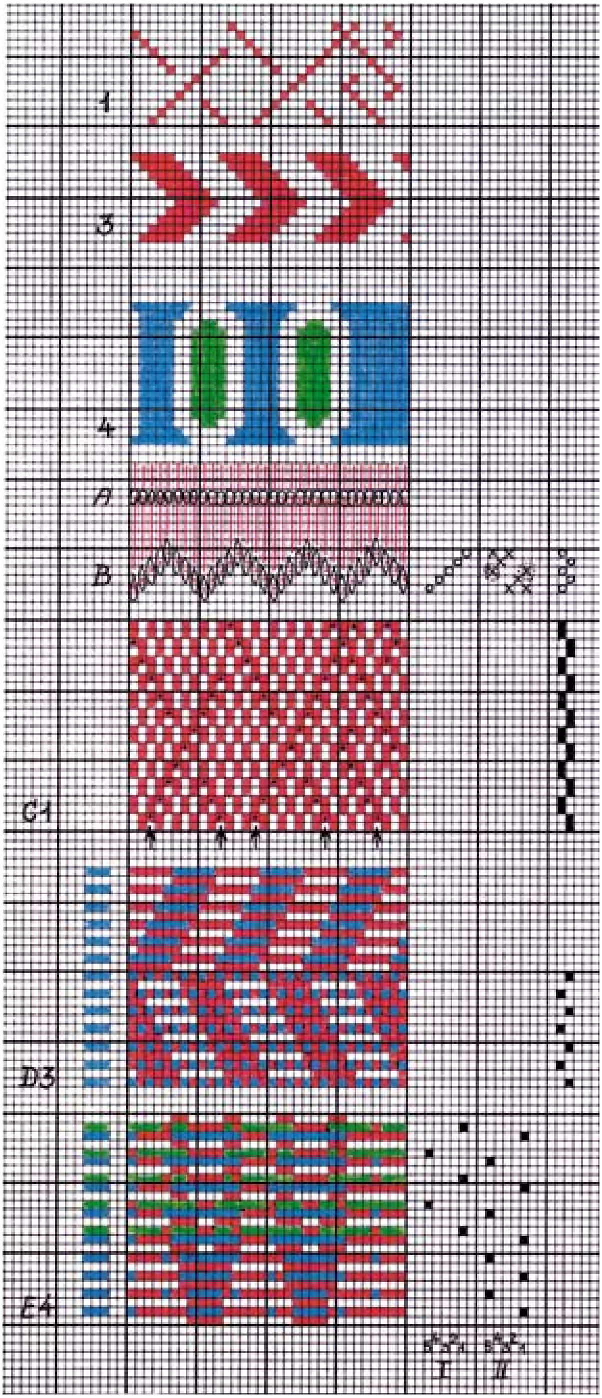


Figure 164 The draft for our replica with ornamented bands. At the top fragments of three simplified patterns are illustrated, marked 1–3–4. At A and B the warp is entered in the same way as in Figure 155. Note that two treadles for tabby are added, and that, in the tie-up for treadle group II, shaft 3 has been released from treadles 1 and 5, so that they can be used for binding the longer weft floats, see the draft at E 4.

binding warp; this is shown only on the blue wefts. If the weft floats on the reverse side tend to be too long, lifting treadle 1 or 5 is used; this is shown only on green wefts. This example shows a rather haphazard method but it is our impression that every possibility was utilized for these weaves.

It was strangely fascinating to weave this experiment on a drawloom set up as described above; more and more variations turned up and it was hard to stop. Gradually it became apparent that the Spanish weaver had been seduced by such prospects of imagination and had used his craftmanship to the heights of virtuosity.

Chapter 8
Patterned double cloth

Generally this type of weave is called 'double weave', but there are so many different types of double weave that the term has no precise meaning without an added explanation.

Our concern here is the patterned double weave, and to differentiate this from other double weaves we prefer the term 'patterned double cloth'. This term denotes a textile consisting of two separate layers of tabby simultaneously woven in contrasting colours one layer above the other. Patterns are formed when the layers change position, always appearing in reversed colours (Geijer 1979, p. 60).

Of course the Scandinavian 'pick-up double cloth' belongs here, but our term is meant to include also drawloom-woven silks and block-patterned textiles woven on a shaft loom; therefore the term 'patterned double cloth' is more adequate.

The earliest known example of patterned double cloth was found in Peru, and is dated to the Paracas Cavernas period, 850–300 BC (Mason 1968, p. 256). The high quality of this example indicates a long previous development. Patterned double cloth is richly represented among Peruvian textiles from the whole pre-Columbian epoch (d'Harcourt 1962); these textiles are perfectly woven with the primitive implements of the ancient Peruvians.

Persian weavers on the other hand utilized the double cloth for some very exquisite silks woven on drawlooms. Müller-Christensen (1985) describes a silk woven with three layers (triple cloth) from the tomb of bishop Hartmann buried in the Cathedral of Augsburg in the year 1286. The motif is the Sassanian king, Bahram Gor, AD 420–438. The author compares this silk to two examples in the Abegg Stiftung, Bern (Lemberg

← **Figure 165** Double cloth in red and white silk brocaded with gold thread. This exquisite silk was woven on a drawloom in Persia about the year 1600 (Motala Church; now in Linköping Museum, Linköping, Sweden). Note that on the face side, above, the gold brocading appears only on the red figures. Face and reverse side are shown; height of pattern unit ca. 14.5 cm. Photo: ATA, Stockholm.

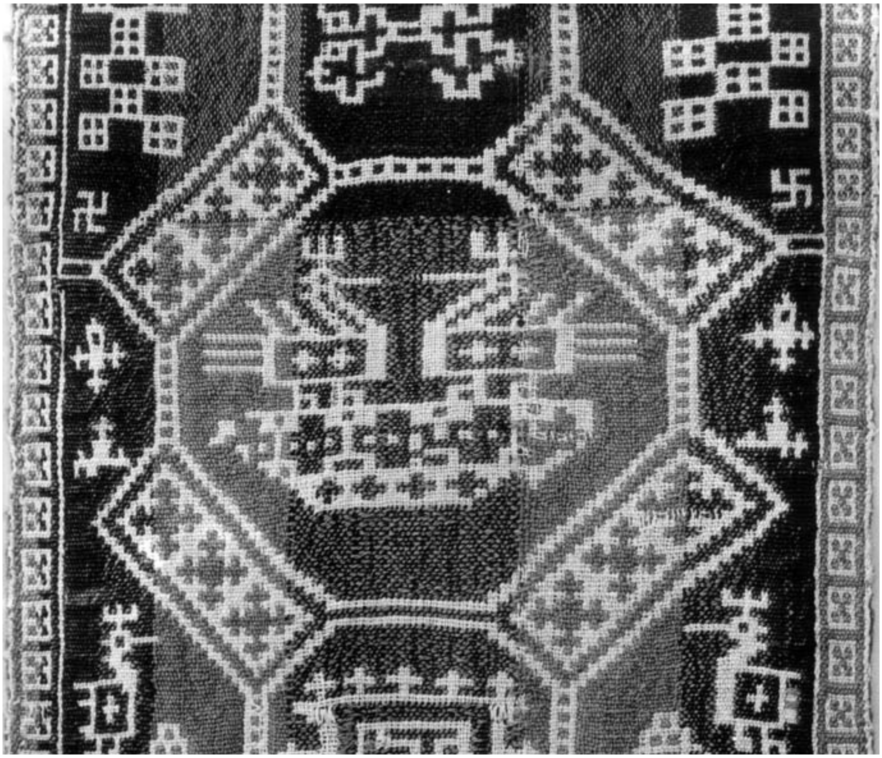


Figure 166 Pick-up double cloth from Northern Sweden, 13th century (Överhögdal Church; now Jämtlands Museum, Östersund, Sweden, P. no. 3450/56). One layer of linen thread and the other of red and blue woollen yarn; reversible double cloth.

Warp: 12–16 ends in each layer, total 24–32 per cm.

Weft: ca. 8 wefts in each layer, total ca. 16 wefts per cm.

Découpure: visible warp ends 3, visible wefts 2. Entire width: ca. 27 cm. Photo: ATA, Stockholm.

& Schmedding 1973, pl. 9 and 10), here dated to the 11th century. We used one example (pl. 9, inv. no. 1143) for an experiment.

A very fine example of Persian double cloth is shown in Figure 165 (Geijer 1979, pl. 56). This exquisite silk in red and white, brocaded with gold thread, is dated to about the year 1600.* From Scandinavia the earliest

* Several examples of double cloth in intricate variations are among the notorious Buyid silks, whose authenticity was hotly debated in the CIETA Bulletins nos. 37–43 (1973–76). The origin of these silks is still questionable and they are therefore of no help in dating early Persian weaving techniques.

extant examples date from the 13th century and were found in northern Sweden and Norway; one example is shown in Figure 166.

The term *dubbelväv* in Scandinavia generally means the pick-up double cloth. Terms such as *finnväv* and *ryssväv* ('Finnish weave' and 'Russian weave'), which occur in early Swedish and Finnish sources, would seem to suggest an Oriental origin (Geijer 1979, p. 60). Beautiful examples of hangings from the 15th–16th centuries are preserved in Scandinavian museums.

Pick-up double cloth was widely woven as a folk art in later centuries in Finland, Norway, and Sweden. The technique is especially well represented in Norway and Sweden in the region straddling the border between the two countries. The material was hard spun wool for one layer and unbleached linen for the other. Often an extra effect was added by stripes of several colours in the woollen layer in warp as well as in weft. In some cases wool was used for both layers.

Block-patterned double cloth woven on shaft looms was widely used for coverlets by immigrants in the United States and Canada during the first half of the 19th century. The large collection of double-cloth coverlets in the Royal Ontario Museum is extensively described by Dorothy and Harold Burnham (1972, pp. 298–316). The origins of the pioneer weavers are traced to certain places in Europe: southern Germany, Switzerland and Great Britain, here especially Scotland and Wales. The block patterns can often be found in the pattern books mentioned in the footnote on page 184.

From the above-mentioned examples it is evident that patterned double cloth had a wide distribution from pre-Columbian Peru to modern Scandinavia. The weaving was executed on primitive looms with pick-up rods, on many-shafted looms of more intricate construction, and also on draw-looms with silk and gold thread in sophisticated patterns.

The principle of weaving patterned double cloth

The principle of double cloth is illustrated in Figure 167. The two layers of dark and light tabby change from one side to the other according to the check pattern shown at A in Figure 168.

The construction and afterwards also the reading of a detailed draft for double cloth can be troublesome. Several methods are used. For double

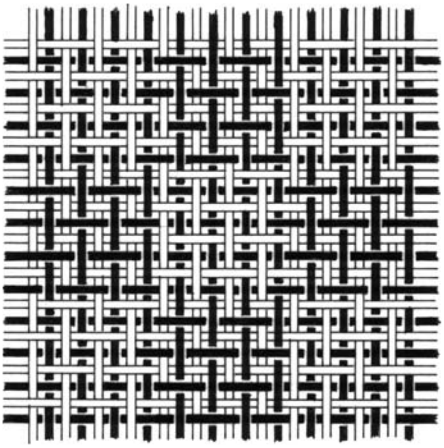
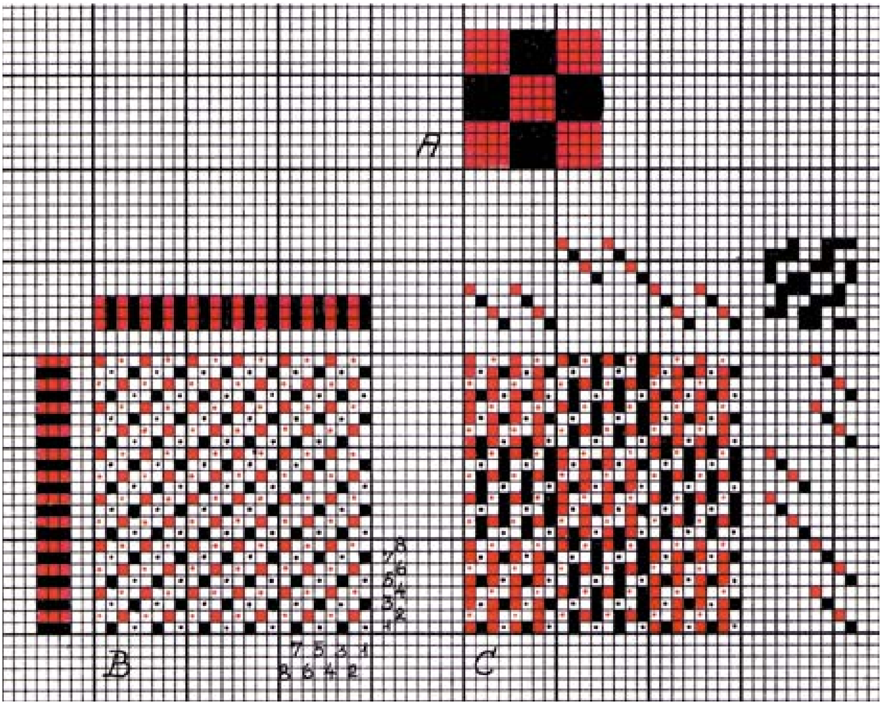


Figure 167 Diagram showing the principle of double cloth. The two layers of dark and light tabby form a check pattern, as at A in Figure 168.

↓ **Figure 168** Draft for double cloth woven on a shaft loom. Black and red here denote two yarns of different colours and do not have the technical significance which is usual in our drafts. At B is shown what we call the 'basic draft'; filled squares mean lifted warp ends. For clarity wefts are suggested by points. The 'basic draft' illustrates two independent layers of tabby, and upon this the detailed draft C is drawn according to the motif A. Within a red block all red warp ends are lifted over every black weft. Within a dark block all black warp ends are lifted over every red weft. Horizontal rows of white squares are alternating red and black wefts.



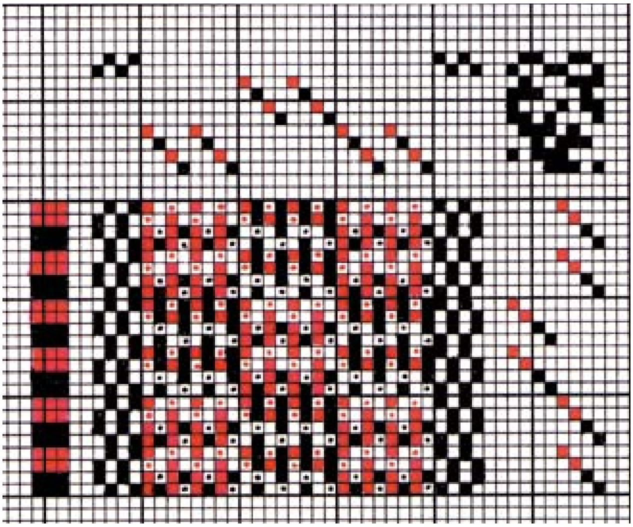


Figure 169 The detailed draft for the shawl shown in Figure 170; the order of wefts is here two white – two black. The selvedges are woven with rep weave; eight double warp ends are entered into two extra shafts. The rep weave is placed so that each shed contains one white and one black weft.

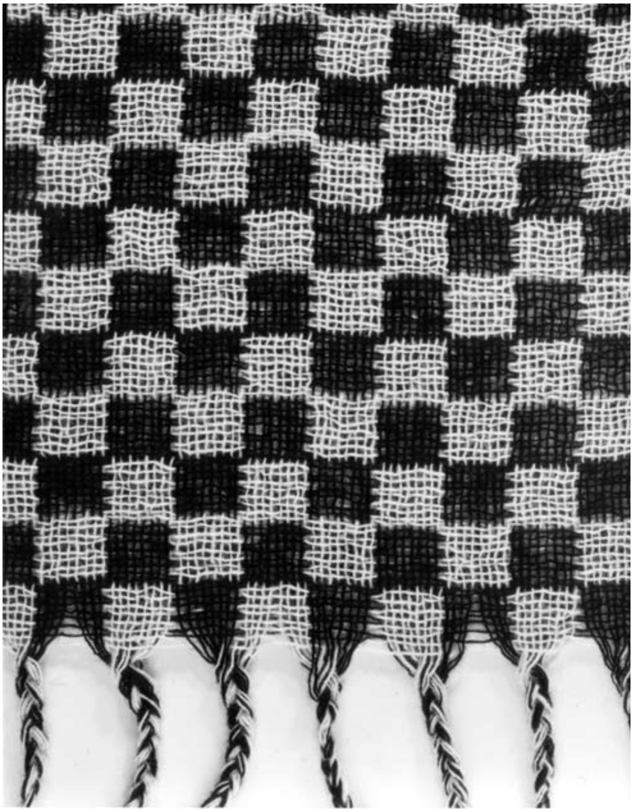


Figure 170 Black and white woollen shawl woven according to the draft in Figure 169.

Warp: single wool Nm 6, alternately black and white, 6 ends per cm.

Weft: single wool Nm 6, 2 black and 2 white, 6 wefts per cm.

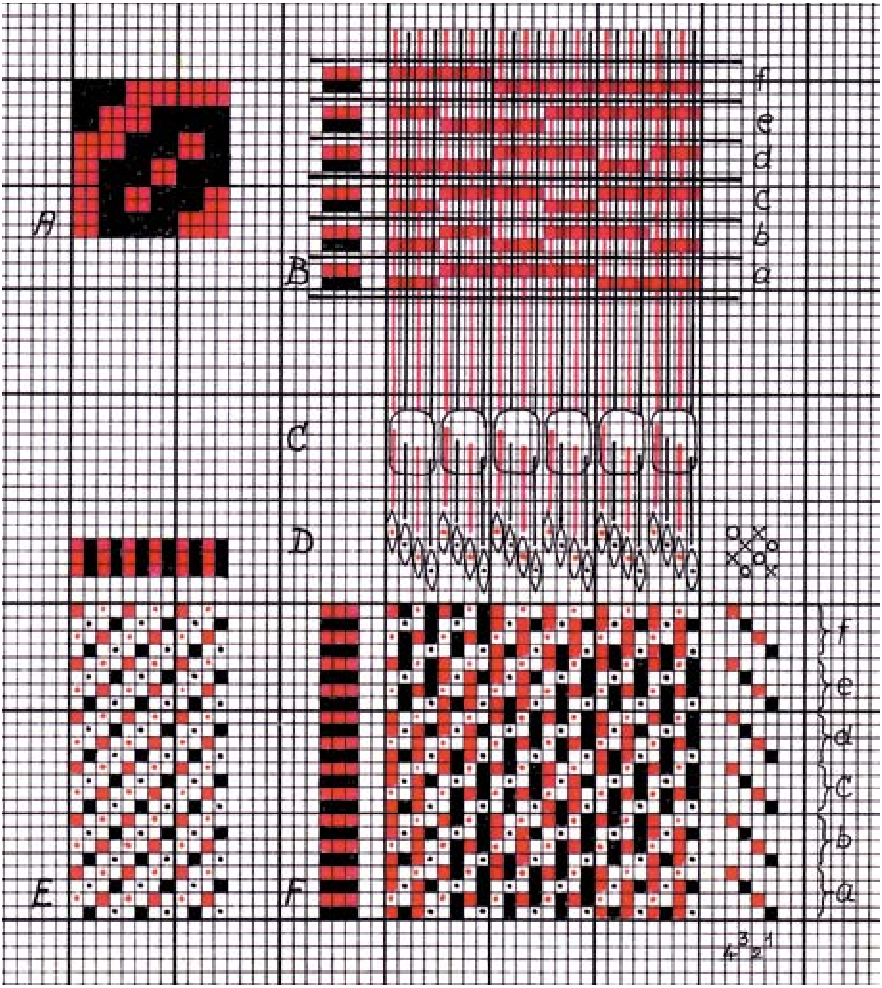


Figure 171 The setup of double cloth on a drawloom. As shown above in Figure 168 the detailed draft was started with the 'basic draft' E and marked according to the motif A. Four warp ends, two white and two red, are entered into each of the mails or leashes at C, then alternately white and red into four shafts with long-eyed heddles d. The découpure is four in both warp and weft.

cloth with tabby binding in both layers we found useful a method shown by Geismar (1929, p. 33 and fig. 40).

First the area of ruled paper intended for the draft is marked by warp ends thus: odd-numbered black and even-numbered red, see Figure 168 B. Note that black and red here denote yarns of two different colours and do not have the technical significance which is usual in our drafts. The order of warp ends is shown above; filled squares mean lifted warp ends. The order of wefts is shown at the left. For better clarity wefts are suggested by points; these points must never be covered by warp. This 'basic draft' is thought to illustrate with a little imagination two independent layers of tabby: one black and one red. Of course this is not a true draft; but it is a useful ground upon which the detailed draft for a double cloth can be drawn. Upon this 'basic draft' it is easy to lift (i.e. mark) individual warp ends according to a motif. Here the check motif A is used for the draft C. Within a red block all red warp ends are lifted over every black weft. Within a dark block all black warp ends are lifted over every red weft. Thus red and black squares in the draft C mean lifted warp ends. Horizontal rows of white squares are alternating red and black wefts suggested only by points.

This two-block pattern is woven with eight shafts and eight treadles as shown in the draft, Figure 168 C. Each new block in a pattern means that four shafts and four treadles must be added. This method was used by the Canadian pioneer weavers for their coverlets woven with white cotton for one layer and indigo blue wool for the other layer. Patterns with as many as five blocks, requiring twenty shafts and twenty treadles, are shown (D. and H. Burnham 1972).

Some lightweight shawls in white and black wool (Figure 170) were woven in our workshop in a similar way. Instead of changing wefts one by one we preferred the easier method of changing two by two as in the draft, Figure 169. This alteration does not detract from the appearance of the textile. In order to provide solid even selvedges eight double black warp ends were entered into two extra shafts for rep weave as in the draft.

Double cloth on a drawloom

We made some experiments with patterned double cloth on a drawloom. Our method is illustrated in the draft, Figure 171. As in the draft of Figure 168 we started with the 'basic draft' and lifted red and black warp ends according to the motif A. Note that black means the white silk. The detailed draft came out as shown at F. Four warp ends, two black and two red, were entered into each of the mails shown at C, then entered alternately black and red into four shafts with long-eyed heddles, D.

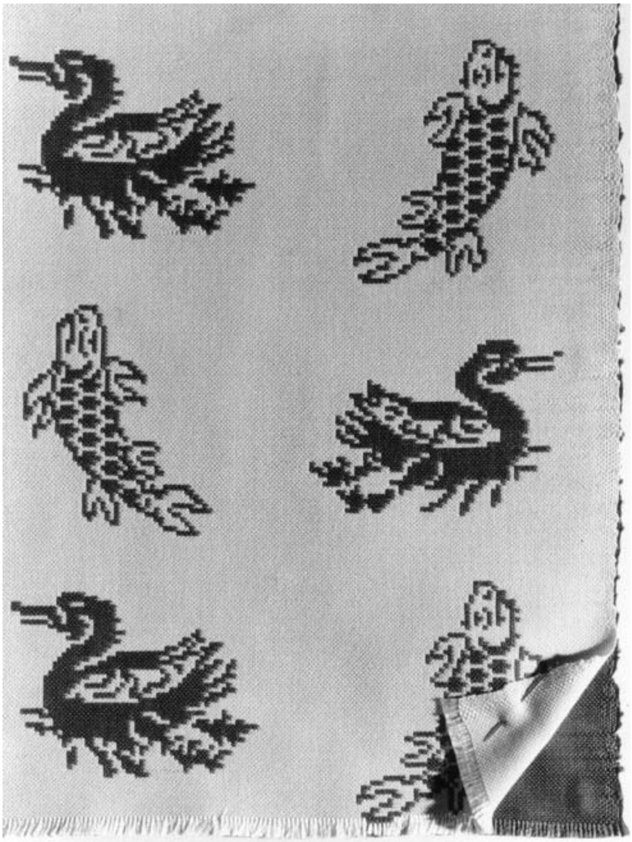


Figure 172 Our woven sample of double cloth on a drawloom.

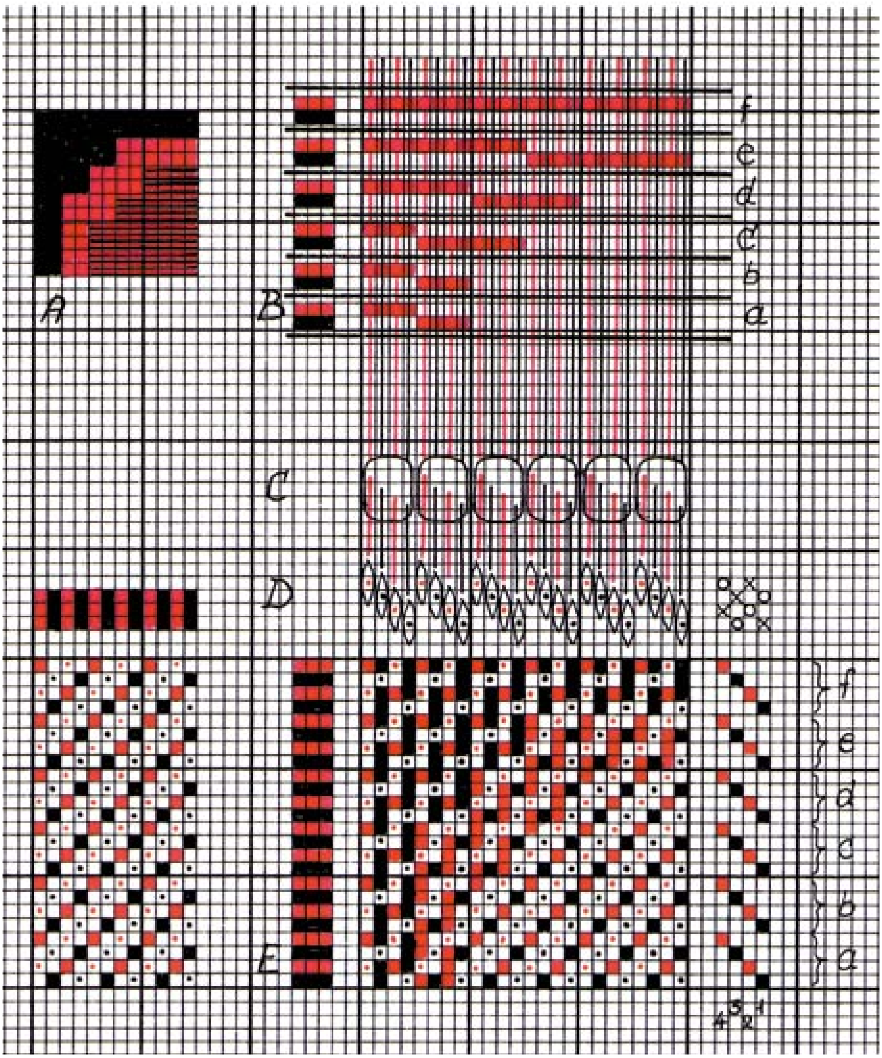
Warp and weft: spun silk Nm 10, white, 12 per cm; organzine Nm 12.5, red, 12 per cm. Total 24 ends per cm in warp as well as weft. In the lower corner at the right the white layer is folded over to show the two separate layers.

The lifting plan is shown at B. Each découpure is four wefts, two of each colour. For a white weft the groups of red appearing in the motif on the upper side are lifted. Treadles 1 and 3 lift alternating white warp ends (black in the draft) from the lower shed face; this is the visible white parts on the upper side. From the lifted groups treadles 1 and 3 also depress every other white warp end; these groups appear on the reverse side. The opposite lifts function for the red wefts with treadles 2 and 4. Each pair of lifts is used twice for a découpure.

→ **Figure 173** The draft for the variant with both layers woven on one level for a third effect. The detailed draft E is started with the 'basic draft' as shown above, and marked with lifted warp ends according to the pattern A. For black squares black warp is lifted, and for red squares red warp is lifted. Striped squares denote both layers woven on the same level; here warp ends are not lifted by the harness cords as shown in the lifting plan B. The 'basic draft' alone is used for a very tight twill 1/3.

With the drawloom set up in this way we wove the sample shown in Figure 172. As a motif we used some details from a Persian silk in the Abegg Stiftung, Bern (Lemberg 1973, pl. 38). This silk, in red and white with silver, is dated to the late 16th century (the Safavid period, 1503–1735).

Also from the Safavid period a number of variations of patterned double cloth are extant. In Figure 165 is shown a silk from a Swedish church woven with red and white silk and richly brocaded with gold thread.



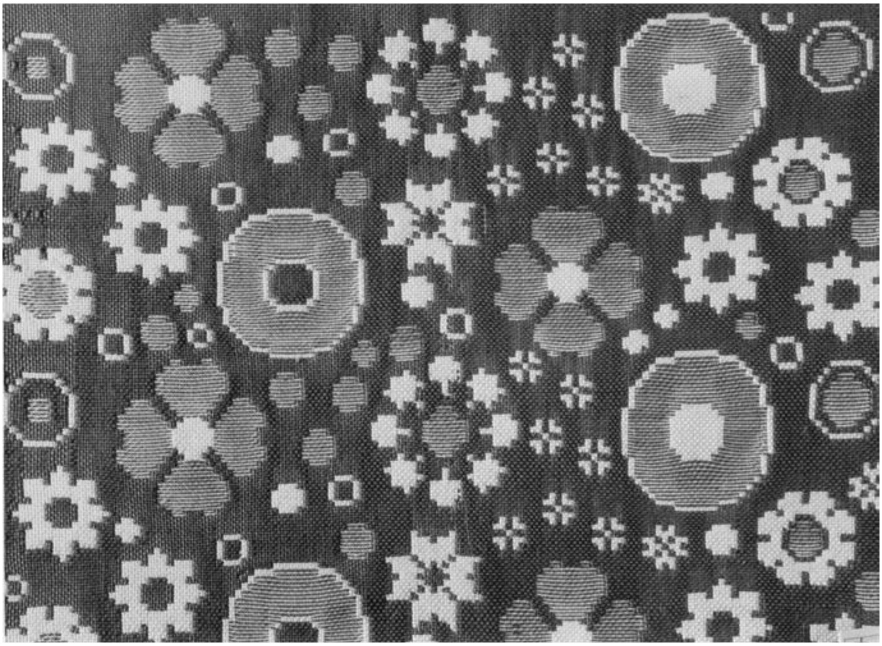


Figure 174 The sample woven with both layers on one level, as in the draft Figure 173. The red layer forms the background, while the white layer is used for outlines and details and the narrowly striped effect is used primarily for the larger flowers.

Warp: spun silk Nm 10, white and purple, 24 ends per cm.

Weft: spun silk Nm 10, white, 12 per cm; red, organzine Nm 12.5, 12 per cm; total 24 wefts per cm.

Another silk from the Safavid period is illustrated by Reath and Sachs (1937, pl. 36). Besides the two layers, red and white, a third narrowly striped effect appears. This is obtained by weaving the two layers together on one level; i.e. all red and white wefts here work with all of the red and white warp ends, as in the draft, Figure 173 E.

For this experiment we made a pattern with stylized flowers, Figure 174. The red layer forms the background and the white layer is used for details and outlines. Where the striped effect appears, harness cords are not lifted at all and red and white weft work with all of the warp ends; see in Figure 173 B the lifting plan in connection with the detailed draft E. A very tight twill weave 3/1 appears; our 'basic draft' here functions as a true binding. This is possible only with silk yarn with its great compressibility. On the upper side alternate red and white stripes appear in weft direction, on the lower side in warp direction.

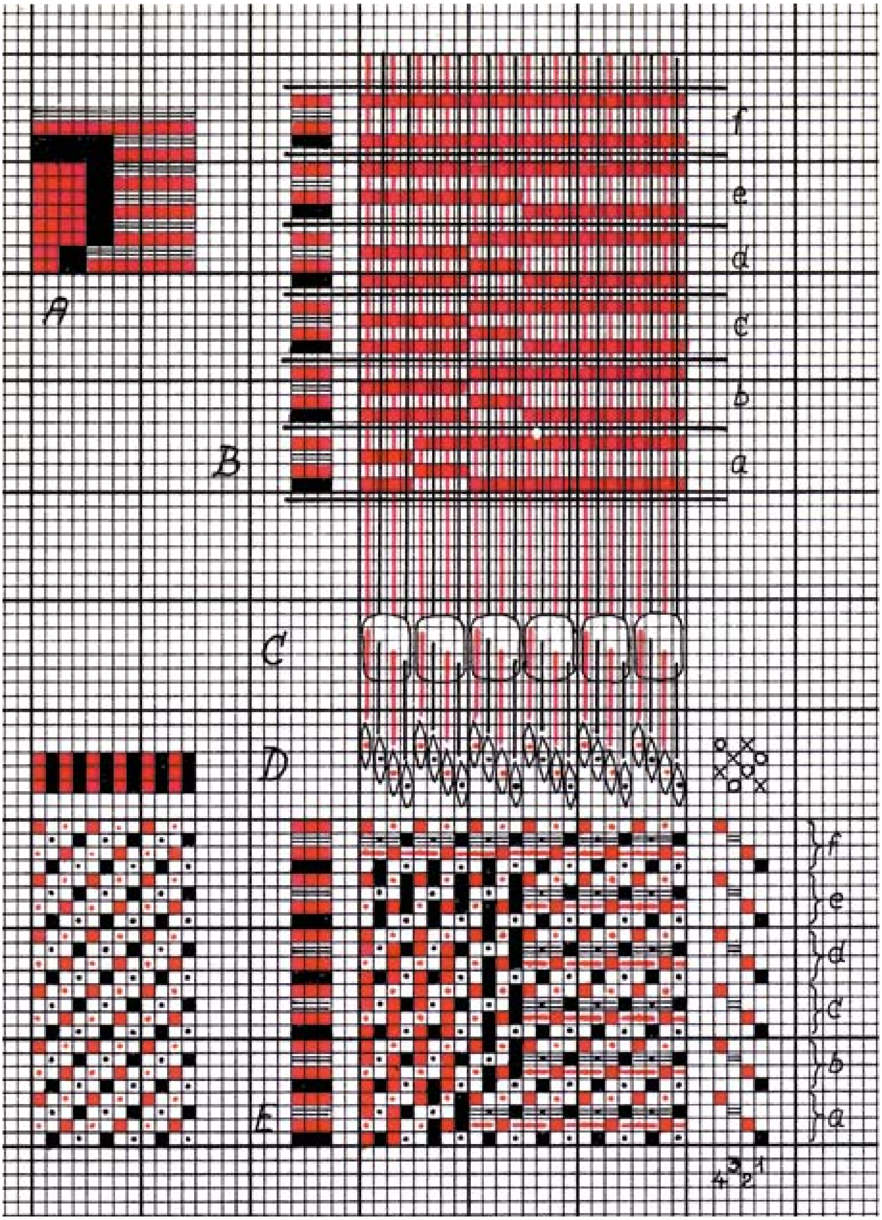


Figure 175 The draft for the variation with the ground striped with red and silver. Every other white weft is replaced by a silver thread. The red and the white layers form the pattern, while the face side of the ground shows alternately a red and a silver weft. For better clarity the silver weft is shown by two thin black lines, and the red weft by a red line on the face side in the detailed draft E.

Figure 176 Our woven experiment with stripes of silver.
Warp: spun silk Nm 10, white and purple, 24 ends per cm.
Weft: white spun silk Nm 10, 6 per cm; silver thread 6 per cm; red organzine Nm 12.5, 12 per cm. Total 24 wefts per cm.

With the drawloom set up as shown above another variation is possible. This variation appears in a silk belonging to the Victoria and Albert Museum, London, no. 916–1897. The motif is an episode from the story of Laila and Majnun, also shown by Reath and Sachs (1937, pl. 34). For our little replica we used some details of leaves and flowers. The white layer is here woven alternately with a white silk weft and a weft of silver thread. The white and the red layers form the pattern. The horizontally striped ground comes out in lines of red and silver.

Unlike the example described above this is double cloth throughout. Layers change for every two wefts as in the draft, Figure 175. In the striped ground, visible wefts are exceptionally shown in the draft, red weft by a red line, silver weft by two thin black lines. Each has a weft on the opposite side: behind the visible red weft is a white weft and behind the silver weft is a red weft. Thus the opposite side is striped in red and white.

Our woven sample is shown in Figure 176.

Our last experiment with double cloth on a drawloom derived from one of the notorious Buyid silks in the Abegg Stiftung, Bern (no. 1143). Of

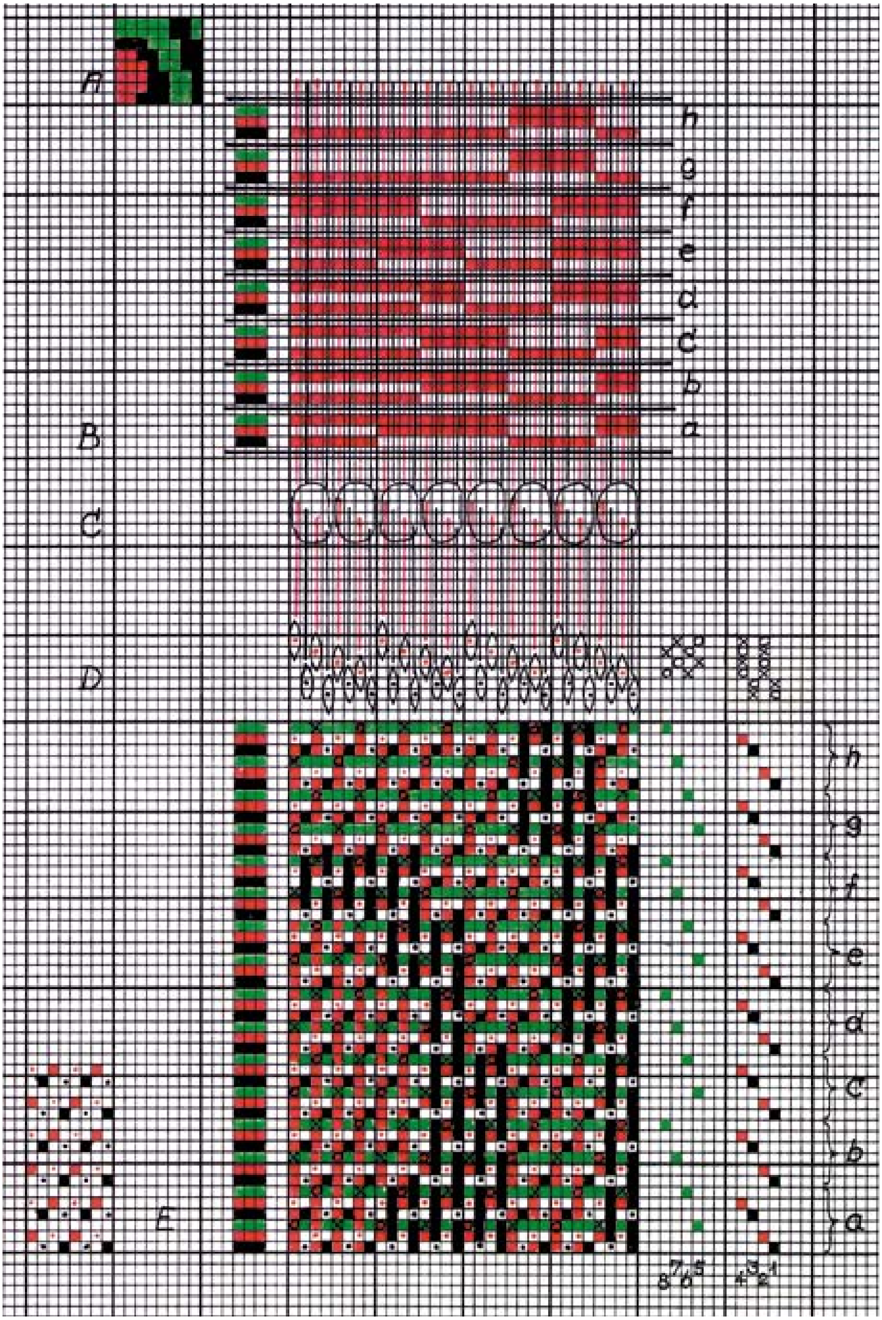


Figure 177 The draft for a double cloth woven on a drawloom with an additional weft of a third colour. This green pattern weft is woven with twill 1/3 on the red warp.

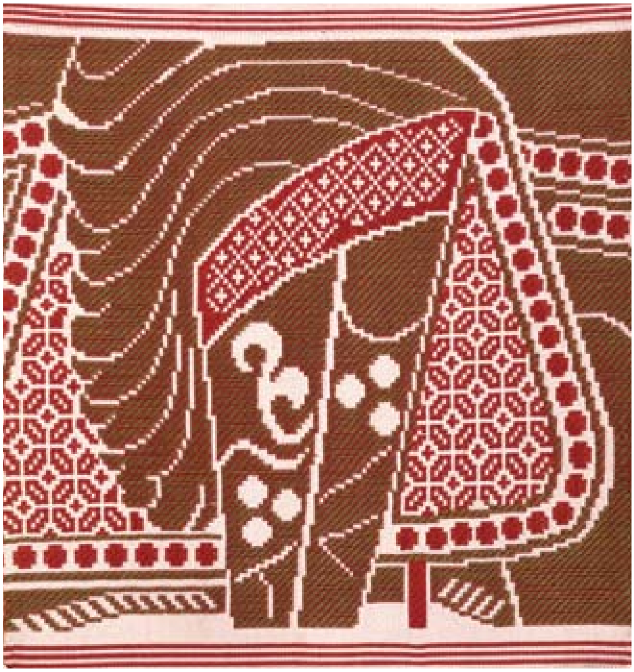


Figure 178 Our woven replica of a double cloth with an extra pattern weft.

Warp: spun silk Nm 10, white and purple, 24 ends per cm.

Weft: white spun silk Nm 10, 12 per cm; red organzine Nm 12.5, 12 per cm; green spun silk Nm 10, 12 per cm. Total 36 wefts per cm.

course we have no competence to state any historical relation to this silk, still we included it here because we found that it represents a useful way to add a third colour to a double cloth with two layers. A short description by Vial (1973, p. 71):

> These two tabbies are one over the other by turns, each time forming layers quite separate. A further weft, a pattern one, can be added to them (No. 1143) in quite different positions: face, middle, or reverse.

In the draft Figure 177 the motif A shows the red and white layers of tabby (black denotes white silk); green shows the twill pattern weave. Each vertical column means four warp ends, two red and two white. Each horizontal row means six wefts: white, red, green, and once more white, red, green.

The green pattern weft is woven with twill 1/3 on the red warp, and four shafts with long-eyed heddles are needed for the red warp, see Figure 177 D.

The detailed draft E is started similarly to the method shown above. Red and black warp ends are marked with tabby, but here it is necessary to leave out every third row of squares for the green pattern wefts; see the specimen shown at the left of E. Then the black warp ends are lifted over red and green wefts according to the motif A. The white layer of tabby when it appears on the face side is always a separate layer, so is also the case when it appears on the reverse side under the green patterned parts.

The green pattern weft works only with the red warp and it is useful now to mark along the empty rows for green wefts where a red warp end is lifted by an o, and where it is depressed by an x according to the tie-up.

In the red part of the motif red warp ends are now lifted over every black weft and over green wefts, only points marked by a cross must be avoided. In the green parts red warp ends are lifted over black wefts and over green wefts where an o shows a lifted red warp end. Then it is easy to mark the green weft for better clarity.

For white wefts with treadles 1 or 3, the harness lifts groups of green and red according to the motif A. For red wefts with treadles, 2 or 4 groups of black are lifted. For green pattern wefts on treadles 5–8, groups of black and red are lifted. Our woven replica is shown in Figure 178.

The Scandinavian pick-up double cloth

In Scandinavia two main methods are utilized for picking up the pattern. One method produces the reversible double cloth with equal numbers of light and dark threads on each side. The other method, the non-reversible double cloth, gives clear and sharp outlines to the figures on the face side, but on the reverse side figures appear with jagged outlines and details sometimes disappear entirely.

Signe Haugstoga (Engelstad 1958, pp. 124–125) gives fine descriptions of both methods. By kind permission we use here versions of her diagrams and descriptions.

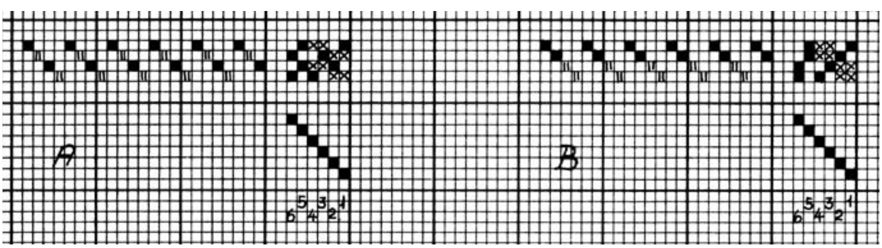


Figure 179 Entering and tie-up for pick-up double cloth on a countermarch loom. The order one light – one dark, shown at A, is mostly used for reversible double cloth; while entering two light – two dark, as at B, is most useful for non-reversible double cloth. In the tie-up filled squares mean depression shafts, empty squares mean lifting shafts, and crosses mean no tie-up.

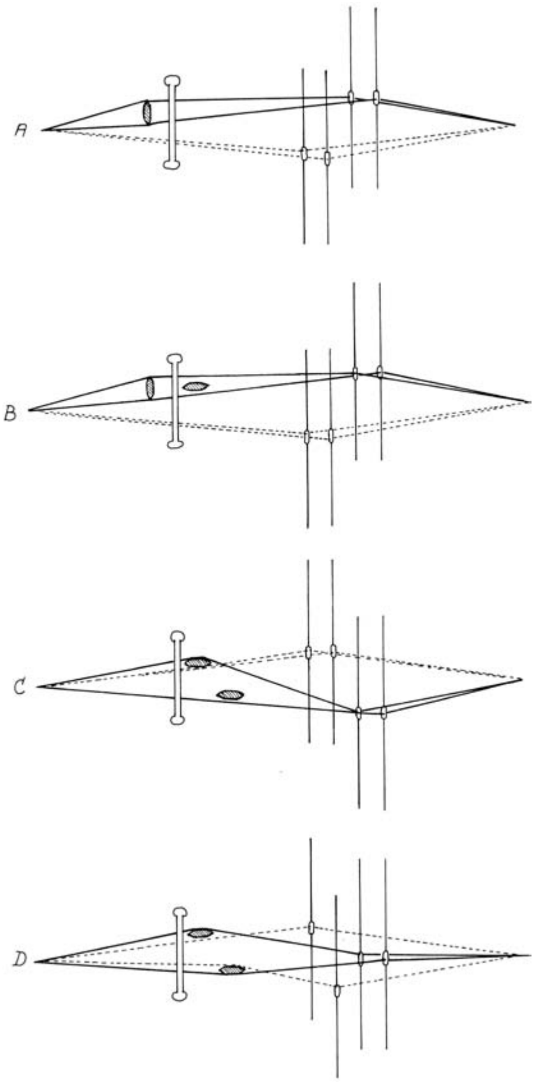


Figure 180 Cross-sections showing the general weaving method for pick-up double cloth; see Figure 179.

A. For a light weft the dark warp is lifted by treadle 6 and the pattern is counted in on one shed stick.

B. The first shed stick is raised on edge and the other shed stick is put into the pattern shed behind the reed; the first shed stick is pulled out.

C. The light warp is lifted by treadle 5. A new shed appears behind the reed under the shed stick; the first shed stick is carefully placed into this new shed.

D. Both shed sticks remain in the warp while a light weft is made with treadle 3. Note that dark warp is locked above and below the light warp. The other light weft with treadle 4 can be made with the same pattern shed.

For the dark wefts the procedure is repeated with the opposite colours.

A four-shafted loom is used. On a loom with countermarch six treadles are used as shown in Figure 179. On a loom tied up with pulleys four treadles are sufficient, but then two treadles must be pressed down simultaneously to lift the entire light or dark warps. Two pointed shed sticks, ca. 3–4 cm wide, are used; they must be 10–15 cm longer than the width of the weave.

The warp is entered either one dark – one light or two dark – two light as shown at A and B in Figure 179. In the tie-up white squares mean lifted shafts, black squares mean depression shafts, and crosses mean no tie-up. Treadle 5 lifts all of the white warp ends and treadle 6 lifts all of the dark warp ends. Treadles 1 and 2 are used for tabby in the dark layer, while treadles 3 and 4 are used for tabby in the light layer.

The weaving method is the same for both types of pick-up double cloth; therefore it is useful to be acquainted with the method from the start. The method step by step is shown by the cross-sections in Figure 180.

It is important from the beginning to remember that for a light weft, the dark pattern is counted in on the dark warp; and for a dark weft, the light pattern is counted in on the light warp.

Cross-section A shows a row of pattern counted in on the dark warp with one shed stick; this pattern shed is taken past the reed by the other shed stick, as in cross-section B. The first shed stick is drawn out. Then the whole of the light warp is lifted by treadle 5, as in cross-section C. A new shed appears below the shed stick. The first shed stick is now carefully taken into this new shed. Both sticks remain in the warp when a light weft is made with treadle 3, as in cross-section D. The dark warp ends are now locked above and below the light tabby weave. Dark ends intended to be visible in the next row are above the weave, while those below the weave will appear on the opposite side. If the weaving is done with two wefts of each colour the next white weft can be made with the same pattern shed. Then both shed sticks are drawn out.

For the dark weft the procedure is repeated, but with opposite colours. The light warp is lifted by treadle 5, light pattern is counted onto the shed stick, the shed is taken past the reed, and this time the whole of the dark warp is lifted by treadle 6. The free shed stick is taken into the lower shed, and dark wefts can be woven with treadles 1 and 2.

This 'opposite' way of counting in on the dark warp for light wefts and vice versa may be confusing for a beginner; therefore it is useful as soon as possible to become accustomed to the method.

Reversible pick-up double cloth

The earliest of the preserved double cloths in Scandinavia (see Figure 166) was woven with this method. In this way the same number of threads

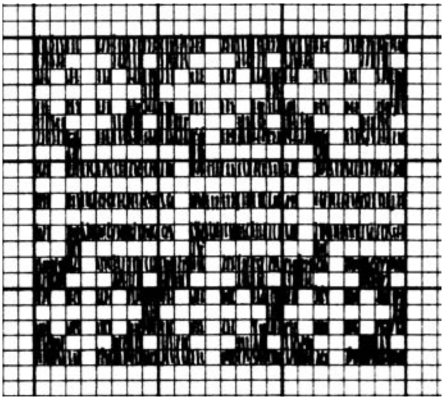
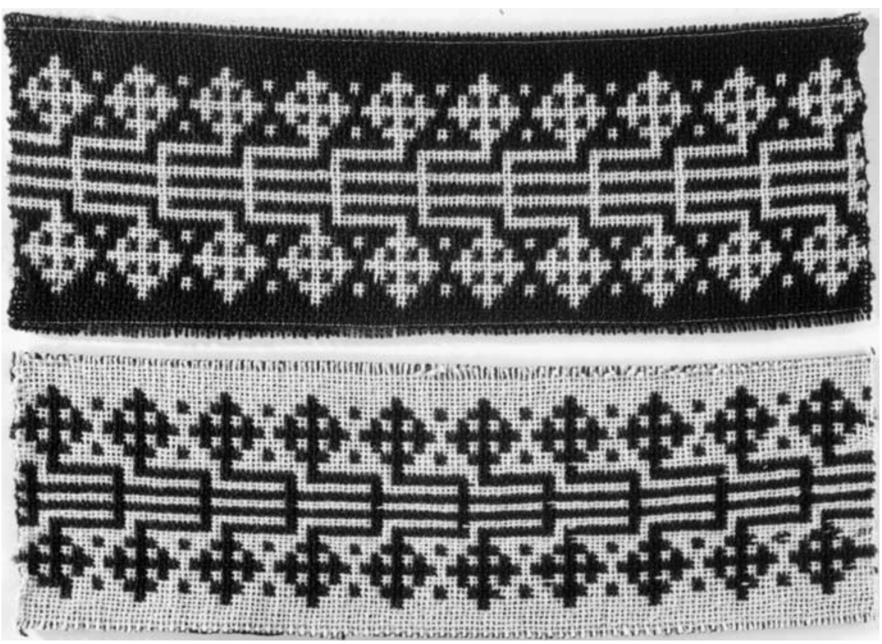


Figure 181 A fragment of an old Norwegian border drawn on ruled paper for our sample of a reversible double cloth.

appears in each detail of a pattern on both sides; the only difference between the sides is that the colours are reversed.

It is easy to pick up with a pattern drawn on ruled paper. In Figure 181 is shown part of an old Norwegian border (Engelstad 1958, p. 29). Each square means four threads, two visible on the upper side and two of the other colour on the opposite side. Patterns have two straight contours while two are jagged; this is especially evident when a rough material is used. It is best with this method to enter the warp with the order one dark – one light,



as shown at A in Figure 179. Our example, Figure 182, was woven in this way. Also the wefts were changed one by one. It is very time-consuming to count up pattern for every individual weft. When it is not too important if outlines appear a little jagged it is very much easier to change the wefts two by two.

Non-reversible pick-up double cloth

With this method for counting up, finer outlines and better details appear on the face side. On the reverse side patterns appear faulty and minor details disappear.

Judging from extant examples this technique came into use during the 14th and 15th centuries. A very beautiful hanging of the 15th century, woven with blue and white wool, is preserved from a Swedish church (Geijer 1979, pl. 87 b).

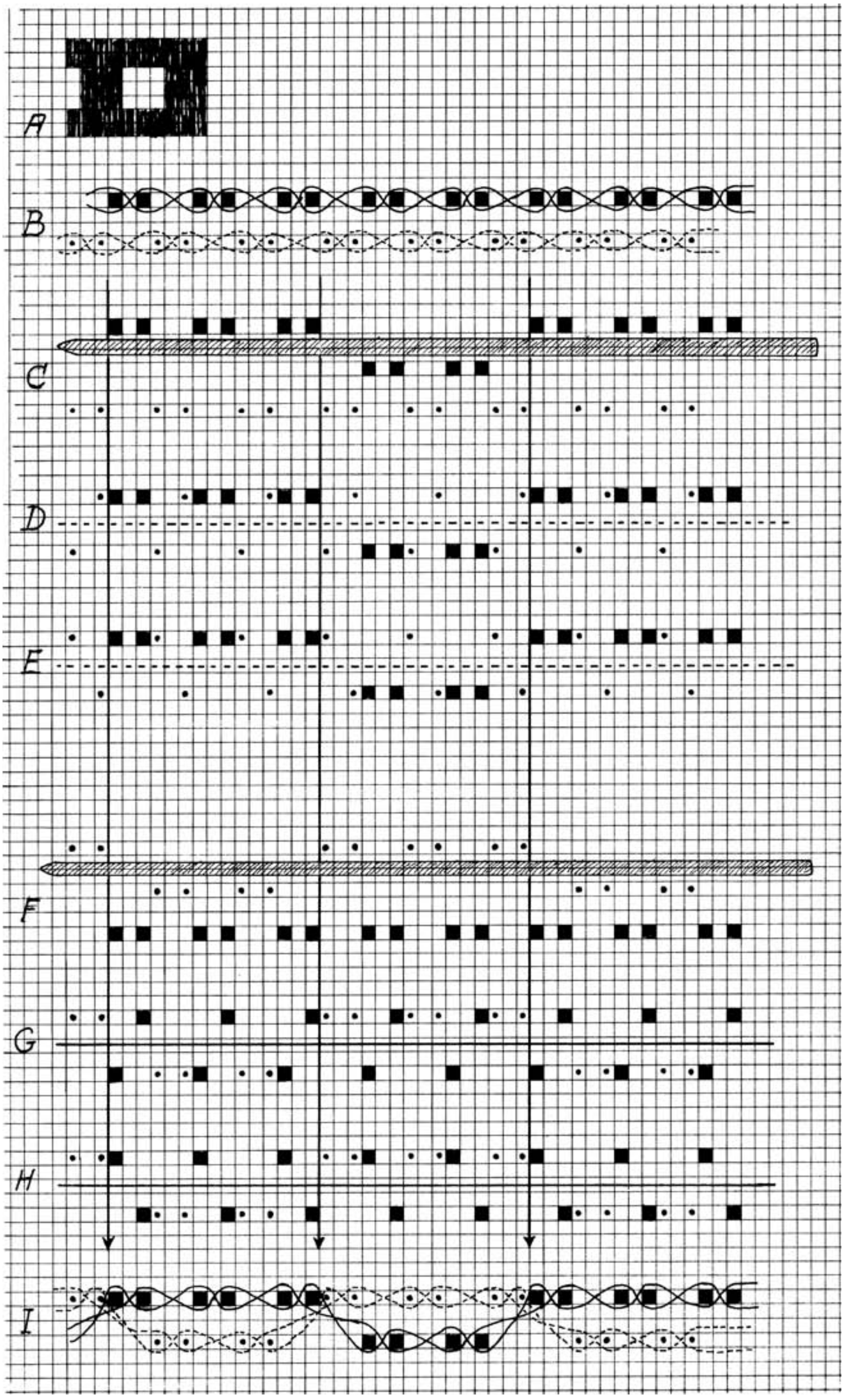
Such magnificent weaves were certainly the products of professional workshops. The motifs seem to be more or less directly derived from imported silks of Italian or Spanish origin.

As the name implies, these weaves have a pronounced face side. Contrary to the reversible double cloth the number of threads on each side is not the same. Each detail is outlined by two threads of its own colour on all sides, and therefore a larger number of threads is needed on the face side.

It is not possible to set up an absolutely stringent rule for drawing and counting up a pattern. As a guide to this method cross-sections for a detail of a pattern are shown in Figure 183. At A is shown a simple motif. An unpatterned area with the dark layer uppermost is done by placing a shed stick between the dark and light warps as at B. At C the counting up for light wefts in the dark warp is shown. Note that the warp is entered two by two (as at B in Figure 179) and one vertical column in the motif A means two visible threads. For the light part in the middle only two pairs of dark warp ends are taken below the shed stick. At D and E the weaving of two light wefts with treadles 3 and 4 is shown. In this way six warp ends appear on the face side.

← **Figure 182** Both sides of the example of reversible double cloth.

Warp and weft: 2-ply wool, white and olive. Four white and four olive threads per cm in warp as well as in weft.


A
B
C
D
E
F
G
H
I

For the dark wefts pattern is counted up in the light warp as at F. Note that three pairs of light warp ends are above the shed stick. Two dark wefts G and H are woven with treadles 1 and 2.

Cross-section 1 shows that each part of the pattern is always outlined with two ends of its own colour on the face side.

The wefts follow the same rule. For instance when two light wefts are used to form a narrow horizontal line on a dark ground, dark wefts are not woven in the lower layer.

A method to draw a working drawing for a non-reversible double cloth is shown in Figure 184. The motif, a row of pelicans, appears several times in Norwegian coverlets from the 18th century (Engelstad 1958, fig. 2). The figures are outlined by a solid black line, and dark areas are hatched for better clarity. The printed lines of the ruled paper denote two dark threads; at A solid black lines denote two dark warp ends, and at B the solid black lines denote two dark wefts. Each interval between printed lines denotes two light threads; at A two thin lines mean two light warp ends and at B two thin lines mean two light wefts (this is not shown within the drawing).

For unpatterned areas counting-in is not needed; weft pair 1 is two light wefts below the figures. The light warp is lifted and two light wefts are woven with treadles 3 and 4. For the dark weft pair 2, also without pattern, the dark warp is lifted and two dark wefts are woven with treadles 1 and 2.

Weft pair 3 is the first row of pattern, with two light wefts. For counting up, the dark warp is lifted by treadle 6. Every solid vertical line, and every

← **Figure 183** Cross-sections showing an example of picking up for a non-reversible double cloth. The warp is set up as shown at B in Figure 179; two light – two dark warp ends.

A. The motif. Each vertical column represents two visible threads.

B. The dark unpatterned part. One shed stick is placed between the two warps. Points denote the light warp ends.

C. The counting-up in the dark warp for light wefts. Three pairs of dark ends are taken over the shed-stick but only two pairs below. Then the shed is moved behind the reed, the light warp is lifted, and the other shed stick is in its place.

D and E show the weaving of two light wefts with treadles 3 and 4. Note that three pairs of light warp ends appear on the upper side.

F. The counting-up in the light warp for dark wefts. Only two pairs of light warp ends are below the shed stick while three pairs are lifted.

G and H show the weaving of two dark wefts with treadles 1 and 2.

I. A cross-section of the woven row of pattern. Note on the upper side that each part (light or dark) is always outlined by two threads of its own colour.

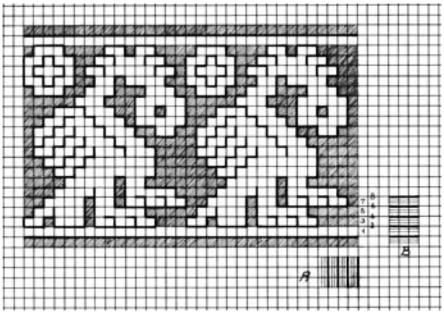


Figure 184 One example of a working drawing for a non-reversible double cloth. The printed lines of the ruled paper denote two dark threads in warp and weft. Each interval between printed lines denotes two light threads in warp and weft, as shown at A and B. For better clarity the figures are outlined by a solid black line and dark areas are hatched. At the lower right corner the first pairs of weft are numbered according to the description in the text.

printed vertical line within the dark parts (hatched), means two dark warp ends taken above the shed stick. When the row is finished over the entire width the shed stick is raised on edge, the shed taken past the reed, and the light warp lifted by treadle 5. The first stick is taken into the new shed, as described above. Two light wefts are woven with treadles 3 and 4. The light layer now appears on the face side according to the drawing.

For the dark weft-pair 4 the light warp is lifted by treadle 5. The counting-in is done along the horizontal printed line. Each interval between

Figure 186 The face side of our example of double cloth woven with a working drawing fastened below the warp.

Warp and weft: 2-ply wool, white and olive. Four threads of each colour per cm in warp as well as in weft.

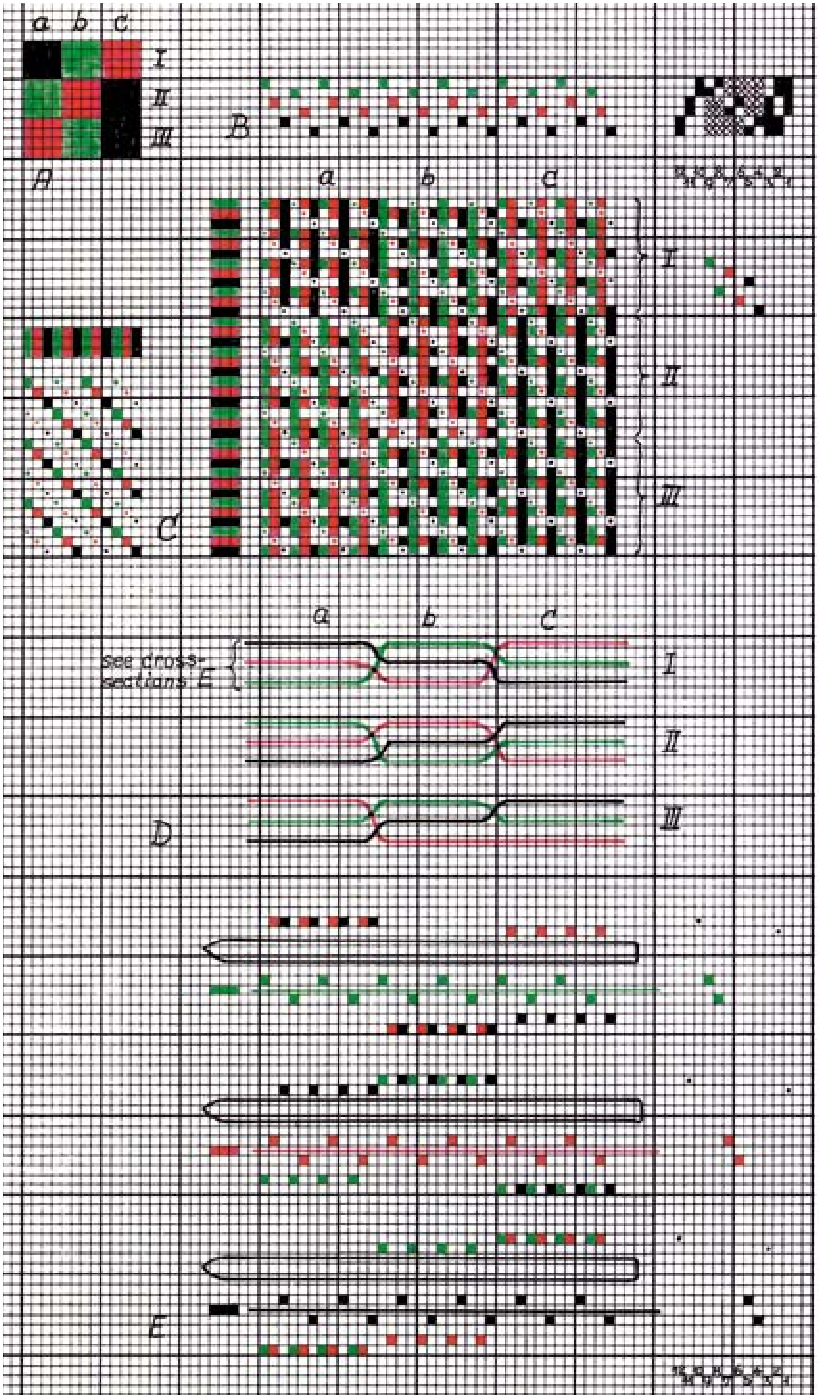
vertical printed lines means two light warp ends. In dark areas (hatched), and where a solid outline is met, the pairs of light warp ends are pressed down below the shed stick; in white areas the light pairs of warp ends are taken up over the stick. The pattern shed is again taken past the reed by means of the other shed stick. The dark warp is lifted by treadle 6 and the first shed stick placed into the new shed. Two dark wefts are woven with treadles 1 and 2. Both sticks are taken out, and the first binding unit is complete. The procedure is repeated for wefts 5 and 6, and so on.

The woven sample is shown in Figure 185.

When a motif for a patterned double cloth can be handled more at liberty, it is unnecessary to draw the pattern on ruled paper. The motif is drawn in natural size with clear black outlines on a solid white paper. For clarity the dark areas may be painted with some colour or entirely filled out with black. The drawing is rolled up and fastened below the fell, and fastened again as the weaving progresses. The weaving method is still the same as described above. For light wefts, dark parts are lifted in the dark

← **Figure 185** The sample of non-reversible double cloth woven according to the drawing in Figure 184. Compare the light figures on dark ground from the face side with the dark figures on the light reverse side.

Warp and weft: 2-ply wool, white and olive. Four white and four olive threads per cm in warp as well as in weft.


a b c
I
II
III
A
B
a b c
I
II
III
C
a b c
see cross-sections E
I
II
III
D
E

warp following the drawing, and for dark wefts, light parts are lifted in the light warp. With some practise this method is very convenient, and no counting of threads is needed. When the outlines are followed carefully, a fine and clear face side (non-reversible) will come out because in each minor part one cannot help but take up the outlines in the right colour. If the drawing is very detailed it may be useful to change wefts one by one. This method is highly recommended. Our sample is shown in Figure 186.

Pick-up triple cloth

A very simplified motif is shown at A in Figure 187. The colours black, red, and green are entered into six shafts as shown at B. The detailed draft is shown at C. At the left is a specimen of our 'basic draft' with three layers of tabby; filled squares mean lifted warp ends, and points denote the tabby wefts for each colour. The entire area for the detailed draft is at first marked in this way. The order of wefts is shown at the left.

The order of layers must be predetermined for part of the pattern, as in the cross-sections for three blocks at D. Block I a shows the black layer on the face side; within this block black warp ends are lifted over red and green wefts. The red layer is in between and red warp ends are lifted over green wefts. In pattern block I b the green layer is visible on the face side, so green warp ends are lifted over black and red wefts. The black layer is in between and black warp ends are lifted over red wefts. The red layer appears in block I c, where red warp ends are lifted over green and black wefts; green is in between and lifted over black wefts.

In the tie-up filled squares mean depression shafts, empty squares mean lifting shafts, and cross-hatched squares mean no tie-up. Treadles 1, 2, and 3 lift respectively black, red, and green warp. Treadle 10 lifts black and red, treadle 11 lifts black and green, and treadle 12 lifts red and green. Treadles 1–3 and 10–12 are used only for counting up pattern with the shed stick. For weaving tabby treadles 4 and 5 are used for black, treadles 6 and 7 for red, and treadles 8 and 9 for green.

The cross-sections at E show three wefts from pattern block I. Consider for example the black weft in the lower cross-section. The shed stick goes

← **Figure 187** The draft for pick-up triple cloth. The motif shown at A is drawn in detailed draft at C. Note that colours here denote differently coloured yarns and do not have the technical significance as usual in our drafts. Cross sections D show the order of differently coloured layers. At E is shown the method for picking up each of the colours for block I.

Figure 188 Our experiment with triple cloth.
Warp and weft: linen yarn, red 14/2 lea, olive 16/3 lea, and green 16 lea.
12 ends per cm in warp as well as in weft. Note the effect of the thin translucent green layer which allows different shades of red and olive to be seen.

in under red and green by means of treadle 12, and under only green by means of treadle 3; where black is visible on the face side both red and green are left below the shed stick. Then this pattern shed is taken past the reed as described above. Because black is to be woven, treadle 1 is used to lift the black warp. A shed stick is taken into the new shed and black wefts can now be woven with treadles 4 and 5, either both or one at a time as shown in the draft.

In Figure 188 is shown our experiment with triple cloth woven according to this method. The lower right corner is folded over to show the three separate layers, olive, green, and red. This sample was woven with a drawing in real size fastened below the warp.

In Figure 189 is shown a decorative textile executed with the above-described method.

Figure 189 Ulla Lorentzen, a student from the School of Arts, Crafts, and Design, Copenhagen, made this decorative textile with the technique of triple cloth.

Dimensions: 50 × 65 cm.

Several colours and thicknesses of linen yarn were used to obtain the finely planned effects in the motif.

Chapter 9
Damask

A damask woven textile, be it a piece of silk or a linen tablecloth, is characterized by its change between dull and shining surfaces. The pattern may be dull against a shining background or, with light from a different direction, the opposite effect may appear: shining pattern against a dull background.

This typical alternation from dull to shining surfaces appears because both sides of an unequal-sided binding are used on the same side of the textile. A binding, for instance twill 1/3 or a satin, is called unequal-sided if on one side the warp predominates and on the opposite side the weft predominates; for example, the draft in Figure 193 A shows both sides of a twill 1/3. Vertical columns of black squares are warp ends; horizontal rows of white squares are weft.

Technically the unequal-sided weave used in a particular piece of damask is called the *basic weave*. Satin weaves give the best result but in the early centuries the satin weave was not known and twill 1/3 was used.

In order to find the birthplace of the damask technique we shall once more go back in time to the earliest centuries. Among the earliest extant examples of damask weave are two silks found in Palmyra (numbered S.6 and S.38) described by Pfister (1934 and 1937). Pfister dates them before the year AD 200.

From a Roman grave in Conthey, Canton Wallis, Switzerland, a patterned silk damask was excavated, dated to the fourth century (Vogt 1934, pp. 202–206, pl. 241–3 and fig. 4).

Two more damask silks similar in pattern and quality to the Conthey silk were found in the coffin of St. Paulinus who was buried in Trier, Germany, in AD 395. They have been described by Kempf and Reusch (1965) and by De Jonghe and Tavernier (1977–78 and 1978).

Timmermann (1982) describes a damask silk which is believed to come from the 'Epiphany Reliquary' (*Dreikönigsschrein*) in the Cathedral of Cologne, Germany. (We are indebted to Agnes Geijer for pointing this out to us.) The weave is similar to that of the Palmyra silk S.38 except that in addition a tapestry decoration of purple wool and gold thread is woven on the same warp.

Several facts point to Syria as the place where the first examples of damask weave were woven. Syria, renowned for its textiles, had for centuries been a great meeting point where novelties of textile technology from East and West came face to face with inherited craftmanship. Anything can happen in such an area (Geijer 1979, p. 73). The large-scale production of fine woollen cloth of an evenly high quality from AD 200 to ca. 1000 (Hoffmann 1964, Geijer 1965) shows that craftsmanship and textile technology were developed presumably centuries earlier, and also that wool of the highest quality was available.

New materials always lead to new weaving practises and loom equipment. Such changes certainly happened among Syrian weavers too. Since they were able to spin wool of such enormously fine quality, and to weave cloth with a thread count of 60 per cm, they were undoubtedly also prepared to deal with the new material silk.

In some of the extant pieces of woollen cloth a woven starting border is preserved; this indicates that a vertical warp-weighted loom was used. In these cases the number of warp ends per cm is usually very much higher than the number of wefts. In other examples the weft is found to predominate, and a high number of wefts tightly beaten in suggests that a horizontal loom with treadles was also used. In one example, described by Pfister (1937, p. 24) the weft count is 160 per cm. The woollen yarn is measured to Nm 83 (83,000 m per kg). A purple wool of this size is used for rep bands in the silk S.38. Most of the fine woollen cloth was woven with twill 1/2 and 1/3 in variations such as chevron or lozenge patterns. Thus the weavers were very practised in twill weaving.

Weaving the earliest examples

Without doubt damask weave was always woven on a horizontal loom with treadles and shafts. From extant examples of high-quality woollen cloth, mentioned above, we know that twill weave was widely used by Syrian weavers. When silk material became available a loom was presumably set up for a twill 1/3; if a weft twill was used every fourth shaft was lifted. Possibly a weaver wanted to add a decorative band to the plain twill weave and took a shed stick under groups of warp ends behind the shafts and

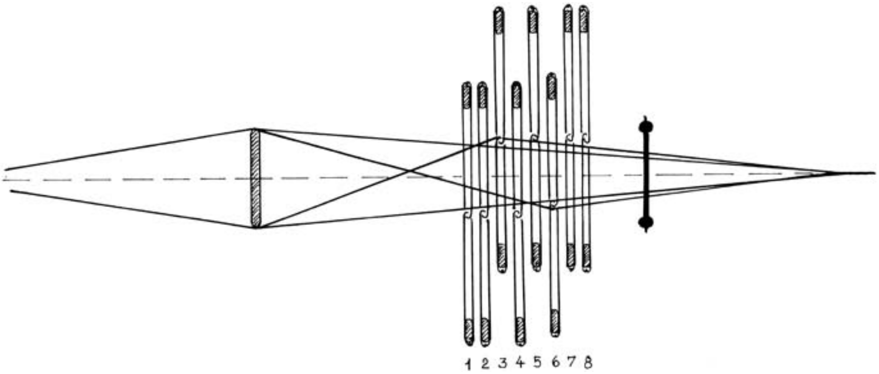


Figure 190 An outline of the damask shed with eight shafts is shown here. Four shafts, 1–4 nearest to the broad shed rod, are entered above the eyes for lifting and four shafts, 5–8 nearest to the weaver, are entered below the eyes for depression. Shaft 6 is pulled down and thus shaft 3 is lifted; see the photograph in Figure 192.

thus opened a pattern shed for a decorative weft. If he happened at the same time to keep the twill shafts lifted, he would find that weft-faced twill could still be woven with the groups of warp below the shed stick. It would not be too improbable for an experienced weaver to make out the next step: to lower every fourth thread from the lifted groups and thus to obtain a textile striped with weft- and warp-faced twill. If the shed stick was taken below the opposite groups of warp a chequered pattern would appear.

This is of course a conjecture, but not too far-fetched; it is supported by a practising weaver's experience. This is what we like to call 'the damask trick', by which weaving can be done with a number of shafts and treadles corresponding to the number of threads in the binding unit of the basic weave. Patterning can be made ad libitum by means of the broad shed rod.

Years ago our first experiment was made with four shafts and four treadles. With a rough cotton material it worked satisfactorily. A similar experiment is described by Vogt (1934). To obtain the lifting of ends from the lower parts of the warp and also to obtain the lowering of ends from the lifted groups of warp the four shafts must be supplied with long-eyed heddles. It seems very doubtful that Syrian weavers could have used heddles with knotted eyes; the most important objection to knots on heddles is the high number of warp ends. Often 50–60 ends per cm were used, sometimes even more. Such densities do not allow any knots on heddles; they would have a disastrous effect on the fine silk warp.

For this experiment we made eight shafts with clasped heddles; the heddle frame is shown in Chapter 12, Figure 27. Four shafts were entered above the eyes for lifting shafts and four shafts were entered below the eyes for depression shafts as in the diagram, Figure 190. Each pair of one lifting and one depression shaft was connected over pulleys; each of the depression shafts was connected to one treadle. In the drafts, Figure 193, an x in the tie-up means depression by a treadle while an o indicates which shaft is lifted.

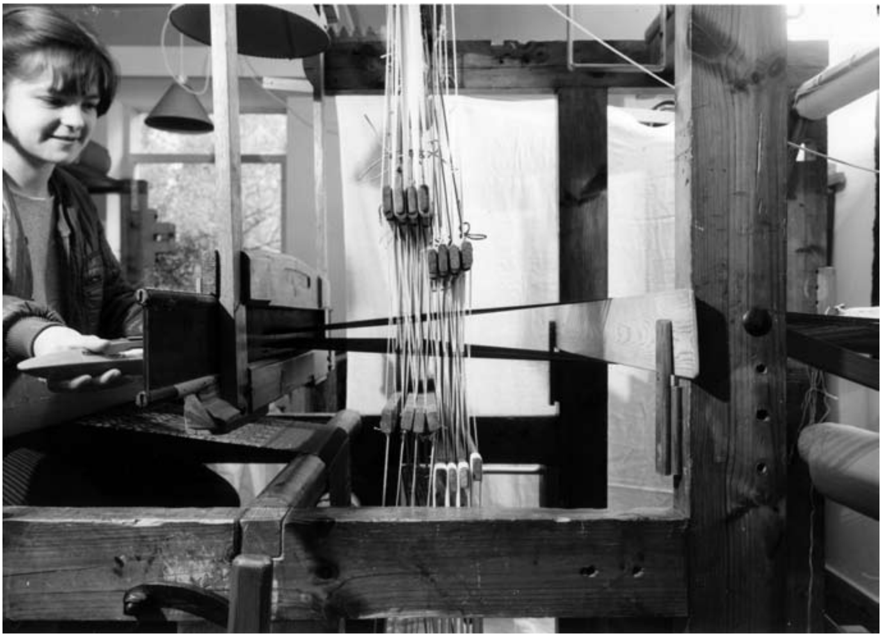
Of course we had much trouble in adjusting the shafts to the proper position. But we know from illustrations of horizontal looms in Persia and Syria (Hald 1963, figs. 2, 6, and 9) that weavers there are accustomed to the use of small pulleys, and apparently work with the greatest ease. We managed to adjust our shafts by means of elastic bands which lift the depression shafts when they are released and also keep the lifting shafts in their lower position as is shown in the photographs of the loom, Figures 191 and 192.

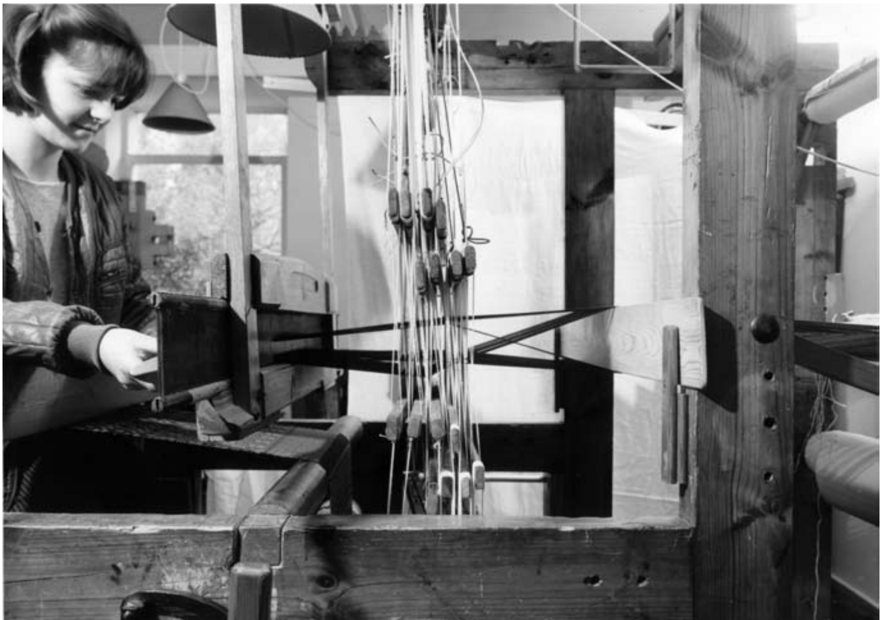
Behind the shafts groups of warp ends are lifted according to the pattern; a broad shed rod (8–10 cm) is taken into this shed and kept in vertical position by means of a slit in the side of the loom, see the photograph in Figure 191. Here the broad shed rod has opened the pattern shed and the shafts are in their middle position. It is evident here that the two groups of shafts allow the pattern shed to go clearly through so that the shuttle can pass. In Figure 192 shaft 6 is pulled down and shaft 3 is lifted ready for a twill weft in the position shown by the outline in Figure 190. When the four treadles are used consecutively a pattern block is woven with the same pattern shed until the right height is woven.

By means of the broad shed rod the weaver can form patterns according to his wishes. It must be noted that the expression 'pattern lift' used by many authors is not quite correct. It is not sufficient to lift groups of warp; the broad shed rod must be placed within the shed. The upper and the lower shed face partake equally in the binding and must be evenly tight. Later on when some sort of drawloom had been developed the warp was kept tight by weighted leashes.

The method is useable for all known variations in extant examples; see the drafts for three different types in Figure 193.

Of course we do not know if this was the method originally used. We can only show that we succeeded in weaving replicas of the examples known to us.





← **Figure 191** The broad shed rod has opened the pattern shed and the shafts are in their middle position. The cords from the shafts go up over small pulleys, and elastic bands are used to adjust the shafts.

↙**Figure 192** Here the shafts are opened for a twill weft, in the position shown by the outline in Figure 190.

The Palmyra silk S.6 (Pfister 1934, p. 42, pl. XIII) has a thread count of 35–39 warp ends and 32–36 wefts per cm. The warp is blue and the weft golden. Sylwan's analysis (Pfister 1937, p. 36) shows that the silk is woven with a broken twill. To obtain the broken twill with the same tie-up it was only necessary to alter the treadle order from 1–2–3–4 to 1–3–2–4 as in the draft, Figure 193 B. The pattern is a variation on a two-block system. The woven replica of S.6 is shown in Figure 194.

A weaving fault in an ancient sample gives some support to our belief that the method described above was used in ancient times. A tiny bit of silk similar to the Palmyra silk S.6 was found in a Roman barrow in Holborough, Kent, England (Wild 1970, p. 101, A 51, fig. 41). Only part of a chequered pattern can be seen. On the basis of pottery and other articles found in the barrow it is dated to ca. AD 250. The analysis of this piece shows a fault on warp end no. 2 from the right, indicated by an arrow in Figure 195. Presumably this warp end had slackened and was about to slide out. It could not lift over weft no. 3 from below. Then it was lifted for the warp-faced pattern; this lift tightened the end so much that it was bound once by a weft. Further on it lies loose over 15 wefts; at this point

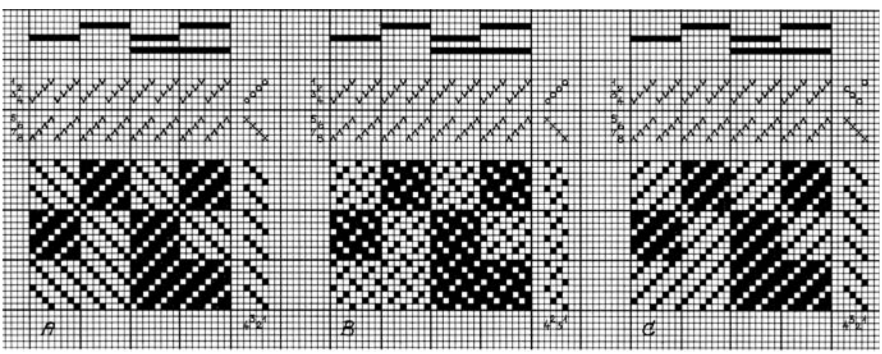
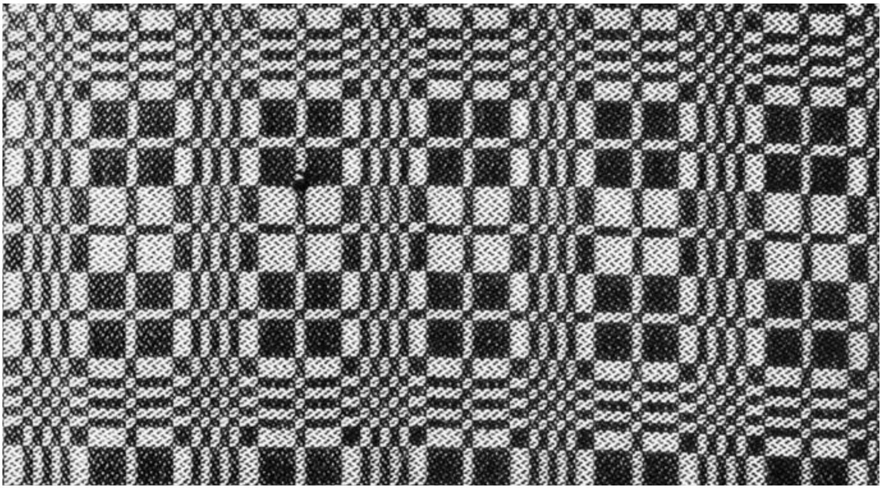


Figure 193 Three possible variations using the same setup of the loom. At A warp-faced twill 3/1 in Z-direction is used with weft-faced twill 1/3 in S-direction. At B a broken twill 1/3 in warp and weft effect is used. Only the order of treadles is changed from 1–2–3–4 to 1–3–2–4 to obtain this weave. At C is shown a damask setup with twill 1/3 in Z-direction throughout. The connection of depression shafts to lifting shafts is altered as shown in this tie-up.



the weaver noticed the fault and secured the thread. If this weave had been made with warp ends entered singly into lifting shafts the loose end would have stayed below until it was secured.

The Palmyra silk S.38 (Pfister 1937, p. 35, pl. IX) outside the damask weave has two purple rep bands. The number of warp ends per cm is 48 and the silk has 50 wefts per cm. In the purple bands, ca. 25 mm in the width, there are 90 wefts per cm of the fine woollen yarn. The same setup

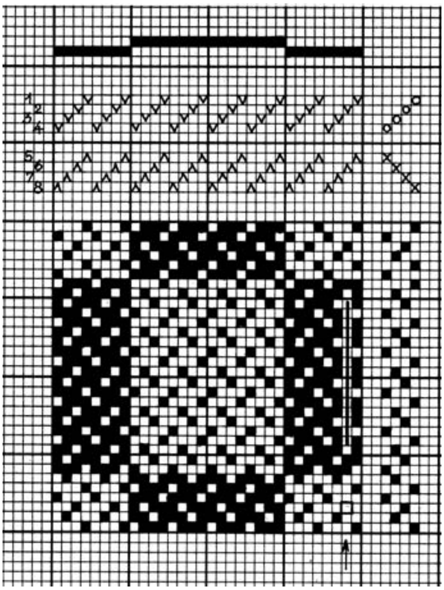


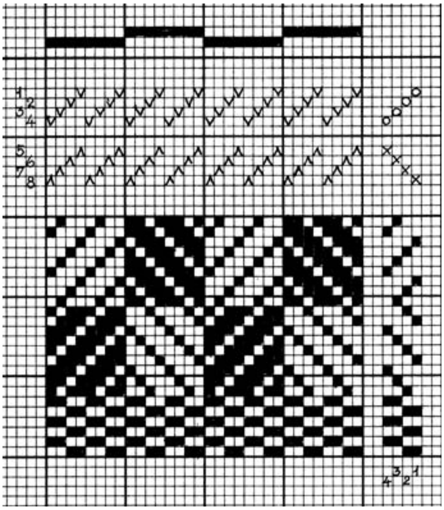
Figure 195 The draft from the Holborough silk (Wild 1970, fig. 41). Note the faults on warp end no. 2 marked by an arrow. The missing binding point on weft 3 from below is marked by a frame.

← **Figure 194** Our woven replica of the Palmyra silk S.6. The draft Figure 193 B was used for this.

Warp and weft: spun silk Nm 10.

Warp: 16 threads per cm.

Weft: 16 threads per cm.



→ **Figure 196** The draft for the Palmyra silk S.38. The setup shown in Figure 193 A is used. When rectangles change from warp-faced to weft-faced effect the treadling order is reversed. For the woollen rep bands two treadles are used at a time, as in the lower part of the draft.

shown in Figure 193 A was used but the order of treadles was turned over to obtain the altered twill directions as in the draft, Figure 196. Black squares above the heddles show the pattern sheds to be opened by the broad shed rod.

The rep weave was easily woven by using two treadles at a time, as can be seen in the lower part of the draft. Weavers accustomed to weft counts of 50–60 would presumably find it tedious and time-consuming even at this early date if this rep weave did not function perfectly; presumably it was woven with shafts and treadles. Our woven replica is shown in Figure 197.

The reliability of the rep weave must have been of still more importance for weaving the damask and tapestry silk from the Cathedral of Cologne. Much has been written on the romantic simplicity of tapestry weave. In this case a damask silk similar to the Palmyra S.38 with a thread count of ca. 50 per cm was woven, after which the warp continued (two by two) for the tapestry with purple wool and gold thread. A gold thread pulled through a silk warp of this fineness by means of a needle (Timmermann 1982, p. 161) could only end in a catastrophe. The use of gold thread for the weft requires a clearly opened shed. Our woven replica is shown in Figure 198.

The Conthey silk (Vogt 1934) has a thread count of ca. 60 per cm in both warp and weft. The pattern is more elaborated than in the earlier examples. Four different pattern sheds are needed; see the pattern lifts

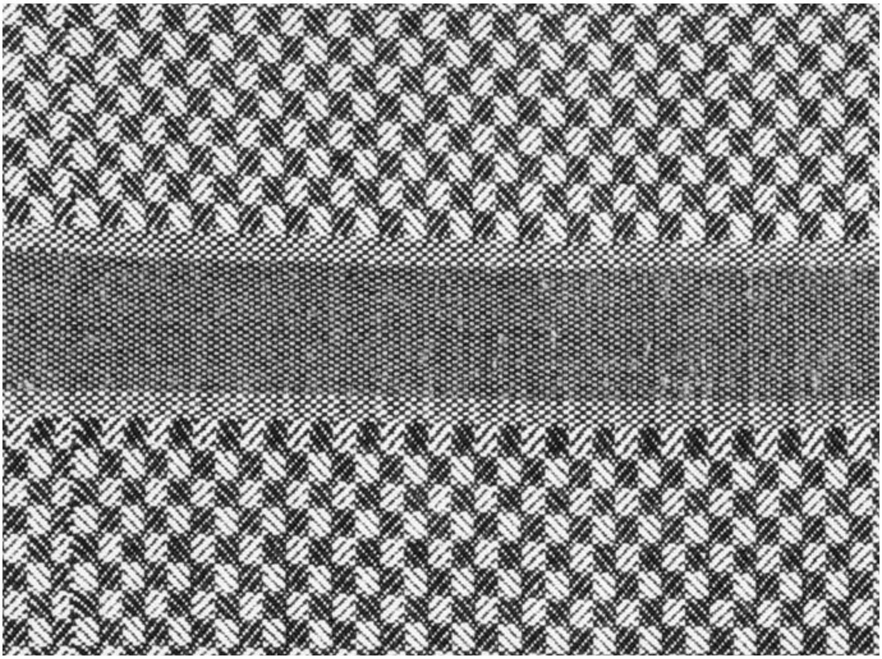


Figure 197 Our woven replica of the Palmyra silk S.38.
Warp: black spun silk Nm 10, 16 per cm.
Weft: white spun silk Nm 10, ca. 16 per cm, purple wool Nm 24, ca. 18 per cm.

marked 1–2–3–4 at the right of the pattern in Figure 199. To preserve the rows of pattern, loose heddles were taken below the groups of warp ends and threaded onto a thin rod for each row. Then one could lift a rod and take the broad shed rod into the pattern shed. This functioned comparatively well with a small number of pattern rows. An assistant to take up the pattern rods would certainly be useful but the weaver would still have to stop and wait while the broad shed rod was shifted. Presumably the Syrian weavers at an early date learned about some form of drawloom from Persian weavers.

If the Conthey silk (dated to the fourth century) should be described in technical terms of our century it should be called a block patterned twill diaper (German: *Drillich*, Scandinavian: *drejl*, *dreiel*, *dräll*). The diaper method requires a loom with many shafts and treadles and was presumably not utilized before the European horizontal loom centuries later had been sufficiently developed. It is possible by this method to weave a perfect technical duplicate of the Conthey silk with twelve shafts and sixteen treadles. But it is doubtful that weavers in the fourth century disposed of so many shafts and treadles. From nearly the same time extant examples display a very rich development of patterns. Such a development would not have been possible if patterning depended on large numbers of shafts and treadles. Therefore we believe that some version of the broad shed rod (described above) was used and rather than diaper we stick to the term damask also for the earliest block-patterned silks.

Vogt in his description of the Conthey silk (1934) suggests a method for weaving a replica of the silk. His method is roughly the same as ours described above. Although such a method functions satisfactorily it cannot of course be proved that it was the method originally used. In a footnote Vogt writes (1934, p. 203):

> We cannot form any real conception of early historical or prehistorical looms. Already much – good or bad – has been written. My observation

Figure 198 Our woven replica of the silk from the Cathedral of Cologne.

Warp: black spun silk Nm 10, 16 per cm.

Weft: white spun silk Nm 10, ca. 16 per cm. For the tapestry weave: purple wool Nm 24 and gold thread.

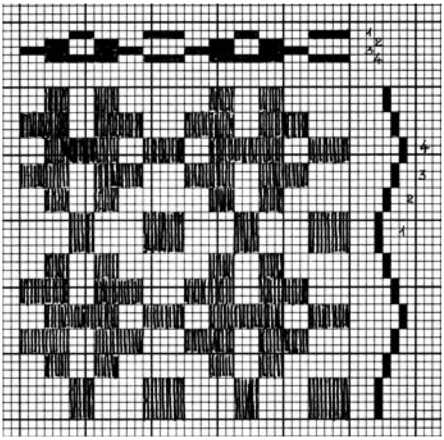


Figure 199 The pattern from the Conthey silk (Vogt 1934, fig. 4). Note at the right that four different pattern lifts are used in point repeat.

→ **Figure 200** Our woven replica of the Conthey silk.

Warp: black spun silk Nm 10, 16 per cm.

Weft: white spun silk Nm 10, 16 per cm.

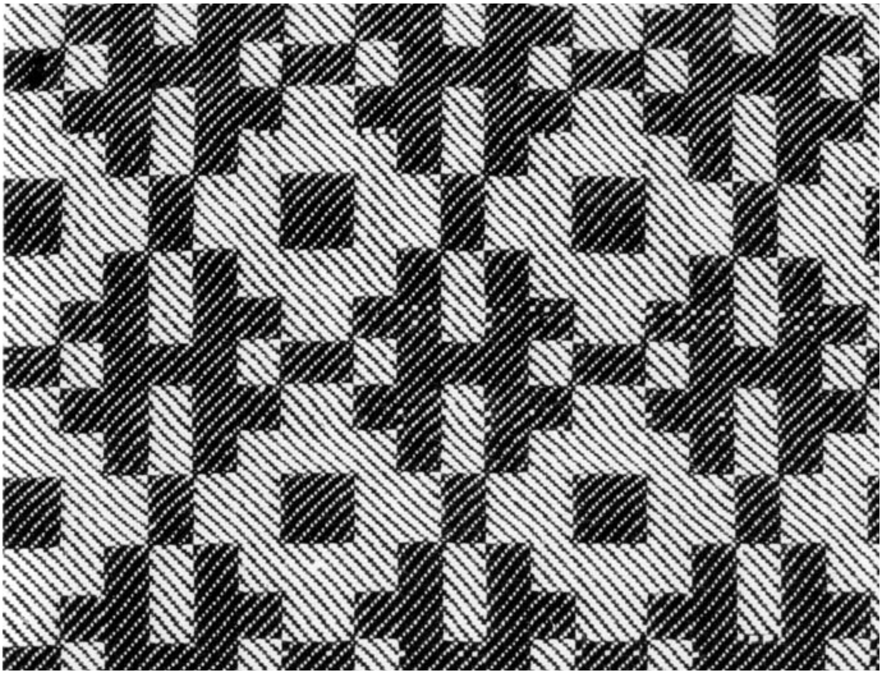
> suggests that the technical experience of people from these early times has been considerably underrated. The conceptions of early looms which most scholars in our day suggest, and which they often have reconstructed after contemporary accounts, are one-sided and most often show only one form of the different looms in use. Thus research on original textiles is still not sufficiently utilized.

As far as we can see the Trier silks are similar to the Conthey silk. They have already been described in such detail (De Jonghe and Tavernier 1978) that we will not use these examples here.*

* De Jonghe and Tavernier's detailed analysis is a valuable contribution; but certain of their conclusions appear to require modification. The authors suggest a method by which this weave could have been woven, but it is difficult to imagine how the proposed weaving method really could have been practicable. It must have been particularly hard for the weaver: '– he was only responsible for:

- opening to a greater extent the provisional shed, formed by the selecting persons, when lifting the heddle rods and establishing it by inserting and raising the shed stick,
- inserting the weft through the shed,
- beating in the weft.'

This repeated ca. 50–60 times for each centimeter! De Jonghe and Tavernier argue that these textiles indicate a major production centre at the imperial court in Trier. But textiles are a commodity which is most easily transported, and this sort of argument requires a great deal more evidence than the mere finding of a few samples. If the textiles were woven locally the weavers were most probably Syrian. They would have used their own weaving implements, and it is not clear that an isolated colony of foreign weavers would have had much effect on European weaving techniques in general, certainly not the introduction of the horizontal loom into Europe.



Damask weave from the early centuries is scantily represented. In Switzerland a number of small pieces are preserved as covers for reliquaries (Vogt 1952; 1958; 1963; 1964; Schmedding 1978, nos. 46, 48, 49, 120, and 186). The patterns mostly consist of diagonally placed diamonds and roundels with details of hearts, stars, and lilies. The pattern units, although not very large, appear to have needed a considerable number of pattern sheds. Some of these patterns are similar to examples woven with samitum technique (Vogt 1952, pp. 11–13). Presumably Syrian weavers at this early time used some sort of drawloom.

The white silks preserved in the church San Ambrogio in Milan, Italy, are the only extant examples large enough to show the sublime art of drawing and the weaver's technical ability. Archbishop Ambrosius died AD 397 and was interred in his own church, San Ambrogio. The white silks were, perhaps years later, placed over his holy mortal remains in his shrine. The silks are tentatively dated to Syria in the early fifth century. A fragment is shown in the photograph, Figure 201.

On certain occasions the contents of the glass shrine were improved upon. In 1940 Alberto de Capitani d'Arzago made a thorough study of the contents of the shrine and published his results in a beautiful and well-illustrated book (1941; review by Geijer 1941 b). The white silks with

Figure 201 A fragment of a hunting scene from the damask silks of San Ambrogio, Milan, Italy (after Capitani d'Arzago 1941).

Warp: white silk, 84 ends per cm.

Weft: white silk, 54 wefts per cm.

The warp direction is shown horizontally.

hunting scenes, a spear-bearing man, and rampant lions are now placed in such a way as to suggest the archbishop's dalmatica as is illustrated in Capitani d'Arzago's pl. IX. A perfectly developed damask weave is here a reality; the pattern units are faultlessly repeated in the height over 1008 threads. Warp- and weft-découpure is four, which means 252 different pattern sheds for each of the motifs. The pattern is turned over once in weft direction and returns symmetrically, as can be seen in the illustration.

The Z-twisted warp has 84 ends per cm, while the weft of nearly untwisted silk has 54 per cm. The basic weave is a twill 1/3, as can be seen in the draft, Figure 202. It is noteworthy that twill-direction Z is used for both the warp-faced and the weft-faced twill. This is also done in the small pieces from Switzerland, mentioned above. A twill direction following the twist of the yarn enhances the gloss of the woven material. The warp is Z-twisted and this is certainly the reason why the twill-direction Z is used throughout.

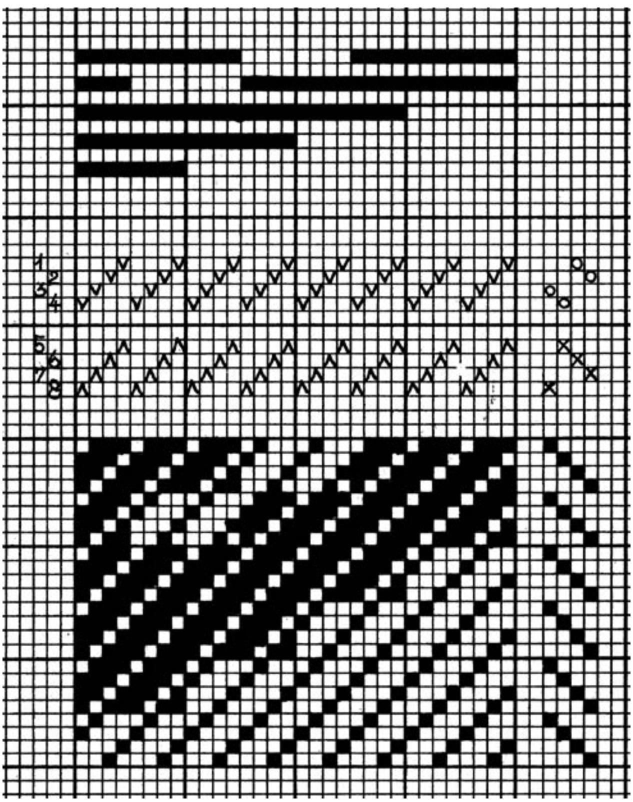
The same setup of the loom can be used also for this example, as in the draft, Figure 202. Only the connections from depression shafts to lifting shafts must be altered; see the tie-up. Our woven replica is shown in Figure 204.

For a period of centuries after this masterpiece of damask weave no more securely dated examples are extant. One tiny piece of silk (3.5 × 2 cm) is preserved in the Abbey of St. Maurice, Switzerland. Vogt shows that this example is closely related in pattern and quality to the Milan silk (Vogt 1958, pp. 121–23; Schmedding 1978, no. 120). Probably damask was still woven in countries near the Mediterranean. Twill damask was woven in China during the Tang Dynasty (AD 618–906), as will be shown in Chapter 10.

Italian silk damask, 15th century

The damask technique was apparently not of much importance until Italian weaving centres during the fifteenth century took up a number of different techniques anew (Geijer 1979, pp. 148–50). After the 'wildly'

Figure 202 The draft shows how the textile in Figure 201 was analyzed by Capitani d'Arzago (1941, pl. XV, fig. 25).



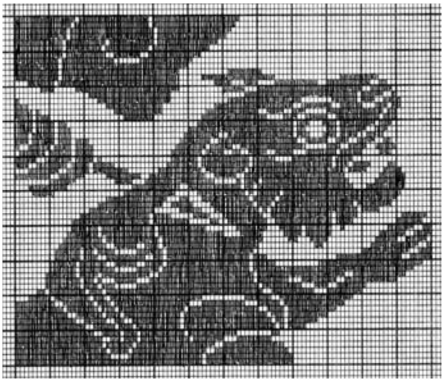


Figure 203 A fragment of one hunting scene is drawn on ruled paper (Capitani d'Arzago 1941, pl. XV). A copy is shown here.

patterned and richly coloured lampas silks a more subtle and quiet effect was now aimed at. Patterns became larger, excessive details were avoided, and more interest was given to the surface texture of the textiles. Different structures were obtained by taking up varied weaving techniques such as velvet and damask. This so-called 'pomegranate period' is perhaps not what we should consider subtle and quiet but the silks were preferably woven in only one colour, and only the changing textures produced the patterns. These silks were used for many purposes such as upholstery, wall lining, and costumes.

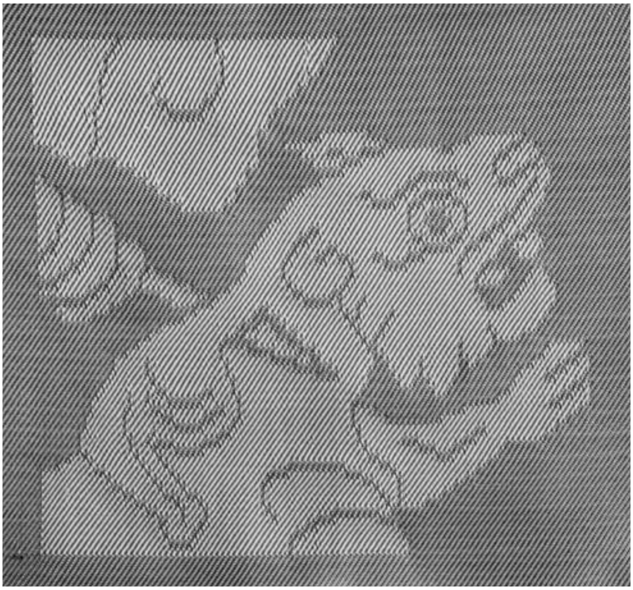


Figure 204 By means of the drawing shown in Figure 203 we have woven the replica shown here.

Warp: white organzine silk Nm 12.5, 24 per cm.

Weft: buff organzine silk Nm 12.5, ca. 16 per cm.

At this time the satin weave was known to Italian weavers, possibly derived from China through Central Asia (Müller-Christensen 1955, p. 30), and the use of this weave in damask highly enhanced the shining surfaces in contrast to the duller parts. When light plays over a silk damask the colour appears in varying degrees of depth and sheen.

The high standard of Italian silk-weaving secured for Italy a leading role in European textile production which lasted several centuries. Later this role was gradually taken over by the French weaving centres, especially with regard to fashion silks for costumes; other European countries also developed silk industries. Nevertheless the fine craftsmanship of Italian silk damask was an important factor in the establishment of the next culmination point of damask weave: fine linen damask for tablecloths.

Linen damask

The establishment of this distinctive production was due in the first place to two quite separate developments: Flemish linen thread and the Italian technique of silk damask (Geijer 1979, p. 171).

In Flanders the cultivation and preparation of flax had been developed through many centuries to the highest standard. Linen tabby of the sheerest 'batist-like' fineness was woven and linen thread of the highest quality was at hand. Also in Flanders was the important Italian trading centre for northern Europe, Bruges, where silks from Italy were on sale and could always be seen.

Flemish linen weavers with their experience soon learnt from the Italian silk damask technique and brought their linen damask to the highest perfection of technique as well as of art.

Of course these products were very expensive; in the sixteenth century tablecloths with oblong napkins were obtainable only by royal courts. Through the seventeenth century they remained an expensive status symbol of wealthy society.

Several specimens of fine table linen are preserved in museums and great houses in Europe. It is possible to study the development of patterning from the first imitations of silk patterns. Later the motifs seem to be derived from woodcuts: figural scenes depicting mythological or Biblical themes. Often descriptive texts were woven in as part of the pattern. In the large width of tablecloths the motifs were executed in point repeat, i.e.

the pattern units were repeated in reverse several times across the width. Vertically there could be a succession of scenes giving a pattern repeat of several metres.

Artisans and master weavers are known from this time. Pasquir Lamertijn (1563–1621) was born and worked in Courtrai, one of the most renowned linen-weaving centres in Flanders. In the last years of the sixteenth century Lamertijn and other skilled weavers were forced to leave their town on account of religious persecution and settle in Haarlem and Alkmaar. These towns then became the principal centres of damask weaving in Holland. Lamertijn invented a method of weaving very large patterns, avoiding repeats in the width. Probably he added enormous numbers of cords to the drawloom harness which required a gang of drawboys with the result that his products were very expensive and no doubt gave him more fame than financial profit. In the first decades of the seventeenth century he was invited by the King of Denmark to found a silk manufacture in Copenhagen. Here three famous tablecloths were executed, one of white linen, preserved at Rosenborg Castle, and two of silk with the same motif, presented as a gift to the Russian Czar and now in the Kremlin, Moscow (Mygdal 1915; Geijer 1979, p. 165). The main part of the design is a ready-laid table; the long sides depict scenes of hunting and of naval battle. The motif of a laid table is occasionally seen on tablecloths from Holland, the *banquet op tafel* (Mygdal 1913).

Quirin Janz Damast, another weaver from Haarlem, is also known thanks to a detailed inventory of his estate (Six 1910).

The demand for fine table linen increased steadily during the following century. In other parts of Europe where linen weaving had been developed to real quality, weavers wished to take up the exquisite damask technique. After the revocation of the Edict of Nantes many French Huguenots were forced to leave their country; they settled in foreign countries, where they instructed linen weavers in this new technique. Irish linen manufacture was very successful thanks to these refugees.

The flax-growing areas in Silesia and Saxony soon became an important factor. At the end of the seventeenth century a real damask manufacture was established in Gross-Schönau, Saxony. During the eighteenth century it gradually overtook the Dutch industry (Geijer 1979, p. 173).

Thanks to a profitable inland cultivation of flax, Sweden during the eighteenth and well up to the middle of the nineteenth century had some excellent linen manufactories. Among these were Flor, Vadstena, and Stenberg; they produced exquisite damask table linen for royal customers and wealthy people living in the great houses of Sweden.

'Kiøng's Manufacture' in southern Sealand was the most important linen manufacture in Denmark. It was founded in 1781 as a 'weaver's seminary to teach the sons of peasants to weave linen cloths after the Scottish method' (N. C. Rom 1871). During the nineteenth century large orders of damask table linen were produced, but at the close of the century this manufacture was closed.

Through most of its history damask was the exclusive province of professional specialists. It is therefore remarkable to find that in the south of Sweden and in Norway, from the first decades of the nineteenth century, it was also produced as a domestic craft.

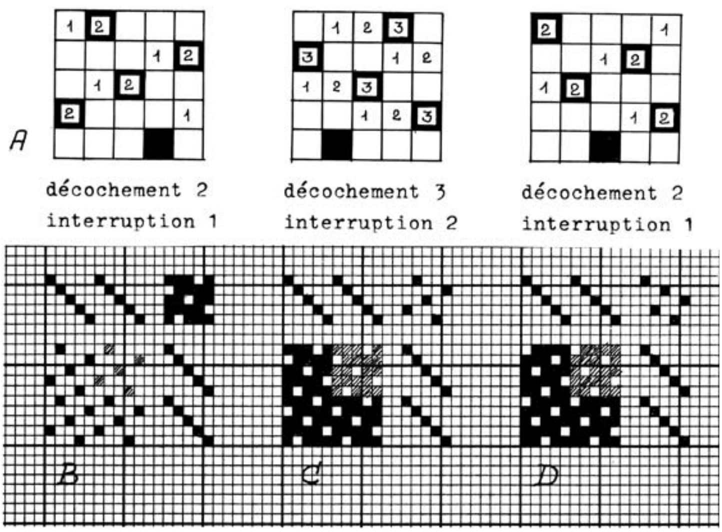
This partly home-made linen differed considerably from the exquisite products of the professional manufactories. The patterns were woven as a true damask and were of a simpler character: stripes and geometrical forms decorated with stars, leaves, and flowers (Fischer 1959). The method used was based on certain standardized weaving equipment developed in England and Scotland. The introduction and widespread knowledge of the new methods is due to the Swedish Ekenmark family. The family consisted of five members, all of them weavers, and some of them worked as teachers at courses in Sweden and Norway. Between 1820 and 1848 they published a number of books including descriptions of the methods, drawings for building the looms, drafts, and a great many plates of patterns (Bugge and Haugstoga 1968).

Damask: weaving technique

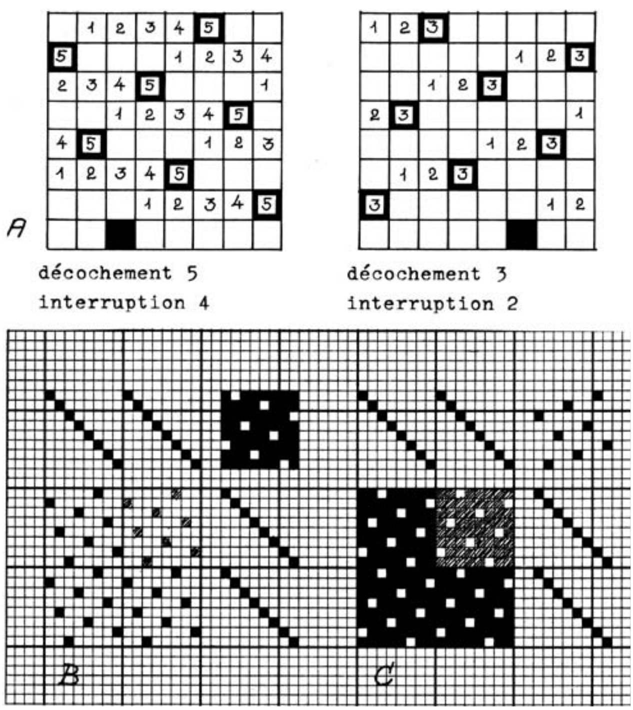
Satin weaves

In the earliest extant examples of damask described above, twill 1/3 was used for the basic weave. In later centuries, at the latest from the first decades of the fifteenth century, satin was generally used.

In a satin weave the warp is prevalent on one side and the weft on the other side. The binding unit of a satin weave always comprises the same number of weft and warp ends and only one binding point is used on each end. Binding points are spread evenly out and never touch each other, so that the surface of the weave has a smooth and shining effect.



↑ **Figure 205** For a 5-end satin, décochement 2 or 3 can be used. At B a weft satin is drawn with décochement 2 and at C a warp satin is drawn with décochement 3. In the regular satins a faint twill direction appears, in B with S-direction and in C with Z-direction. At D a warp satin is drawn with décochement 2 similar to the weft satin B with S-direction. Entering and treadling is always in straight repeat.



← **Figure 206** For an 8-end satin, décochement 3 or 5 can be used, as shown at A. The 8-end weft satin B is drawn with décochement 5 and the warp satin C is drawn with décochement 3.

Note that twill directions are opposed.

Only the satins generally used for damask are shown here: 5-end and 8-end satin are called regular satins because binding points are placed strictly according to décochement or interruption numbers. The French term *décochement* means the number of warp ends over which a binding point is moved from one weft to the next, see Figure 205 A. The English term *interruption* means the number of warp ends *between* binding points on two wefts following each other; i.e. interruption equals décochement minus one. In this book we use only décochement.

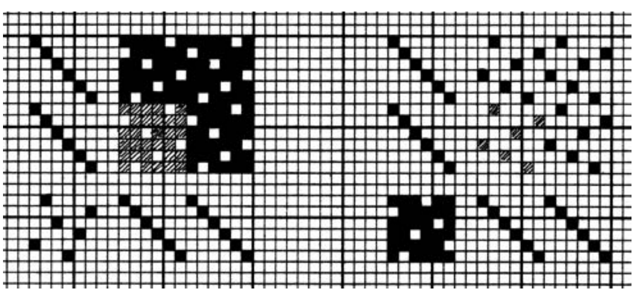
A warp satin is drafted as follows. First binding points are marked with a soft pencil and the empty squares are filled out; afterwards the pencil marks are rubbed out.

The system of damask weave

The normal method of weaving damask on a drawloom uses essentially the same principle as was described above (p. 250) as 'the damask trick'. Outlines of a damask shed with a 5-end satin as basic weave is shown in Figure 208. Five warp ends are entered into each of the leashes of the pattern harness at the left. Warp ends are entered individually into long-eyed heddles on five shafts in straight repeat. In Figure 208 A one group of five warp ends is lifted for a pattern shed, but the shafts are shown still in their middle position. The cross section of warp ends at the right shows the present position. Filled circles mean the lower shed face and open circles mean the upper shed face.

In Figure 208 B the same pattern shed is shown. Here shaft 1 is lifted, lifting every fifth warp end from the lower shed face, and weft-faced satin appears. Shaft 2 is pulled down, depressing every fifth warp end from the lifted group. This means that lifted groups of warp ends give warp-faced satin. At the right the cross section of warp ends shows the shed for one

Figure 207 The irregular 6-end satin is shown here. No twill direction appears. This weave gives a distinctive texture to the surface of the textile. Some variations are shown below.



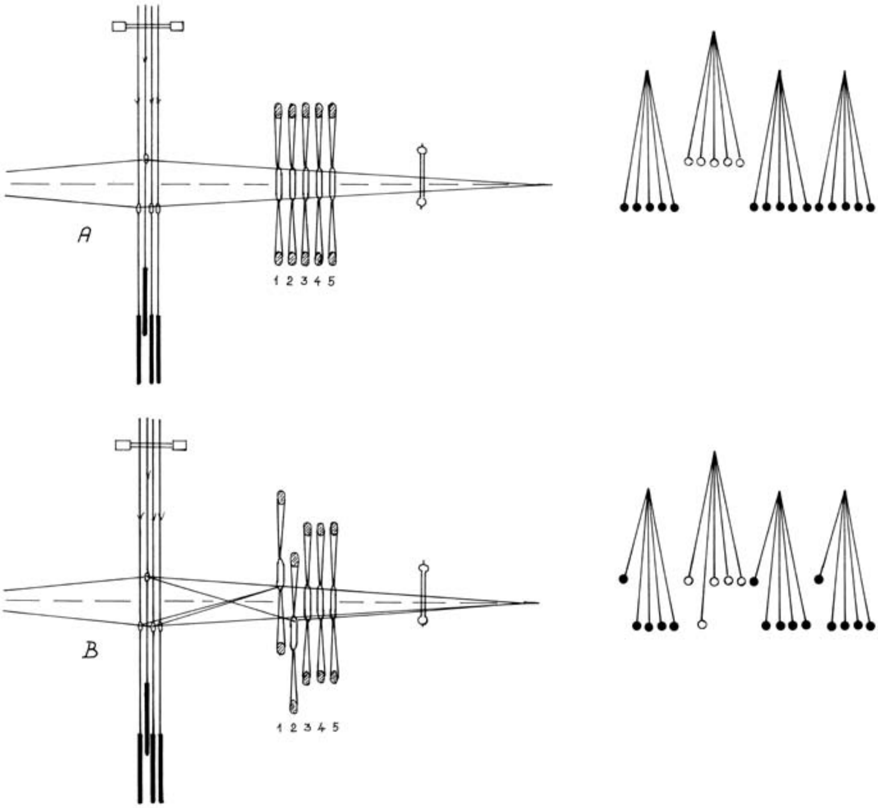


Figure 208 Two outlines (A and B) of a damask shed using 5-end satin for the basic weave. Five warp ends are entered into each of the leashes in the pattern harness; these are then entered singly into five shafts with long-eyed heddles.

At A one of the leashes is lifted, and the pattern shed goes clearly through the heddles. The cross-section of warp ends at the right shows the opened pattern shed.

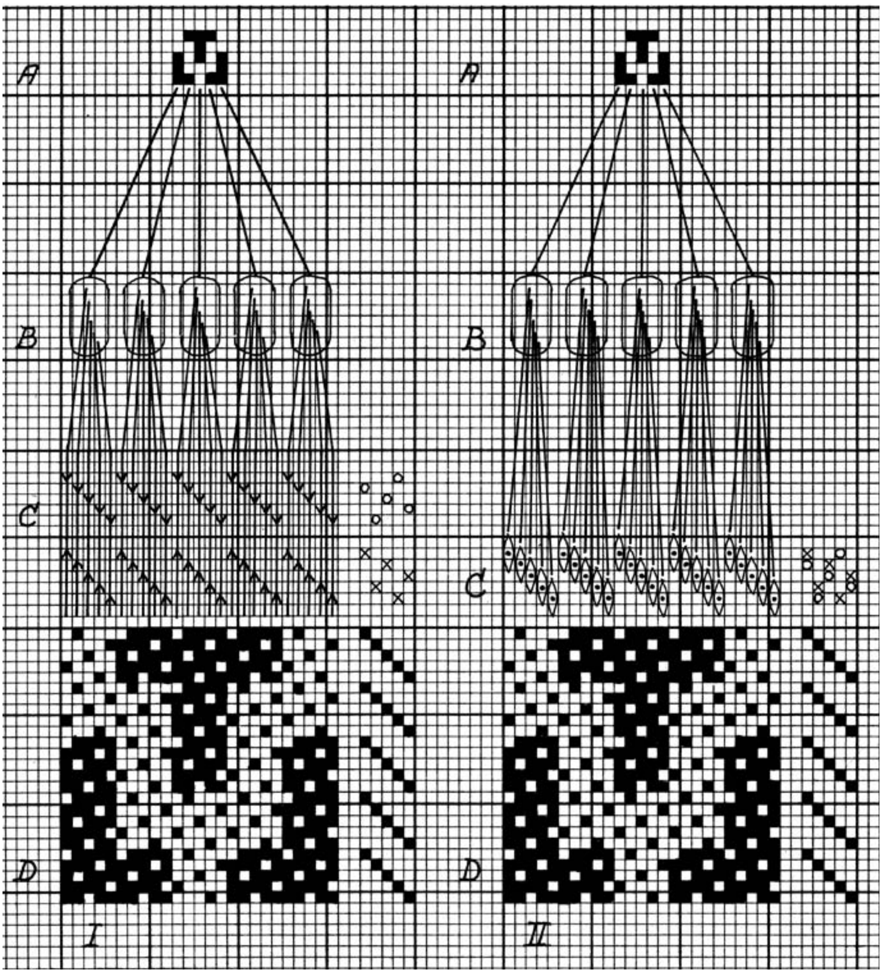
At B shaft 1 is lifted and shaft 2 is pulled down to show the shed for one satin weft. The cross-section of warp ends at the right shows that every fifth of the warp ends from the lower shed face is lifted and that every fifth from the lifted groups in the upper shed face is pulled down. Thus groups of warp in the lower shed face give weft-faced satin and lifted groups in the upper shed face give warp-faced satin.

→ **Figure 209** Two methods for setting up a damask with 5-end satin. In method I, for very fine and tight material, two sets of satin shafts are used, one set for lifting and another for depression, as in C. Method II, with one set of shafts supplied with long-eyed heddles, is more generally used.

weft. In the same way the remaining four satin wefts are woven consecutively with the same pattern shed.

The thread cross between pattern lift and satin shafts causes a heavy strain on these warp ends. The uneven strain on some of the warp ends is considerably reduced if the loom is of sufficient length, with a long distance to the warp beam. It is also useful to place the pattern harness at a distance of 25–35 cm from the satin shafts.

The setup for a damask with 5-end satin is shown in Figure 209. A detail of a pattern is shown at A; each vertical column consists of five warp ends entered five in each of the leashes at B. In draft I two sets of shafts are



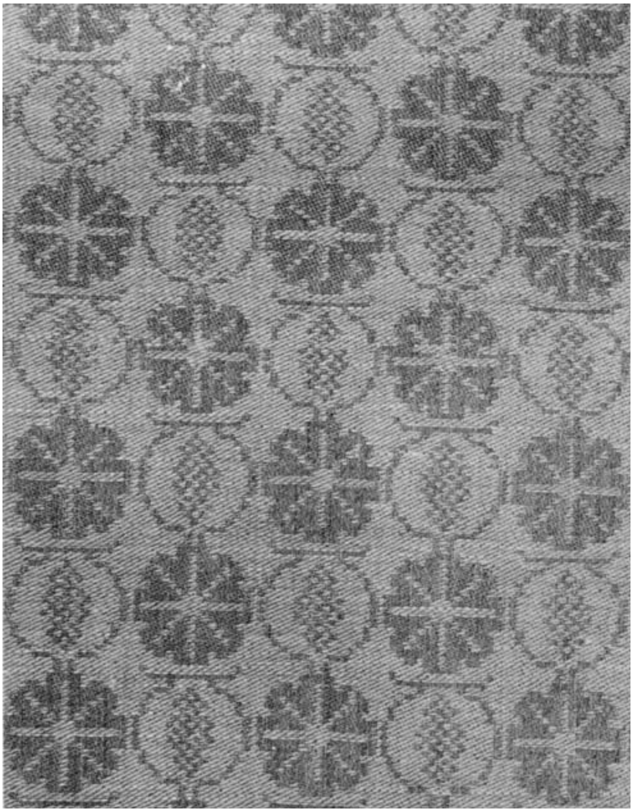


Figure 210 A detail of a tablecloth is shown as an example. The motif is poppy capsules; it was designed and woven in our workshop by method II, shown in Figure 209.

Warp- and weft-découpure is four.

Warp: linen 25 lea, 24 per cm.

Weft: linen 20 lea, 24 per cm.

used, one set for lift and another for depression. When the warp is very fine and tightly set this method is always used; it is still used by French silk-weavers. For our weaves, with warp yarns which are not too fine, method II (Figure 209) with long-eyed heddles is generally used. Then only five shafts are needed as can be seen at II C.

When long-eyed heddles are made knots cannot entirely be avoided. If heddles are made in a frame similar to the type shown in Chapter 12, the upper part of the eye may be clasped but a knot must be made below the eye.

In the tie-up crosses mean depression shafts and circles mean lifting shafts. For each treadle one shaft is pulled down and one is lifted, the remainder of the shafts being left in their middle position.

When a tie-up for damask weave is planned it is necessary beforehand to ensure that the tie-ups for warp and weft satin respectively can work together. One tie-up is placed over the other; if two binding points meet in the same square a shaft should have to go up and down at the same time, and this is clearly impossible. See for instance the 5-end satin Figure 205. The weft satin B (with décochement 2) cannot work with its counterpart, the warp satin C, and therefore the warp satin D (with décochement 3) is used. This rule is still valid when two sets of shafts are utilized: one warp end cannot be above and below the weft at the same time.

Patterns come out more clearly when binding points in warp and weft meet exactly along the outlines of patterns. This principle is of greatest importance along straight lines, where a thread in some cases will slide out and blur the outline. In patterns freely drawn with curving or slanting lines this is not as important. With 5-end satin this correct binding is possible only along one vertical side; on the other hand warp floats are not very long in a 5-end satin and the irregularity has little effect.

In the damask setup, shown in Figure 209, the découpure is five ends, which corresponds to a binding unit for each découpure. This was done only for clarity; a découpure of 2, 3, or 4 can be used as well, as long as the numerical order of shafts and treadles is followed.

It is thought advantageous if twill directions in warp and weft are opposed, because a stronger contrast appears between shining and dull surfaces. With 5-end satin this is not possible, as can be seen in B–C–D in Figure 205 above.

Nevertheless 5-end satin is the weave most often used for damask.

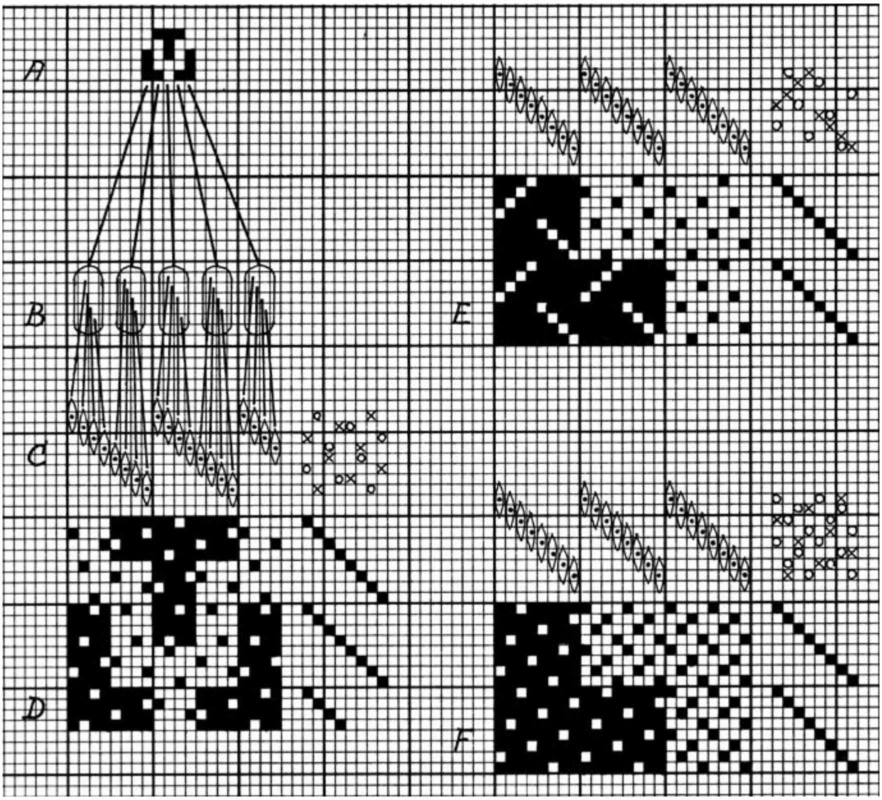
An example woven with 5-end satin is shown in Figure 210. It is a detail of' a linen tablecloth. We have used this quality for many years for table linen. The découpure of warp and weft is four.

Eight-end satin is most useful for very fine and tight qualities; it is also well suited for a strong and heavy material intended for upholstery.

In Figure 211 the draft for a damask with 8-end satin is shown. In the pattern detail at A each vertical column in this case comprises only four warp ends. With the 8-end satin, binding points will meet correctly along every outline, vertical as well as horizontal, with only four ends in each découpure. Also the twill directions are opposed, though they can be seen only faintly with this weave. An experiment with 8-end satin for a tablecloth with coat of arms is shown in Figure 212.

Two variations with 8-end satin are shown at the right. Only the entering of shafts and the tie-up are shown here.

In the variation Figure 211 E the warp-faced satin is altered to a broken twill 7/1. This weave gives a pearly structure to the background and the



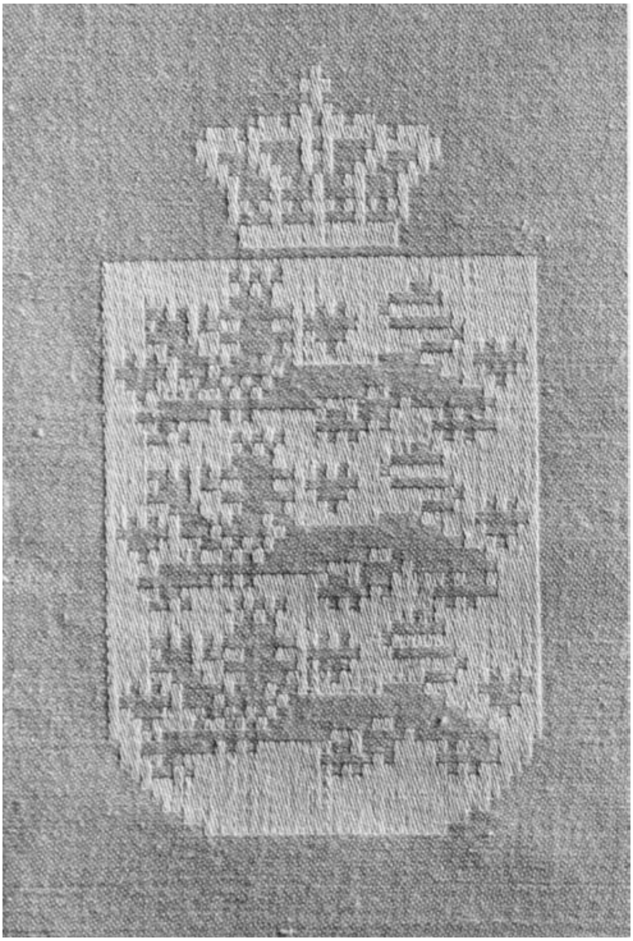
pattern comes out in the smooth even satin. An example with this variation is shown in Figure 213.

In the variation Figure 211 F the 8-end warp-faced satin is maintained and the weft-faced satin is altered to a 4-end broken twill. The 8-end satin is a multiple of the 4-end twill. This means that two binding points are needed for each binding unit of 8-end satin. This tighter weave 'takes up' much more of the warp, and therefore the pattern must be planned in such a way that the tighter weave appears fairly evenly all over the material. The 4-end broken twill gives a considerable contrast to the shining background of 8-end satin and gives a relief to the pattern.

The same detail of a pattern is used for the setup of a damask with 6-end satin in Figure 214 (A–D). In this case each vertical column means a group of six warp ends lifted by one leash, shown at B. Individual warp ends are entered into six shafts with long-eyed heddles. With six wefts and six warp ends in each découpure the binding points will meet correctly in every outline. This irregular satin has no twill direction.

← **Figure 211** A setup for damask with 8-end satin for the basic weave. In this case each vertical column in the detail of a pattern shown at A consists of only four warp ends, in order to show that with this weave binding points meet correctly along every outline.

Two variations, E and F, with 8-end satin are shown at the right. Note that binding points cannot meet correctly here.



→ **Figure 212** An experiment for a tablecloth with coat of arms. The basic weave is 8-end satin, and eight ends are used in each découpure in warp as well as in weft.

Warp: linen 50 lea, 36 ends per cm.

Weft: linen 50 lea, 32 wefts per cm.

At E is shown a variation on a 6-end satin where binding points meet correctly with only three wefts and three warp ends in each découpure. The twill directions are here emphasized and are in opposite directions from warp-faced to weft-faced satin. This weave is especially appropriate for decorative textiles woven with a coarse linen material.

Usually damask patterns are drawn on ruled paper, each little square representing a predetermined number of warp and weft ends. The method shown in Figure 214 E is very well suited to more free weaving with a drawing in real size suspended below the warp, as described above in connection with Beiderwand (Chapter 6) and double cloth (Chapter 8). When only three warp ends are entered into each of the leashes, and the

Figure 213 A woven sample of variation E from Figure 211. Note the contrast between the structure of the background and the smooth weft satin in the pattern. Découpure is four in warp as well as in weft.

Warp: linen thread 16/2 lea 16 ends per cm.

Weft: linen thread 16/2 lea 16 wefts per cm.

outlines of the underlying drawing are controlled for every three wefts, no faults in the binding occur and the method functions very satisfactorily.

The textile shown in Figure 215 was woven with this method. Extra colours besides those of the warp and weft were also used. We wanted to set off the stylized leaves at the upper part of the altar frontal with contrasting colours, pale rose and gold. To obtain this effect the regular brick-red satin weft was first thrown in; the already-lifted groups of warp for the damask pattern were released, while the satin shed was still kept open with the current treadle. The gold threads or other colours were then laid in for each figure (brocaded) according to the design. Thus where

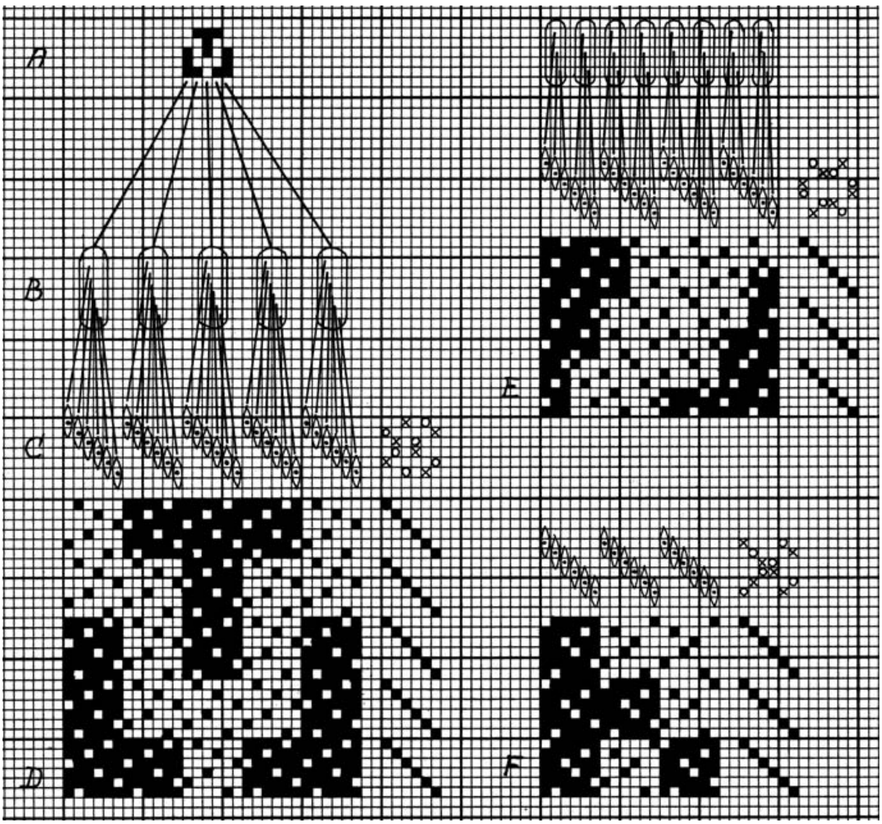


Figure 214 A setup for damask with the irregular 6-end satin. Each vertical column in the pattern consists of six warp ends. When six wefts are used for each découpure the binding points meet correctly in every outline. The variation shown at E is intentionally constructed to show the twill direction. When it is used as shown here, with twill directions opposed from warp- to weft-faced satin, the binding points meet correctly with only three threads in each découpure. The variation shown at F was used in the old tablecloth illustrated in Figure 216.

Figure 215 An altar frontal designed and woven in our workshop for a beautiful old church in Ullerup, in the south of Jutland. It was woven with the method shown in Figure 214 E. Warp direction is shown horizontally.

Warp: brown and black linen 6 lea, 12 per cm.

Weft: brick-red linen thread 16/2 lea, ca. 10 double wefts per cm. Gold thread and linen of several colours for the brocaded pattern.

Photo: N. H. Seedorff.

these new colours appear on the face side there are in reality satin wefts on both sides (a double satin). The regular brick-red satin weft appears on the reverse side.

The method is very time-consuming and is as far as possible restricted to small areas where the extra effect is desirable.

The variation shown in Figure 214 F was found in an old tablecloth; the motif is the Genesis and the year 1613 is woven in. This tablecloth

Figure 216 A tablecloth with a motif from Genesis. The tablecloth consists of two lengths sewn together. The entire length is 200 cm and the width of each woven length is 72 cm.

Warp: white linen, ca. 33 per cm.

Weft: white linen, ca. 36 per cm.

Photo: Ole Woldbye.

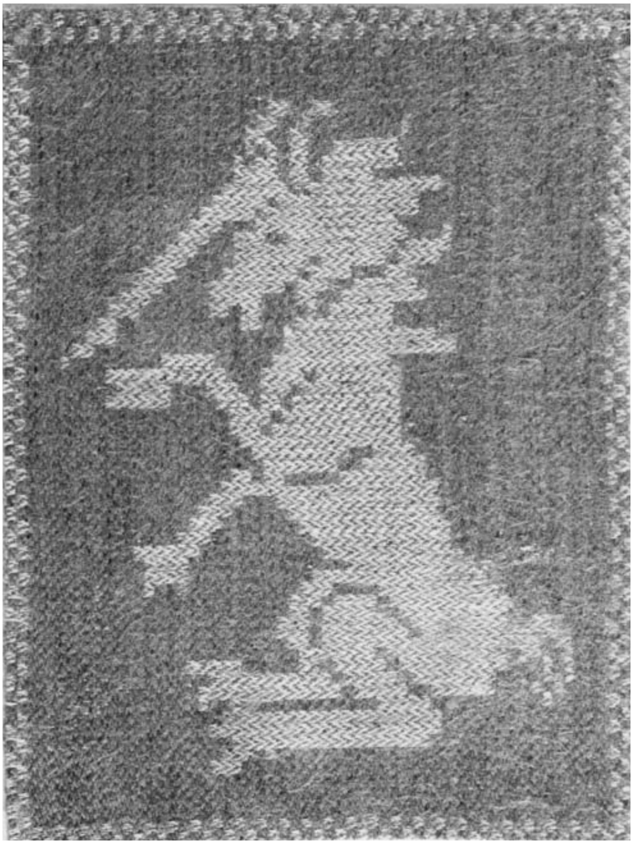


Figure 217 A detail of the tablecloth in Figure 216 woven as an experiment.

Warp: linen 25 lea, 36 per cm.

Weft: linen 50 lea, ca. 28 pet. cm.

is in a private Danish collection; one half of it is shown in Figure 216. Our woven detail, the unicorn, is shown in Figure 217. Another example with the same motif and basic weave belongs to the National Museum, Copenhagen, and is described by Mygdal (1913). The year 1614 has been woven in, and a coat of arms, also woven in, indicates that the cloth was produced in Courtrai.

Selvedges

Selvedges on satin-woven tablecloths and napkins are apt to roll over and are difficult to press out when they have been washed. In a plain satin weave along the selvedge the warp-faced side, perhaps a little tighter than the weft, is apt to expand and then to roll in over the weft-faced side.

Narrow chequered bands are often seen along the outer sides of old tablecloths similar to our detail, shown in Figure 217. The chequered bands are decorative and at the same time useful to keep the selvedges plain thanks to the rapid change from warp- to weft-faced satin.

Selvedges are usually strengthened by entering 4–6 double warp ends in both sides. It is difficult to obtain a straight and even selvedge with a satin weave because the outermost ends have only few binding points. Tabby weave is clearly the most useful for selvedges. It is possible on a damask loom to make tabby selvedges when the basic weave has an even-numbered binding unit.

Two examples, 6-end and 8-end satin, are shown in Figure 218. To show the principle, see the draft A for 6-end satin. At first four warp ends in both sides are marked by black points for tabby. Note that a tabby lift meets a weft point in the adjoining satin weave. The main principle is: for each weft to utilize the current treadle's lift. To this purpose lifting heddles, able to lift but never to pull down, are used here. See the lower weft: treadle 1 lifts shaft 5, then the tabby ends marked for lifting are supplied with lifting heddles on shaft 5. For the next weft, treadle 2 lifts shaft 1 and the tabby ends marked for lifting are supplied with lifting heddles on shaft 1. For the third weft treadle 3 lifts shaft 3 and lifting heddles are placed on shaft 3 and so on.

As can be seen each of the tabby ends has several lifting heddles. To avoid too much wear on the tabby ends, it is useful when the lifting heddles are made to place the lifting point a little lower than the lower knots in the remaining long-eyed heddles. Of course the warp ends for tabby weave are entered into the harness leashes to keep them in the lower shed

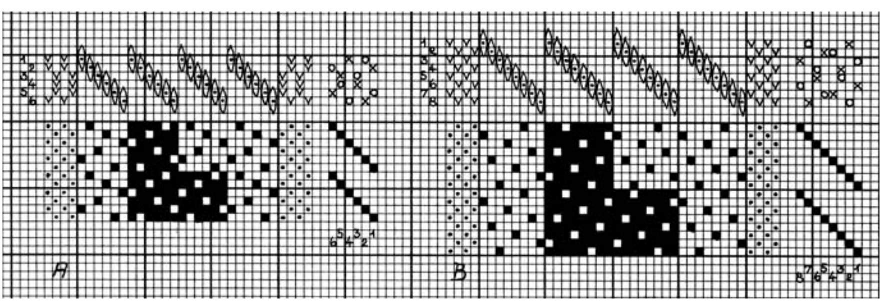


Figure 218 Two drafts for tabby selvedges, A for 6-end satin and B for 8-end satin. Four warp ends are marked with tabby by points at each side. Lifting heddles for tabby are shown by v's.

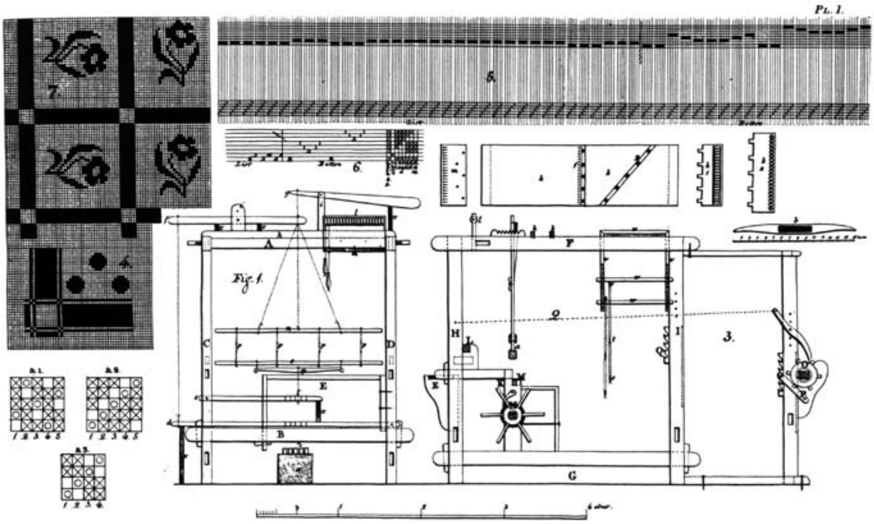


Figure 219 The reproduction of pl. 1 (Ekenmark 1828) shows his drawing for a simple damask loom.

Figure 220 A Swedish damask weaver, Maria Andersson, working with one hundred pattern shafts, photographed in 1950. The loom was built for her mother in the late 19th century by a country carpenter after Ekenmark's descriptions.

face, otherwise the lift would have no effect. The outermost harness cords with the tabby ends are never lifted.

Patterning methods

The methods for forming patterns in damask weave followed the development of drawlooms from the early centuries. This development will be described in detail in Chapter 11. But it will be useful to consider briefly some of the methods used by domestic weavers in the south of Sweden. Their methods represent, in a simplified way, some steps in the development of drawlooms used by professional weavers.

The broad shed rod, shown above in connection with the earliest examples from Palmyra, can still be used for experiments or individual patterns. It is extremely well suited for inserting dates and names in tablecloths; this is also done in connection with more sophisticated patterning methods.

The shaft drawloom (Scandinavian: *dragrustning*), described and illustrated by Ekenmark (1828, pl. 1) and shown here in Figure 219, is certainly the method most widely used in the south of Sweden. Although Ekenmark did not invent the loom and methods, his book (1828) was largely founded and translated from *Practical and Descriptive Essays on the Art of Weaving*, by John Duncan, published in Glasgow in 1807–8 (Bugge and Haugstoga 1968, p. 74). Duncan's essays were intended for professional weavers. The great contribution of the Ekenmark family was that their inventions made it possible for the domestic weaver to weave damask with fairly inexpensive implements added to the normal loom.

Another type of patterning device, the figure harness drawloom (Scandinavian: *harniskrustning*), is also used by domestic weavers. The form used today was developed at Brunsson's Weaving School in Stockholm, Sweden, in the first decades of the 20th century. This renowned school was started in 1889 and closed in 1958. According to Johanna Brunsson's successor Alma Jacobsson, study tours were taken to Schleswig-Holstein (Northern Germany) to study the weaving of Beiderwand (see Chapter 6). Without doubt a loom similar to the example exhibited in the museum of Altona (Sauermann 1923, p. 7) was the model for this system.

In the harness drawloom no pattern shafts are used. A sort of warp made from strong cords is suspended over rollers in the upper part of the loom and loose weighted heddles are knotted to each of the cords.

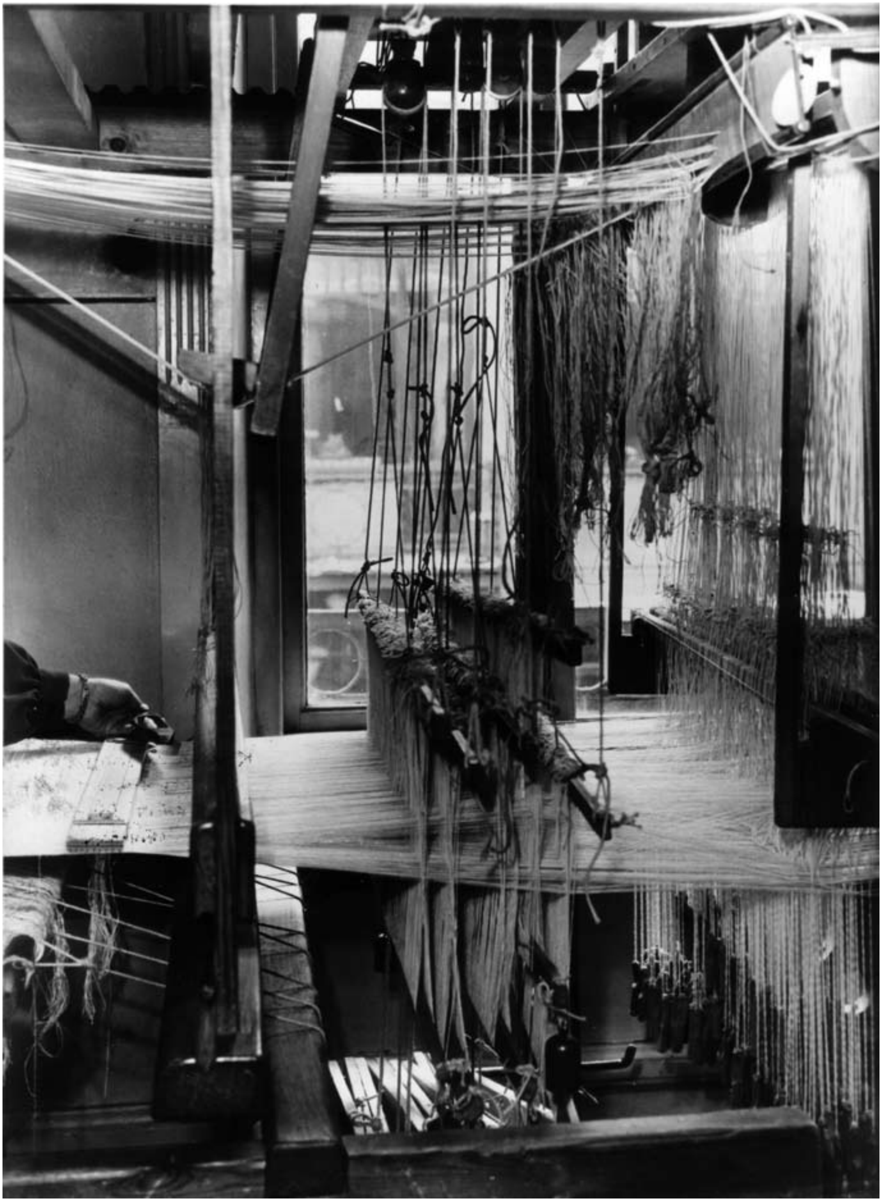


Figure 221 The Swedish type of figure harness drawloom (*harniskrustning*) is shown in the photograph from a weaving school in Malmö, Sweden, ca. 1950.

Patterns are counted in, row by row, above the head of the weaver. Each row is supplied with loops of string (lashes) which the weaver pulls down to open a pattern shed; see the photograph in Figure 221.

Twill diaper and damask diaper

The terms *twill diaper* and *damask diaper* are used in English for the sort of weave which in Germany is called *Drilich*, in Scandinavia *drejl*, *dreiel*, *dräll*. The word *drill* is used in English for an unpatterned cotton material woven with twill for working cloth, sportswear, etc.; for such a material the corresponding words are used also in Germany and Scandinavia.

Diaper is a block-patterned weave constructed with both sides of an unequal-sided binding similarly to the damask weave. Patterns are simple geometrical forms; in many cases they can be traced to the pattern books mentioned in connection with Beiderwand (Chapter 6). It was generally used with linen material for tablecloths or with cotton and wool for shawls, bed hangings, and coverlets. Linen tablecloths of this weave are known from the beginning of the seventeenth century.

The vague terms twill diaper and damask diaper (basic weave respectively twill and satin) suggest that this type was not generally used in Great Britain. But this is far from the case. When the Danish linen manufactory, Kiøng, was founded, one purpose was 'to teach sons of peasants to weave tablecloths after the Scottish method'; preserved papers from the foundation of this factory (1781) prove that not only the method but also the implements for the intricate setup were imported from Scotland. This 'Scottish method' is extensively described and illustrated by John Murphy (1850, pp. 66–95).

The coarser sort of table linen woven with a 4-shaft twill was manufactured at Dornock in the north of Scotland and was called *dornic*. The finer qualities were woven with 5-end satin and called *diaper*.

The block-patterned diaper weave is woven on looms with several shafts and treadles. Each new block in the pattern demands a number of shafts and treadles corresponding to the binding unit. For instance a 2-block pattern, a chequerboard or a variation, needs 8 shafts and 8 treadles if the basic weave is twill 1/3, see Figure 222. Each square in the pattern shown at A means one binding unit. The systematic entering plan is drawn above with black squares in the same way as entering is drawn above a normal binding. Each new block (Murphy says 'division') needs a new group of

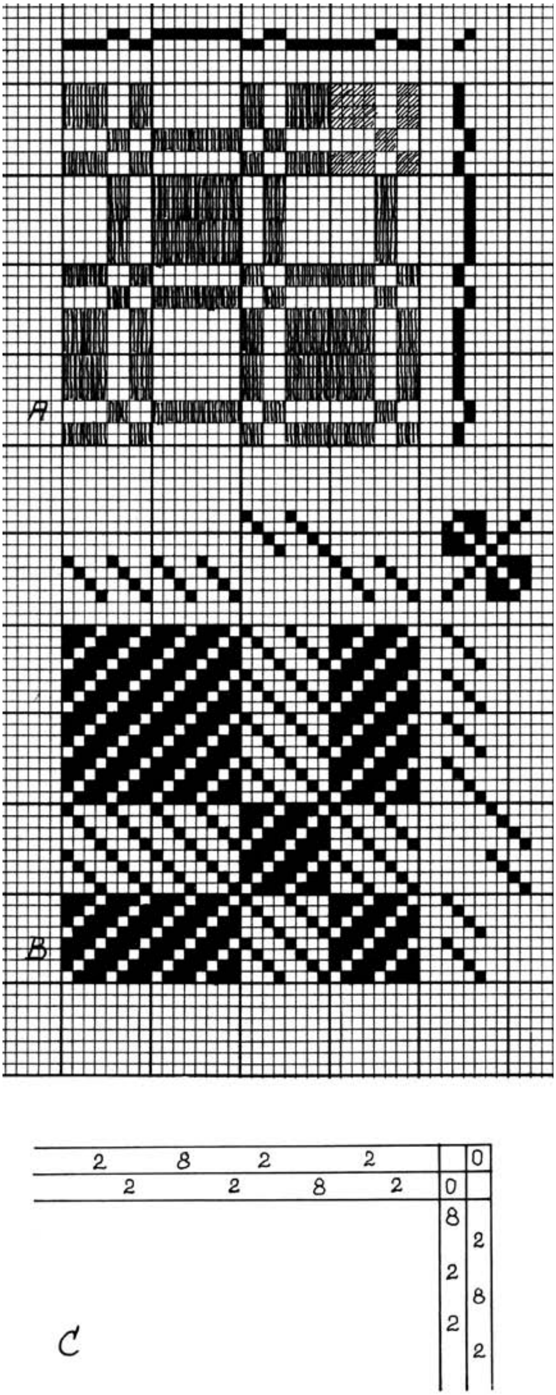


Figure 222 An example of a 2-block pattern is shown at A. The so-called systematic entering and treadling is shown above and at the right by black squares. Each square means one unit of the basic weave; here twill 1/3 is used.

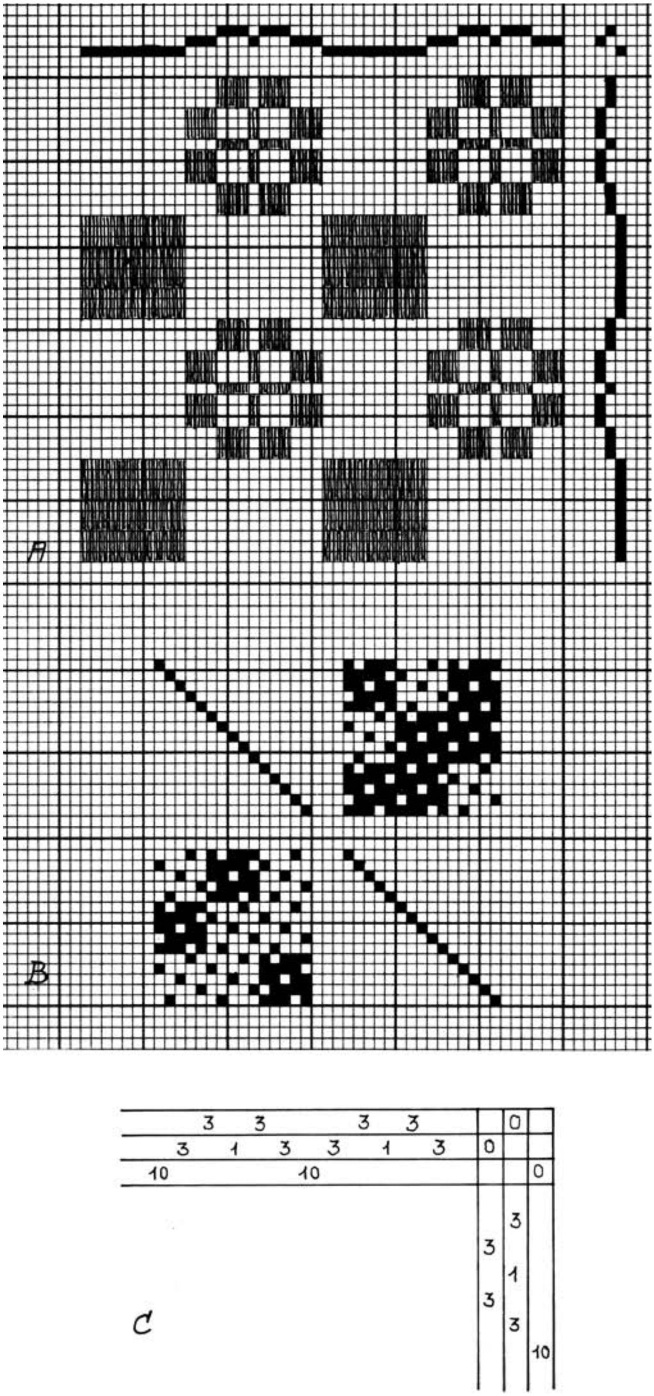
The upper right-hand corner (hatched) is drawn in detailed draft at B. This is the type called 'dornic(k)'.

At C the pattern is shown by means of numbers such as was normally the usage of weavers in older times.

Figure 223 A 3-block pattern is shown at A. The systematic entering and treadling is shown by black squares. Each square means one binding unit, in this case 5 warp ends and 5 wefts; the basic weave is here 5-end satin.

The detailed draft at B shows only one unit for each block.

At C the pattern is shown by numbers as in the old weaver's manuals.



shafts. Treadling is shown in the same way at the right. Black parts of the pattern mean predominating warp, therefore the 'tie-up' comes out as shown here.

The upper right-hand corner (hatched) is drawn below at B in detailed draft.

In old weaver's manuals such dornic or diaper patterns are noted by numbers as shown at C in order to save space and time. Sometimes straight lines are drawn across the blocks, each line representing one thread entered into each of the shafts in the block.

A 3-block pattern is shown in Figure 223. This is meant for a diaper with 5-end satin. The systematic entering and treadling is shown with black squares. At C the simplified method with numbers is shown. The detailed 5-end satin is shown at B; here only the necessary binding for each block is shown. Fifteen shafts and fifteen treadles are needed for a 3-block pattern.

For each new block added to a pattern five shafts and five treadles are to be added. Evidently this rapidly increasing number of shafts and treadles means a limitation to the development of patterns. Still an incredible number of variations within 3- or 4-block patterns is found.

PART IV

The Eclectic Pattern Weaves of Tang China

Chapter 10

The eclectic pattern weaves of Tang China

In Chapters 1–3 above we have described the basic weaves of Han China. Intervening chapters have described developments in the West, and we return now to China for a brief consideration of the weaves of the Tang period (AD 618–907).

The Han dynasty fell in AD 220; during the following four centuries, the Six Dynasties period, China was divided and political conditions were chaotic. The empire was finally reunited under the Tang. It is toward the end of the Han and in the centuries thereafter that West Asian cultural influence first becomes apparent – the best-known example is the introduction of Buddhism in the Han and its spread throughout China in the course of the Six Dynasties period.

The Han weavers were sensitive artists and superb craftsmen, but they used only a limited range of techniques. Chapters 1–3 describe virtually all the techniques used in extant Han textiles. These are all warp-faced patterned tabbies, besides gauze weaves, and the drawloom seems not to have been used. Weft-faced weaves appear for the first time in the third or fourth century AD (Riboud 1975). Since Chinese textiles with patterns clearly influenced by West Asian styles also appear at this time, it is very likely that this innovation, and others which followed it, are borrowings from the West.

Silk weaving in the Tang undoubtedly comprised every advanced technique known in the world at that time. Some techniques, such as weft-faced compound weaves, taqueté and samitum, had already been used by weavers in western Asia from earlier times, and these have been described in preceding chapters in connection with what we assume to be their first appearance. An exhaustive description of the whole complex of textile techniques of the Tang would be unthinkable, and therefore we have preferred to show a few examples to illustrate what we think is a technical development founded on earlier methods described in Chapters 1–3 on silk weaving in the Han. This development sequence is of course only a suggestion, a little rash when

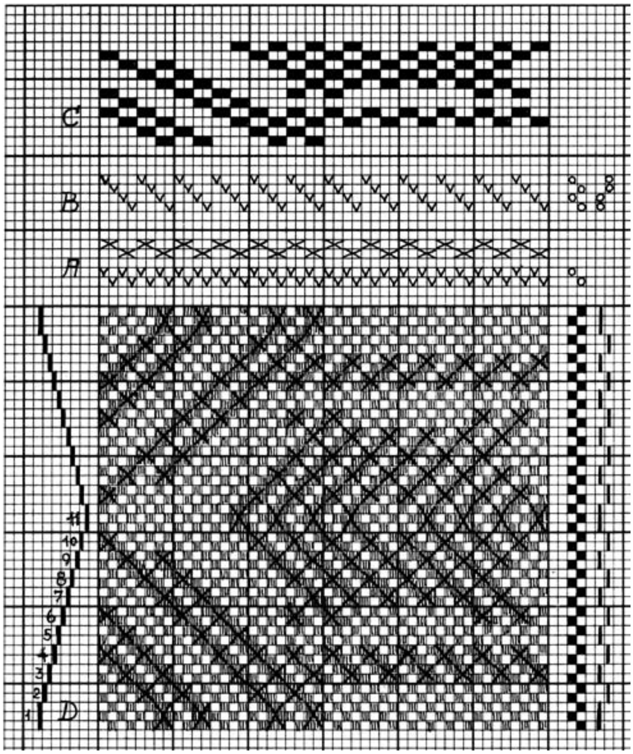


Figure 224 Draft for the monochrome silk woven in accordance with the 2–2 method. At A are shown two lifting shafts for tabby and two dividing rods for counting in the pattern. Our method with four lifting shafts, B, allows the lifting of tabby and also of alternate pairs of warp ends for counting in pattern. At C one-half of the transversally symmetrical pattern is shown by black squares. At the left are suggested the eleven pattern heddle rods. In the detailed draft D black crosses show the lifted groups of warp ends.

no exact data for the examples are known. The idea is to draw attention to certain facts which turned up in our practical experiments.

Pattern heddle rod loom or drawloom

As has been argued in earlier chapters, one may generally presume that warp-faced polychrome weaves were woven with the pattern heddle rod loom, while weft-faced weaves were woven on a drawloom. Along the Silk Road a large number of weft-faced silks have been found; the patterns often show Sassanian-Persian influence but in some cases Chinese characters are woven in. Other examples show ornaments of pronounced Chinese style. Such silks were undoubtedly woven by Chinese weavers, but not necessarily in China proper. A Chinese source of the eighth century tells of Chinese weavers working at that time in the Abassid capital, in modern Iraq (Pelliot 1928).

Sylwan (1949, pp. 147–155) discussed this interesting subject, comparing material from the excavations of Aurel Stein and Sven Hedin; she concluded that the weft-faced weaves were probably woven in Central Asia. This was probably the case in the earlier centuries, perhaps in the centuries before the Tang. But it appears nearly unthinkable that weavers in China proper, during the flourishing Tang period with its extensive commercial contacts with the western world, should not have had the drawloom.

Riboud's discussion (1975, pp. 13–39) of three examples of the earliest weft-faced silks is founded on a more modern, advanced research technique. There is reason to hope that such methods will provide means to solve many problems.

The continued use of Han monochrome techniques

From the Tang dynasty a large number of monochrome silks of the type *qi*, tabby patterned with twill, are preserved. This type of weave was apparently in continuous use from the early Han at the latest.

One example shown by Sylwan (1949, p. 108, pl. 14C) was excavated in the Lop Desert and dated to early Tang (ca. AD 600–750). It is from the sleeve of a blouse woven with untwisted silk and dyed red. It has 50–55 warp ends and 35–40 wefts per cm. The pattern repeat in weft direction is ca 9.5 cm; in warp direction the pattern unit measures 0.6 cm repeated in transversal symmetry. This example therefore shows the usual characteristics of the Han silk patterns.

Our replica was woven with eleven pattern heddle rods as shown in the draft, Figure 224, using the same 2–2 method described above in Chapter 1. Note that heddle rods 1 and 11 are used for three consecutive wefts instead of two in order to change the twill direction.

Presumably there had by this time been a development toward more efficient looms and it is possible that eleven mechanically lifted pattern shafts were used (treadles or lifting cords?) But the use of such a procedure cannot be proven from this example.

Our replica, Figure 225, is shown with the weft-faced twill up, as is Sylwan's example (1949, pl. 14 C).

A number of richly decorated silk banners is preserved in the Shōsōin collection, Nara, Japan, and in the Musée Guimet, Paris. The size of the banners is generally 18–20 × 100–180 cm. They are made from several sorts of silk weave, three or four to each banner (Riboud and Vial 1970). They constitute a rich source for studying varied types of weaving tech-

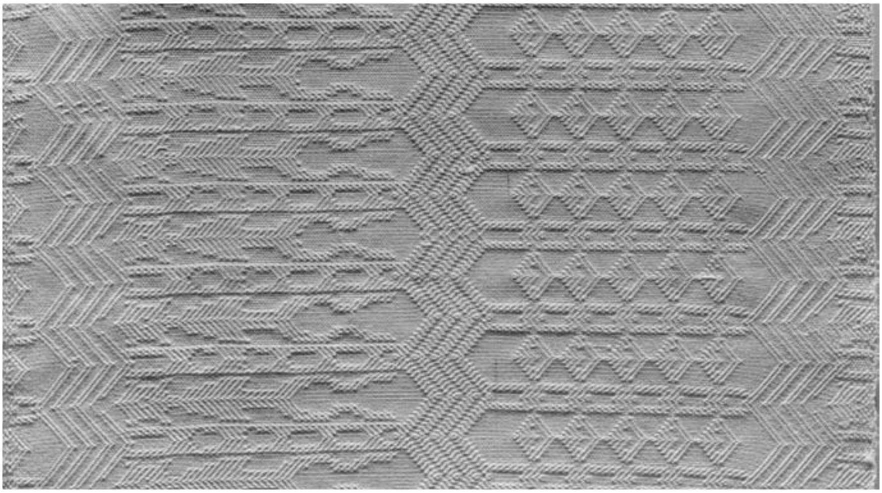


Figure 225 Our woven replica. Exceptionally the weft-faced twill is shown on the face side as is also the case in Sylwan's example.

Warp: spun silk Nm 10, 18 ends per cm.

Weft: spun silk Nm 10, 14 wefts per cm.

niques. The lower part of the banners is often formed as three fluttering ribbons cut out of a piece of silk.

Our next example, a monochrome lozenge-patterned silk (54–56 warps/cm, 34–36 wefts/cm), was used for such ribbons (5.5 cm wide) on a banner, EO.3653 (Riboud and Vial 1970, p. 337). For a replica we again used the 2–2 method, described in Chapter 1. Two other possible methods are also shown in the draft, Figure 226. Because only four pattern heddle rods are needed it would be possible to tie up four lifting shafts and to lift these shafts by means of four treadles simultaneously with the treadles for tabby. This method, always lifting warp ends in groups of two, causes the twill direction to follow the outlines of lozenges on one side and cross the outlines on the other.

Vial also suggested the method shown uppermost in the draft. Eight heddle shafts are entered as shown at C. This means that eight treadles must be used in the same order to obtain the same effect on the lozenge pattern. This way of entering and treadling appears somewhat hypothetical. Entering alternately in straight repeat for half of the unit and in broken repeat for the other half is rather intricate; still more so appears the order of treadles. But the method is useable.

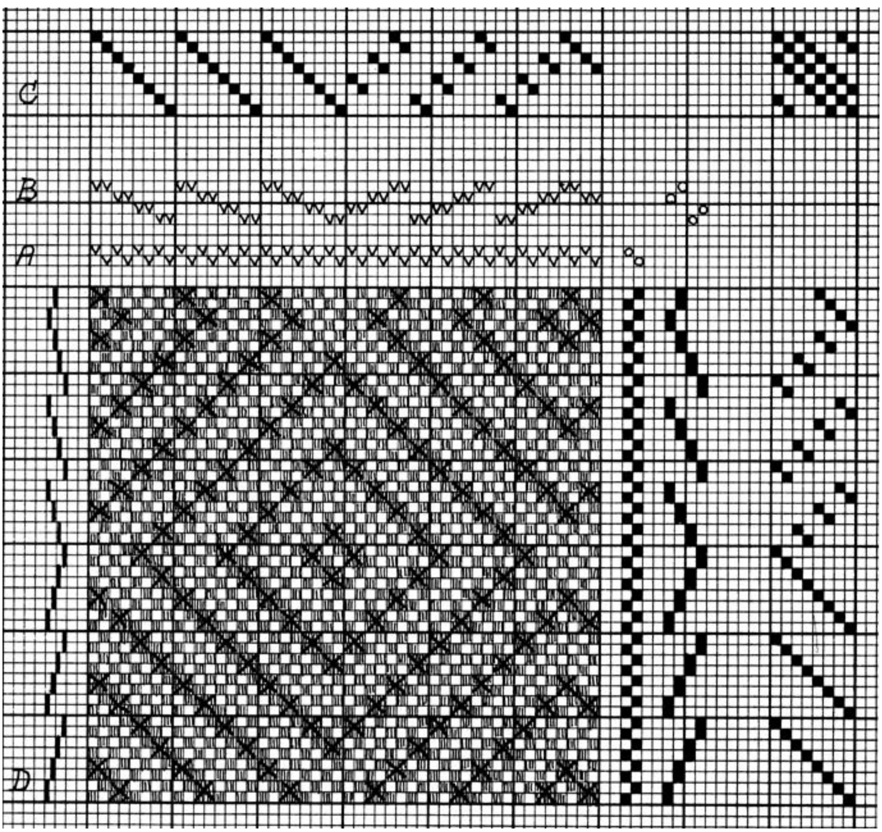
Our woven replica is shown in Figure 227.

True damask with twill 1/3

Onto another banner described by Vial (1970, EO.3652, p. 327) two ribbons, the width ca. 3.5 cm, are hung along the sides. They are woven as true damask with the basic weave twill 1/3, similar to the early damask silks from Syria.

Monochrome silks from the Han were tabby decorated with twill 1/3. Twill binding was therefore known to weavers in the Han, but it was used only for patterning, not in the ground as shown in Chapter 1. As far as we know textiles entirely woven with twill, i.e. woven with four or more shafts and treadles, are never found. Later on, possibly during the centuries be-

Figure 226 Draft for the lozenge-patterned silk. Two tabby shafts for the 2–2 method are shown at A. Another method is suggested at B; four lifting shafts are entered with two ends to each heddle in point repeat and lifted simultaneously with the normal treadles for tabby. At C is shown the method suggested by Vial (1970, p. 337): eight shafts are entered alternately in straight repeat and in broken repeat. The order of treadles is shown at the far right.



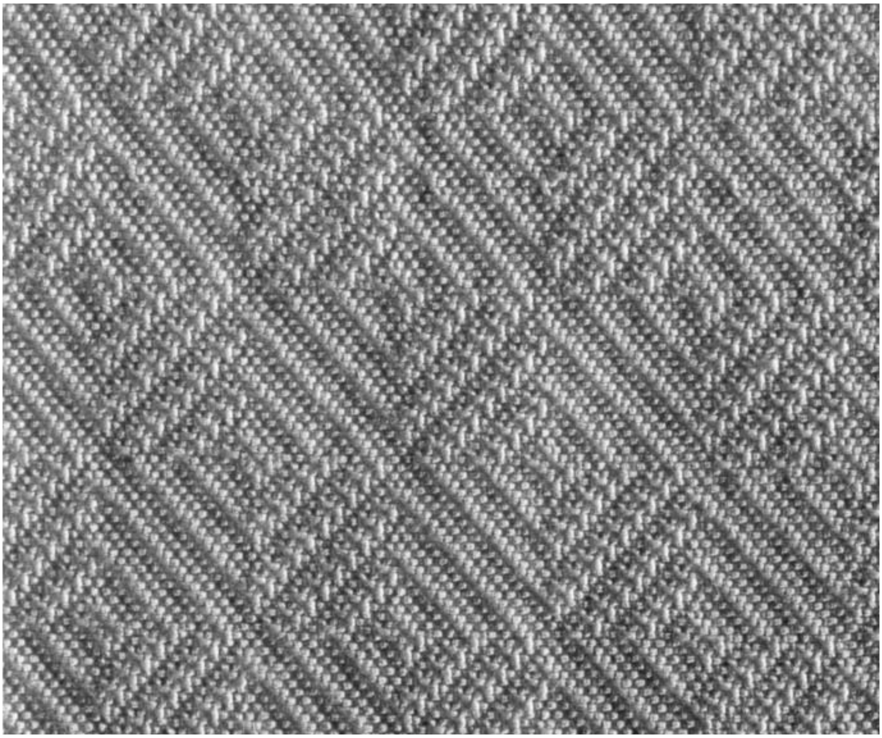


Figure 227 Our woven replica of the lozenge-patterned silk.
Warp: spun silk Nm 10, 16 ends per cm.
Weft: spun silk Nm 10, 14 wefts per cm.

tween Han and Tang, Chinese weavers had learnt the method of weaving twill with shafts and treadles, presumably from Western Asia.

Vial (1970, p. 306) suggests a method for this damask weave which is very much in accordance with the Han weaving methods. Warp is lifted in odd-numbered groups of two for two wefts, then for the next two wefts even-numbered groups of two are lifted. This is exactly the same patterning method which we believe was used in the Han monochrome weaves (the 2–2 system). The difference is that the basic weave is twill 1/3, so that four shafts and four treadles are needed. Lifting heddles are still used throughout and warp ends are lifted for pattern in groups of two.

We used this method for our woven sample as shown in the draft, Figure 228. It was made on a drawloom; two warp ends were entered into each of the mails and then one by one into four shafts with lifting heddles, as shown at D. In the lifting plan A filled squares show the lifting of warp ends in groups of two. The binding shafts at D with the four treadles give a plain *weft*-faced twill 1/3, but when groups of two are lifted for pattern the supplementary warp ends come up to form the *warp*-faced twill 3/1 shown by black crosses in the detailed draft E.

It is interesting to compare this 'Chinese' method with the method suggested for Syrian silk damasks in Chapter 9 on damask.

Our woven sample is shown in Figure 229. Note the warp-faced twill in S-direction and the weft-faced twill in Z-direction. It was woven reverse side up; see the draft in Figure 228.

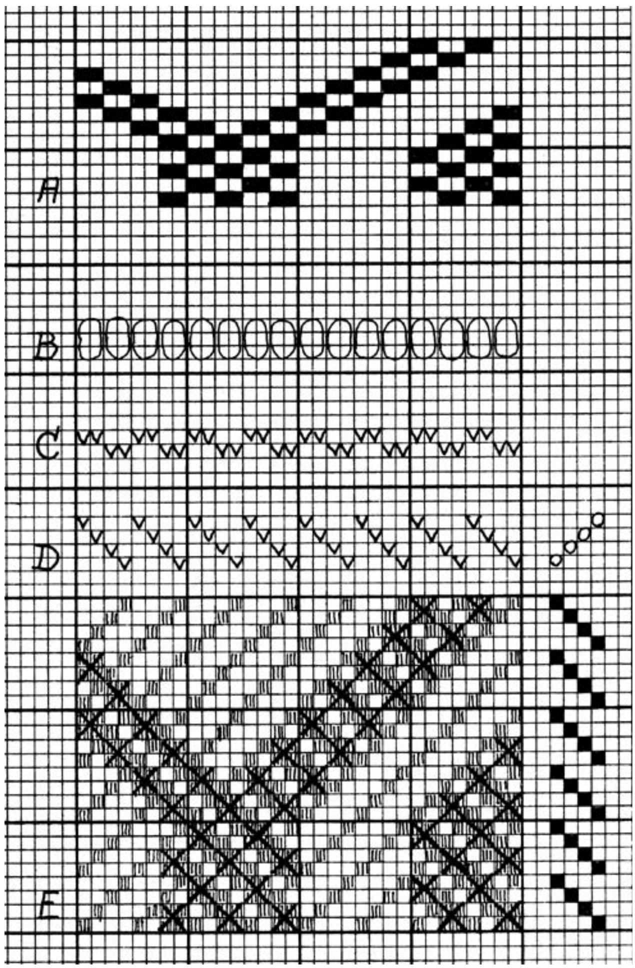


Figure 228 Draft for the damask weave. A fragment of the pattern lift is shown at A. We used a drawloom and entered the warp two to each mail as at B instead of using the dividing rods shown at C. Four lifting shafts are necessary to weave twill 1/3 all over the warp. In the detailed draft E black crosses show the lifted groups which add the supplementary warp ends so that pattern comes out in warp-faced twill on a ground of weft-faced twill. The draft is shown with the reverse side up.

Damask with twill 1/2 and 5/1

This further developed damask weave forms the upper main part of a banner from Dunhuang described by Vial (1970, EO 3662, p. 157). In this example twill 1/2 is used for the ground and twill 5/1 for the pattern. The use of two different twills is possible when one is a multiple of the other; see the discussion in Chapter 9. This silk has 46 warp ends per cm and the weft is very uneven, 25–38 per cm.

Apparently Tang weavers were accustomed to employing several shafts and treadles. Nine shafts are needed for this weave, six for depression and three for lift; see the draft, Figure 230 C. As usual, warp ends are entered two into each mail, as at B. Note that the entire groups of pattern are lifted; this is possible because depression shafts are utilized.

Découpure in warp as well as in weft is two; see the black crosses in the detailed draft at E. When two sets of shafts are used, as shown at C, six depression shafts are necessary for the warp twill 5/1 while only three lifting shafts are needed for the twill 1/2 in the ground.

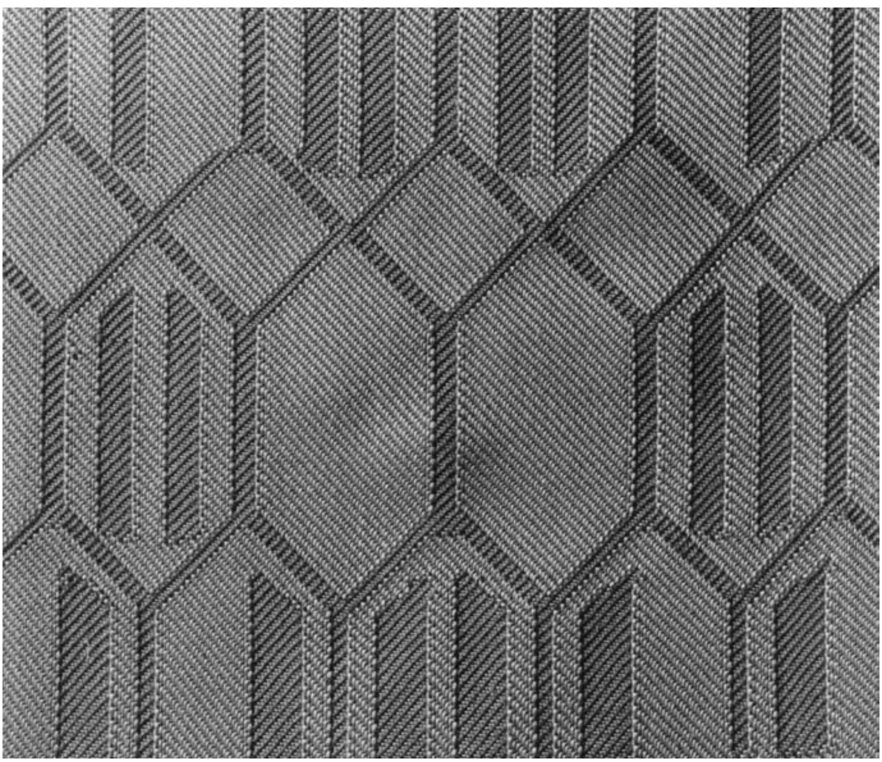
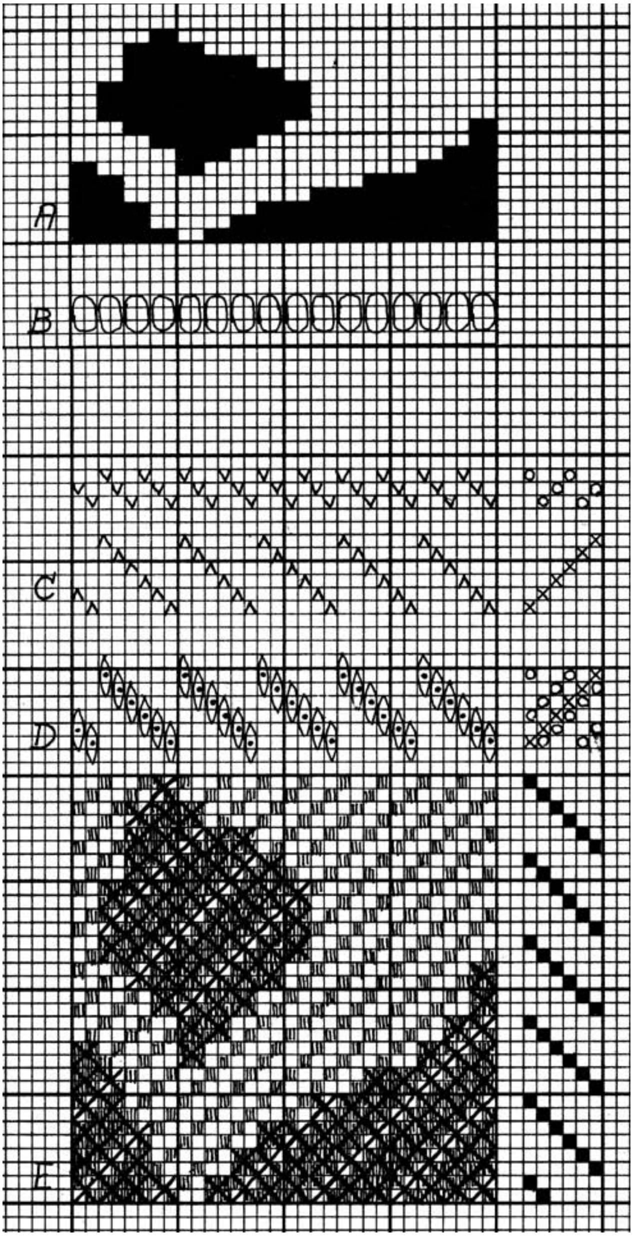


Figure 230 The draft for damask with twill 1/2 and 5/1. Note in this case that every warp end in the pattern is lifted. The warp is entered two to each leash at B. Two groups of shafts are shown at C, three for lifting and six for depression. At D is shown our method with long-eyed heddles.

The draft is shown face-side up.



← **Figure 229** Our woven replica shown face-side up. Note the warp twill in S-direction and the weft twill in Z-direction.

Warp: spun silk Nm 10, 16 ends per cm.

Weft: spun silk Nm 10, 16 wefts per cm.

Figure 231 Our woven replica of the damask silk with weft twill 1/2 for the ground and warp twill 5/1 for pattern.

Warp: spun silk Nm 10, 16 ends per cm.

Weft: spun silk Nm 10, 16 wefts per cm.

We used six shafts supplied with long-eyed heddles for both weaves, as shown at D. The replica is woven face-side up.

The replica is shown in Figure 231. The pattern was woven with a full-sized working drawing fastened below the warp. As a motif for our experiment we used a detail from the banner (Vial 1970, EO.3662, pl. 31).

Tabby patterned with twill 5/1

We used another silk from the same banner (Vial 1970, EO.3662, p. 157) for our next experiment. This silk was cut into three ribbons sewn onto the lower part of the first silk. It has ca. 60 warp ends and 40–44 wefts per cm.

This example can be considered as a development of the *qi*; instead of warp twill 3/1 the pattern uses twill 5/1. As in the 2–2 method described above, twill is obtained by combining tabby with warp ends lifted in groups of two. Warp is entered into two lifting shafts for the tabby weave, see D in Figure 232. We used our drawloom and entered the warp with two ends to each of the mails. With the 2–2 method for *qi* with twill 3/1 odd-numbered groups of two are lifted for two wefts, and for the next two wefts even-numbered groups of two are lifted: i.e. the lifting process follows a kind of tabby system. To obtain the twill 5/1 the groups of two are lifted following a twill 2/1: two groups up – one group down. This could have been done as shown at C with three shafts and treadles used only when pattern was counted in. Instead of this we supplied the harness cords with rows of lashes accordingly and lifted them in the order shown by the treadles 1–2–3.

It is remarkable in this example that warp twill 5/1 is woven in straight repeat for one-half of the symmetrical motif, while the twill is broken in the other half. While the lower half of the symmetrical pattern is counted in according to the twill 2/1 (see the lifting plan at A) and supplied with lashes, the other half is woven with the lashes in reversed order. Note that the pattern row in the middle, no. 9 in this example, is used only once. Because of this the broken twill appears. See the detailed draft E in Figure 232; black crosses show the lifted 2 × 2 squares of warp ends.

Using this method the whole pattern of the original piece requires 31 different pattern lifts (Vial 1970, p. 158). Vial discusses which type of loom could have been used: the pattern heddle rod loom or some type of drawloom. It is of course not possible from this single example to decide which type was used. It is possible to utilize 31 heddle rods for the first half of the motif and then in reversed order for the other half.

For our simplified experiment we fastened a full-sized working drawing below the warp in the drawloom and lifted for the lower half of the symmetrical motif. In each group harness cords were lifted according to the twill 2/1; see the black crosses in the detailed draft E in Figure 232. Lashes were knotted onto the harness cords according to the filled squares shown at A. Here only nine rows are shown; no. 9 is used only once, after which the rows are taken in reversed order. The reversed half of the motif comes out in broken twill 5/1.

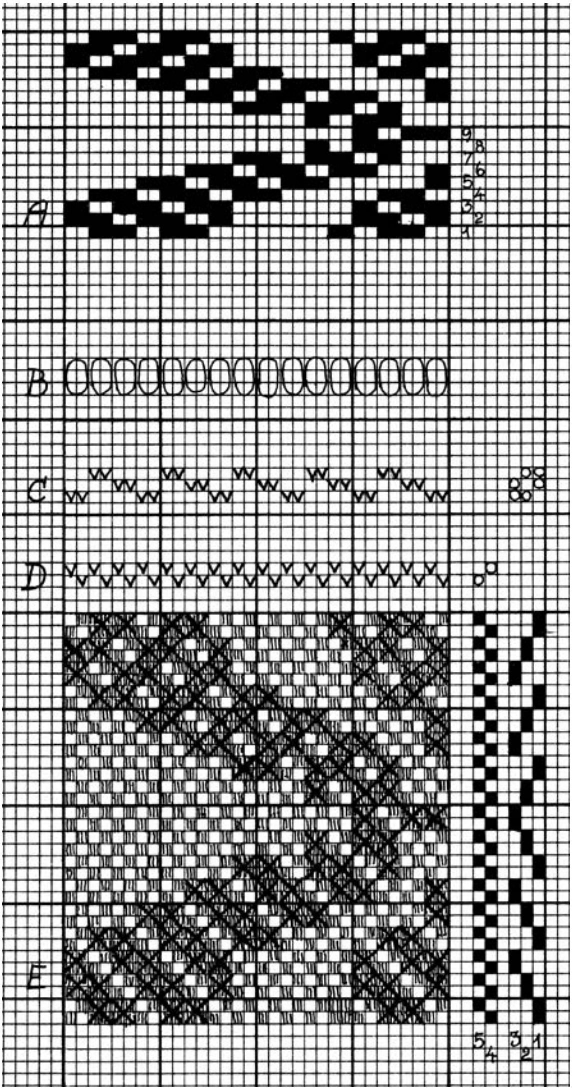


Figure 232 Draft for tabby patterned with warp twill 5/1. In the fragment of the lifted pattern at A it can be seen that the groups of two are lifted following the system of a twill 2/1. When one-half of the transversally symmetrical pattern has been woven the pattern lifts are used in the reversed order and the broken twill appears; see the detailed draft E.

Our woven replica with tabby patterned with twill 5/1 is shown in Figure 233.

Warp-faced compound twill

Warp-faced compound twill is a polychrome weave and may be considered to belong to the same group as the polychrome weaves of the Han. The

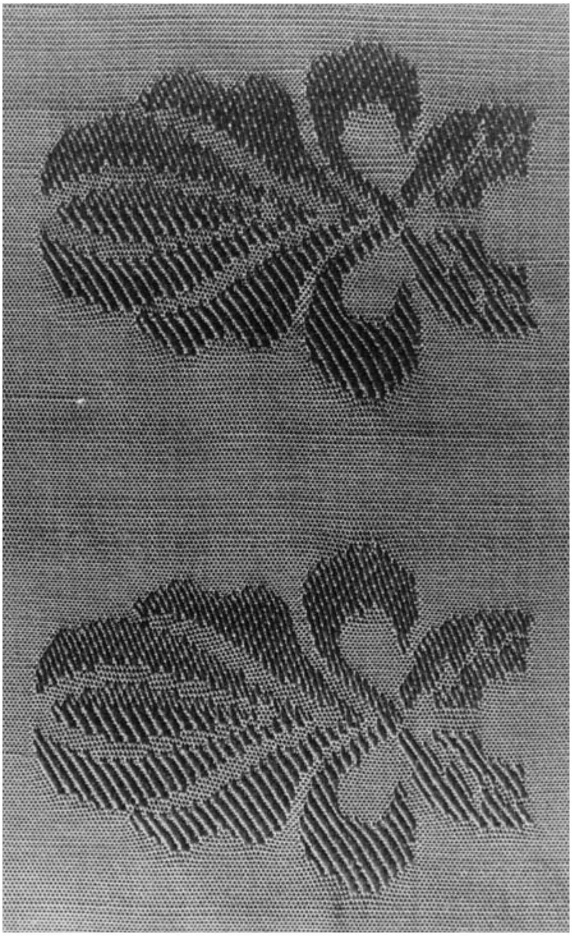


Figure 233 Our woven replica with warp twill 5/1 on a tabby ground. The regular straight twill comes out clearly against the broken twill in each figure.

Warp: spun silk Nm 10, 16 ends per cm.

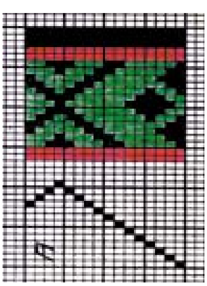
Weft: spun silk Nm 10, 10–11 wefts per cm.

weaving method must have been largely the same except that here the basic weave is a warp-faced twill 2/1 which brings out the soft brilliance of the silk material to greater advantage.

Warp-faced compound twill was developed to the highest sophistication during the Tang. Large numbers of marvellous silks are still in existence. Vial (1970) gives extensive descriptions of several of these silks from the Musée Guimet, Paris; most of these are so intricately executed that they evidently must be products of the highest expertise.

To show an example of this weave we used a detail from a silk in the Shōsōin collection, Nara, Japan, reproduced by Lowry (1963b, p. 24). It is dated to the 8th century AD.

We used the weaving method described in Chapter 3 on polychrome silks from the Han except that here we used warp-faced twill 2/1 for the basic weave. The fragment shown at A in Figure 234 is drawn in detail at F.



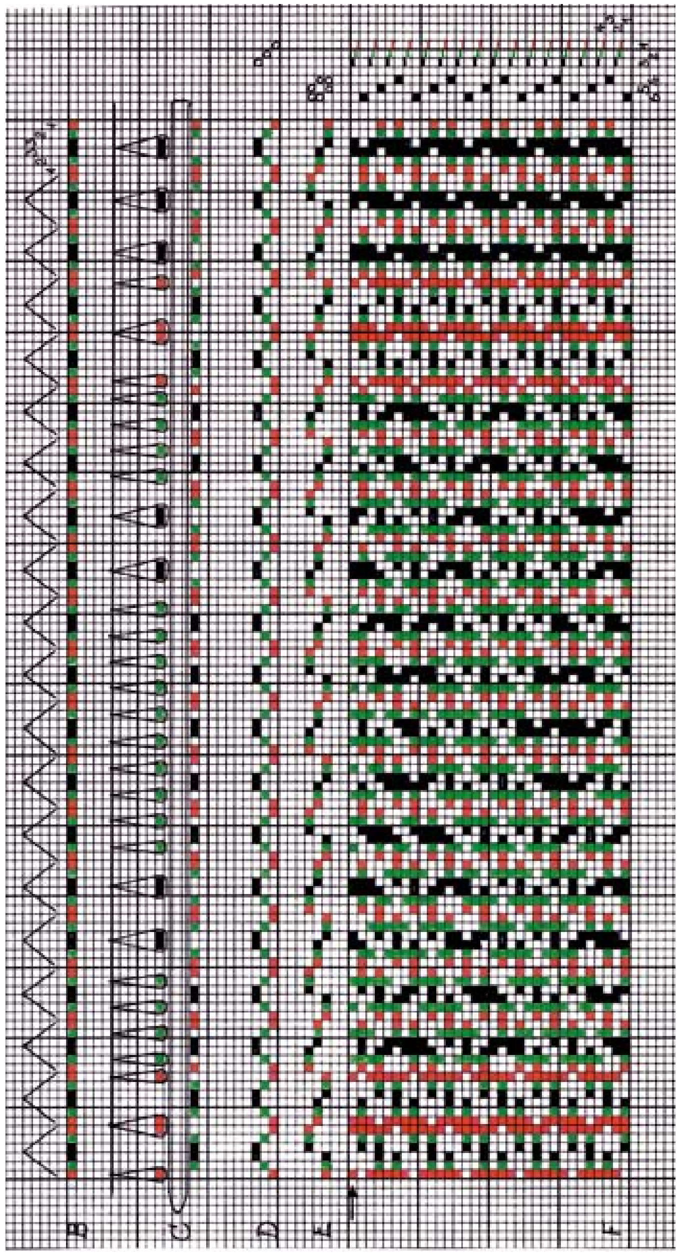


Figure 234 Draft for the warp-faced compound twill. The fragment of the pattern shown at A is drawn in detail in the draft F. At B is shown the order of colours, and the lifting for the weft indicated by an arrow is suggested at C. Our method of sorting out colours individually is shown at D. At E are shown three lifting shafts for twill 2/1 entered with one end of each colour into each heddle. Treadles 1–3, shown at the right, are used only for counting up a pattern; treadles 4–6 are used for twill with odd-numbered wefts.

The colours in the draft denote silk yarns in three different colours and do not have the technical significance which is usual in our drafts:

red means crimson silk
green means dark olive silk
black means buff silk

At B is shown the sequence of colours in the warp. Inverted v's above denote the 'working companies'.

The pattern lift for the uppermost weft, marked by an arrow, is shown at C. Black warp ends are always lifted in pairs. In order not to disturb the 'working companies', red is lifted singly near the outlines of a group, while in between red is lifted in pairs. Green warp ends must always be lifted one by one.

At D is shown our method for lifting colours individually for counting in. Beginning from the right side black warp is lifted by treadle 3 and three pairs of black ends are taken over the pattern rod; then red warp is lifted by treadle 1 and one red end, then two, and finally one are taken over the rod; green warp is lifted by treadle 2, four single ends are taken up, and so on according to the pattern shown at A. Thirteen pattern heddle rods are needed for the transversally symmetric pattern. Treadles 1–2–3 are used only for counting up, and could in principle be dispensed with.

The twill shafts at E are supplied with lifting heddles; one end of each colour is entered into each of the heddles. Treadles 4–6 are used for the twill binding with odd-numbered wefts. For the even-numbered wefts the pattern heddle rods are lifted by an assistant.

Vial (1970) suggests the use of a pattern heddle rod loom for the warp-faced compound twill weaves. It is clear that Burnham's objection to the drawloom for polychrome silks in the Han (1965) is just as important for this type of polychrome weave.

Our woven replica is shown in Figure 235.

Weft-faced compound twill, samitum, weft-faced on both sides

From the Pelliot Collection in the Musée Guimet, Paris, is also shown a piece of silk (ca. 5.5 × 30 cm) decorated with undulating branches and stylized leaves (Vial 1970, pl. 28, EO.1203/H). It is woven with weft-faced compound twill or samitum which in its classic form shows a pronounced difference

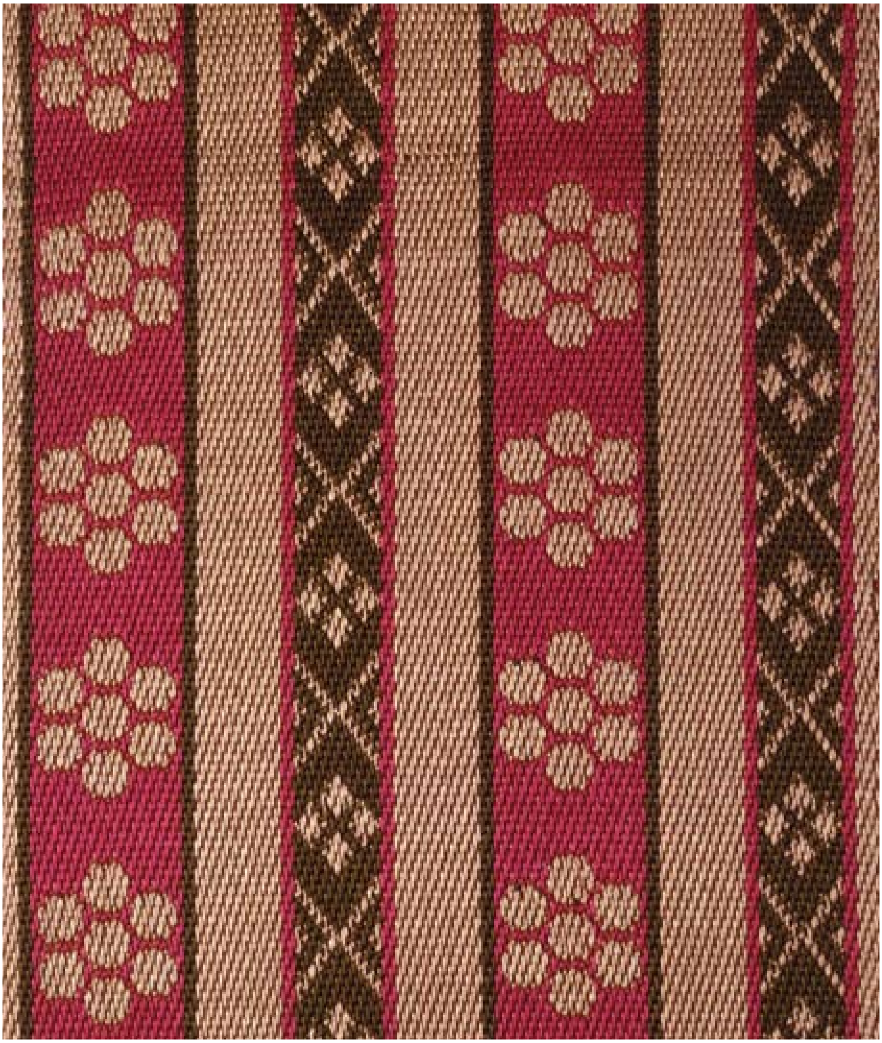
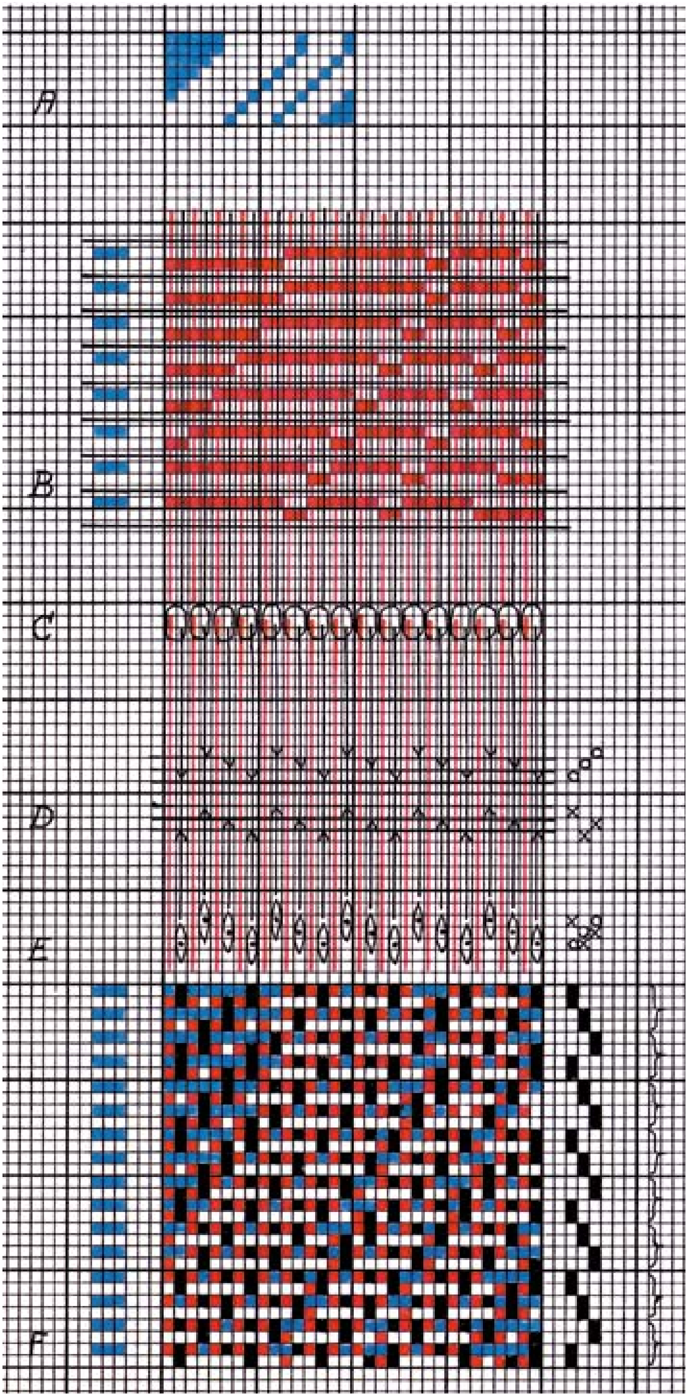


Figure 235 Our woven replica of a warp-faced compound twill.
Warp: organzine Nm 12.5, crimson, buff, and dark olive, 54 ends per cm.
Weft: spun silk Nm 10, buff, 12.5 wefts per cm.

→ **Figure 236** Draft for a weft-faced compound twill, weft-faced on both sides. A fragment of a pattern is shown at A, the corresponding lifting plan at B. The mails at C are entered with one main-warp end and one binding-warp end. Three lifting shafts and three depression shafts are shown at D. Our method with only one group of three shafts supplied with long-eyed heddles is shown at E. In the detailed draft F it can be seen that when a weft goes down to the lower side it is bound by only one binding-warp end for each binding unit, a blue point on the lowered blue weft and a white point on the lowered white weft.


A
B
C
D
E
F

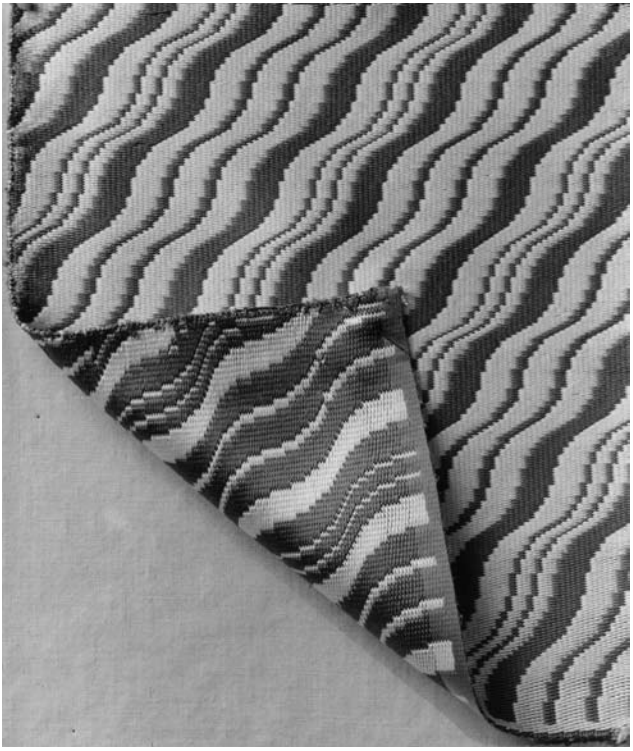


Figure 237 Our woven replica showing the weft-faced twill on both sides.

Warp: spun silk Nm 10, 12 ends per cm.

Weft: organzine Nm 12.5, 64 wefts per cm alternately white and red.

from face to reverse side. In this example both sides show the weft-faced twill 2/1, the only difference being that the colours are reversed.

As far as we know a 'reversible' samitum has never been found from Western Asia; therefore we suggest that this is a specifically Chinese way of dealing with samitum. The weaving method suggested by Vial (1970), with two warp ends lifted by each of the mails, is in accordance with Chinese procedure.

We made a simple waving pattern for this experiment; a fragment is shown at A in Figure 236. Each vertical column means one binding-warp end and one main-warp end; both are entered into a mail governed by one harness cord, as shown at C. Main warp is taken past the binding shafts. Because binding warp is lifted together with main warp for pattern it is necessary also to use depression shafts. Two sets of shafts are suggested at D, three for lifting and three for depression. At E is shown our method with only one group of shafts supplied with long-eyed heddles.

In the detailed draft F it is easy to see that when a blue weft goes down on the lower side (red main warp lifted) only one twill binding point is visible (blue square). The binding-warp end is pulled down by a depression shaft. Thus weft-faced twill 2/1 appears on the lower side as well. The same procedure can be seen where a white weft goes down to the lower side.

For each découpure we used four passées. Only two passées for each découpure are shown (see the braces at the right).

Our replica is shown in Figure 237. One corner is turned over to show the opposite side.

PART V

Weaving Implements

Chapter 11
The development of mechanical patterning
'The' drawloom

With the material now at our disposal it does not appear possible to document the actual historical development of looms and mechanical patterning devices. Evidence of the use of particular devices is too sparse, and too uncertainly provenanced, to allow us to show how, when, and where various developments occurred. In the following we shall present what we call a *logical* development sequence; that is, we suggest how various developments might logically be expected to have occurred. There is no doubt that the actual developments with which we are concerned were far more complex than the simple sequence given below. Technical inventions appeared at different times in widely separated places; weaving centres guarded their methods as trade secrets; different types of looms or methods were used simultaneously for different purposes; earlier systems were adopted anew for specific materials.

We see the logical development of patterning devices as follows:

1. Pattern rods within the warp.
2. Pattern heddle rods.
3. True pattern shafts.
4. The cross harness, as seen in Persian and Indian drawlooms.
5. Individually weighted harness cords, as seen in Chinese drawlooms.
6. The true drawloom with comber board and exactly controlled repeats of pattern unit.

The first three devices have been considered in detail in earlier chapters, and in the following they will be reconsidered briefly. The rest of the chapter will then be devoted to the development of the drawloom.

Archaeological finds of woven material from the earliest times are extant in overwhelming quantities but no single part of an ancient loom has ever been found (apart from weights from warp-weighted looms).

Illustrations of looms with patterning devices are not very trustworthy, and therefore we have mainly to rely on what can be learned from extant woven material. Our experience in weaving replicas of most of the early weaves has given a varied experience of possible looms used and in some cases also thrown new light on certain weaving methods.

The word 'drawloom' has been used (and misused) for a great many different types of loom. It is therefore necessary to provide a definition of what *we* mean when we use the word. A drawloom is a loom in which the pattern is formed by a mechanism which lifts individual warp ends or small groups of warp ends. What we call the 'true' drawloom is the finally developed loom supplied with an exactly calculated comber board and simple cords arranged with a proper method for the drawing of patterns.

The word *draw* in this connection always refers to the lifting of predetermined groups of warp ends.

Some particular types of drawloom are discussed below. Several types still used in the 20th century do not prove that these looms are the original types used in ancient times, but the continuous use of such looms suggests that they may be similar to the types originally used. Of course any conclusion must always be considered in connection with extant textiles and the history and civilization of the country referred to.

1. Pattern rods within the warp

Naturally the first attempts to weave patterns were very simple. A number of smooth rods were counted into the warp on a loom set up for plain tabby, as discussed under 'à la planche' and 'Egyptian inlaid design' in Chapter 6 above.

Apparently pattern rods were used by primitive weavers all over the world. Generally the weaves produced by means of pattern rods were plain tabby decorated with floating wefts.

In Chapter 1 on monochrome silks from the Han we have described how pattern rods could have been used with the 2–2 method for transversally symmetric patterns.

In Scandinavian folk-art from later centuries pattern rods were used in a similar way for decorative bands on hangings and coverlets (Geijer 1979, p. 92).

Pattern rods are also utilized in other ways: pattern is picked up by means of rods in patterned double cloth in Scandinavia, as discussed in

Chapter 8 above. For the first experiments with damask weave pattern rods were also utilized; see Chapter 9 above.

Pattern rods placed within the warp cannot go past each other; they must always be used in strict sequence. It is possible to count in and weave half of a pattern and then to weave the other half symmetrically and at the same time to pull out the rods. Then the pattern must be counted in anew. For patterns repeated continually all over the material this method is very time-consuming and presumably weavers discovered a more efficient method: pattern heddle rods.

2. Pattern heddle rods

The term *pattern heddle rod* indicates that loops of string are taken round groups of warp to be lifted for pattern and knotted to the rod (type A, Figure 266) (D. Burnham 1980, p. 97). This method is described in Chapter 1 on monochrome silks from the Han. With a rough material and few rows of pattern the heddle rods can possibly be left lying on the warp, but for fine silk in a dense warp an arrangement to keep the rods above the warp and in their proper order is certainly useful.

With this method it is possible to use pattern units continually, for one heddle rod can function through other rows of pattern. A motif for the pattern unit is formed in the loom and secured row by row by loops for repeated use. The method allows an elaborate working out of details in the motif, as can be seen in the sensitively drawn polychrome silks from the Han. Presumably only a master weaver with his experience was able to work out the first pattern unit. It is characteristic for silks from the Han that patterns change all over the width but the height of the units is only a few centimetres.

The pattern heddle rod method was presumably used for the early examples of damask weave from Syria.

In Scandinavian home-craft the method was widely used. For rougher materials discarded heddles were placed round groups of warp ends ('half heddles') instead of knotted loops.

Similar pattern heddle rods were used in many ways by weavers all over the world, for example the African weaver photographed by Picton and Mack (1979, fig. 107).

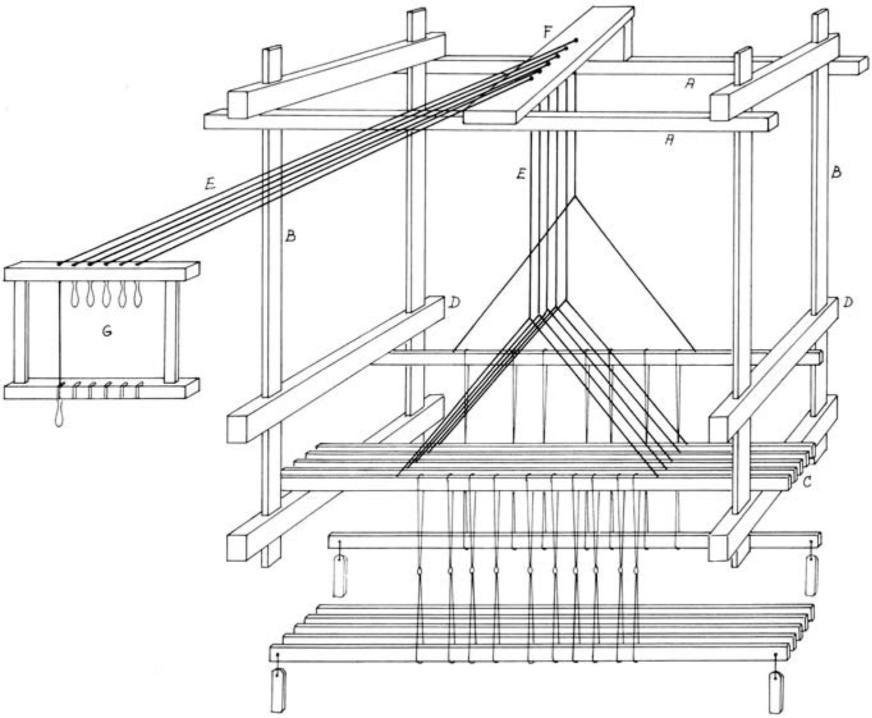


Figure 238 Outline of a typical shaft drawloom. Two strong boards, A, placed on the upper frame of the loom, carry the patterning arrangement. A frame B is placed on each side. Pattern shafts are hung onto the transverse bars at C. The adjustable bars D determine the lifting height. Each pattern shaft is connected to a lifting cord E. The cords are taken over pulleys in the slanting board F and horizontally forward to the frame G placed conveniently before the weaver. Pulleys are also inserted in the upper part of the frame G. Each of the cords is supplied with a wooden handle. When a shaft is lifted the cord is pressed into a slit in the lower bar of the frame to keep the shaft lifted while one row of a pattern is woven. Then the handle is loosened and the weights below the pattern shaft bring it back to its lower position.

3. True pattern shafts

For the next step in the technical outline we suggest true pattern shafts. A pattern shaft consists of two rods supplied with heddles. Such shafts must therefore be entered with loose warp ends directly from the warp beam. Warp is then entered into the binding shafts before it can be tied and tightened on the loom. This means that patterns have to be more or less planned in detail beforehand, as in the example from Dura Europos in Chapter 4, Figure 74.

Pattern shafts are generally lifted by means of cords over pulleys connected to handles controlled either by the weaver himself or by an assistant. The shafts are supplied with weights to bring them down after use. When this arrangement for pattern shafts was fully developed it was in reality the so-called shaft draw system (Scandinavian: *dragrustning*) described by Ekenmark (1828); see Chapter 9. This loom can be considered a sort of drawloom and represents the first example of true mechanical patterning. An outline of a typical shaft drawloom is shown in Figure 238.

When only a few pattern shafts are needed lifting is easily done either by the weaver, using treadles, or by an assistant. Crowfoot (1939, p. 46) discusses this in connection with the Egyptian woollen weft-faced compound tabbies (taqueté). Crowfoot suggests that a horizontal loom with treadles was used for this weave and says 'There is little to be gained by multiplying heddles [i.e. shafts] unless they can be controlled by treadles.' This is not quite correct: a group of pattern shafts behind the binding shafts can easily be lifted by an assistant without treadles.

It is still an open question how early a sort of shaft drawloom can have been used. A system of this type must have been the implement for weaving the earliest patterned textiles from Western Asia and Sassanian Persia. As is always the case the demand for more and more elaborate patterns arises, and the number of pattern shafts increases until the loom is nearly unmanageable.

Looms with a large number of pattern shafts have been used until our time; see for instance the Swedish damask weaver with her hundred shafts in Figure 220. However, for a professional silk-weaving workshop producing richly patterned textiles with large pattern units, this type of loom must be a clumsy instrument. It is our opinion that the cross harness was its natural successor.

The cross harness

In the Persian drawloom, instead of a number of heavy pattern shafts which occupy a great deal of space on the warp, strong cords are suspended across the warp. Such cords occupy no more than a fraction of the space required by shafts and their weight is insignificant.

The drawloom supplied with cross harness is thoroughly described and illustrated in detail by Wulff (1966). The photograph shows these draw-

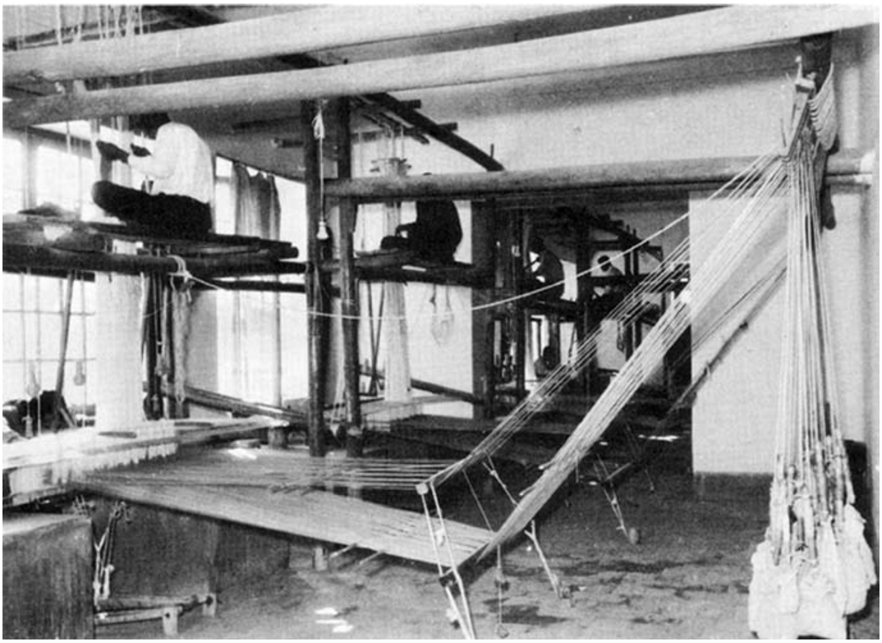


Figure 239 This photograph was taken in 1963 in a silk-weaving manufactory in Teheran (Wulff 1966). Note that the weaver's seat is on a higher level than the ground where treadles are placed in accordance with the pit used by common weavers. The position of the binding warp and the main warp is clearly to be seen.

looms in silk-weaving factories in Isfahan and Teheran in the year 1963, see Figure 239.

An outline of the cross harness system is shown in Figure 240. A large number of strong elastic cords (Wulff mentions gut strings) is stretched horizontally above the warp. For clarity only a few cords are shown. A vertical drawstring, B, is knotted to the middle of each cord and fastened to the ceiling above the loom. Each of the drawstrings is supplied with a weight, C, below the warp, in order to straighten up the drawstrings when the pattern shed is released.

Behind the group of drawstrings near the ceiling a seat for the drawboy is shown at D. When a cord in the cross harness is lifted the shed is raised much higher at the centre than at the sides. Therefore the weaver uses two angle hooks, E, pivoting at a point uppermost in the loom; these are pushed under the lifted cross-harness cords to give an even horizontal shed.

In Figure 240 each of the cross cords is supplied with eight heddle loops. This means that the pattern unit is repeated eight times in the width.

A side-view of the same loom is shown in Figure 241. The cross harness is fastened at A and the vertical drawstrings B are fastened to the ceiling. The lashes for the pattern unit (Persian *naqšeh*) are shown at F. The drawboy, sitting on the seat D, takes out one of the lashes, shakes the drawstrings free, and puts in a V-shaped branch under the group to be lifted. He turns the branch hook round and rests one end on his shoulder. The weaver pushes in his angle hooks E and weaves the pattern row. When this is finished he signals to the drawboy to lift for the next row.

In Syria, Persia, and neighbouring countries a pit was generally dug into the ground below the loom; see the loom in Figure 242. Presumably this was originally done to save the expensive wood which is rather scarce in these regions. The weaver sits on the ground and the treadles are placed below in the pit. In some cases the roof and walls support the upper part of the loom with pulleys for the shafts, and the length of warp may be stretched over the weaver's head and fastened to the wall behind.

The drawloom described here is one in a row of four or five of the same type. The weaver's seat G is part of a long concrete 'floor' along one side of the workshop, see Figure 239. The treadles for binding shafts are placed below just as in the pit generally used by common weavers.

Note that binding warp stretched below the rod H goes horizontally into the shafts connected to treadles. The main warp, lifted by the cross harness, is stretched slanting to the ground by the rod I. In this way the heddle loops are always kept straight and any tangling of loose loops is avoided. Compare the method described in Chapter 3.

Both warps go over a strong rod K placed near the ceiling. A row of small teeth in the rod keeps the sections of warp clear of each other. Each is weighted down by bags filled with sand. When a good length has been woven and the material is little by little rolled up onto the cloth beam, the balls of warp are near the rod K. The balls are then released, lengths of warp are unrolled, and the weights are again hung onto the balls a little higher than the ground, L.

The different tasks attached to a weaving factory are always done by persons of specialized profession. The warp winder makes the warp in the required length and number of ends. He winds up the sections of warp into large balls. These are then delivered to the heddle maker. He knots the necessary number of heddle shafts, and it is also his job to enter the warp ends into the heddles and to sley the warp into the reed. The whole arrangement is then delivered to the weaver ready to be mounted on the loom.

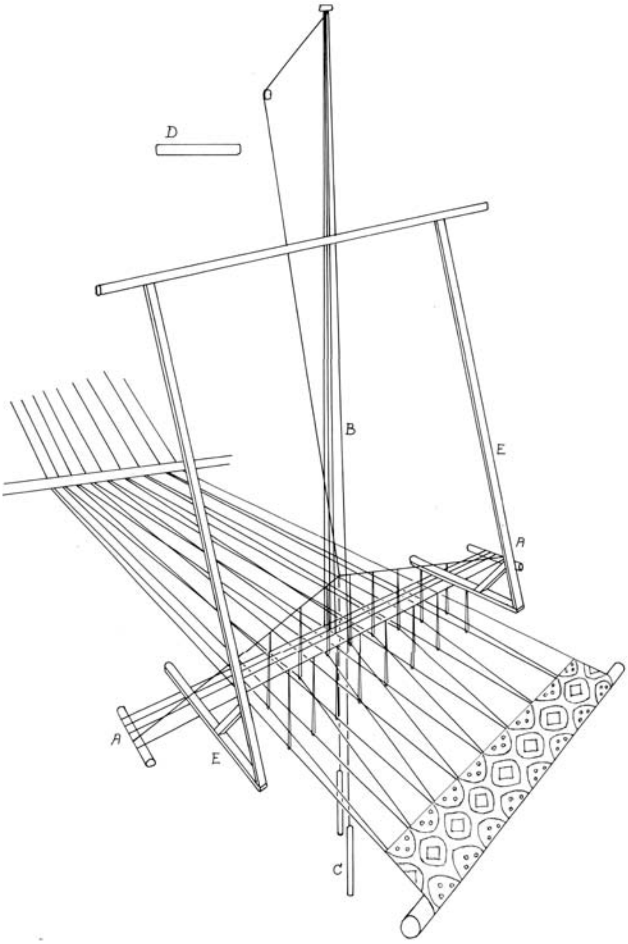


Figure 240 Outline of a cross harness.

At A–A a few of the cross cords are shown. The vertical draw cords B are fastened to the ceiling and supplied with weights C. The drawboy's seat is shown at D. The angle hooks E are pushed under the lifted cords to give an even horizontal shed. Each of the cords is supplied with eight heddle loops; this gives eight repeats of the pattern unit in the width.

The photograph in Figure 243 of an Indian drawloom was taken in 1980 in a workshop belonging to a family of silk weavers in Banaras.

Note that the principle used here is in general the same as that used by Persian weavers outlined above in Figures 240 and 241.

In the Indian loom the drawboy's seat is placed behind the vertical drawstrings just above the warp. The drawboy is at the moment more interested in the photographer; otherwise it is his job to pull out lashes from the bundles near his head and to lift the rows of pattern ready for the weaver. The angle hooks which the weaver pushes under the lifted cross-harness cords are clearly to be seen.

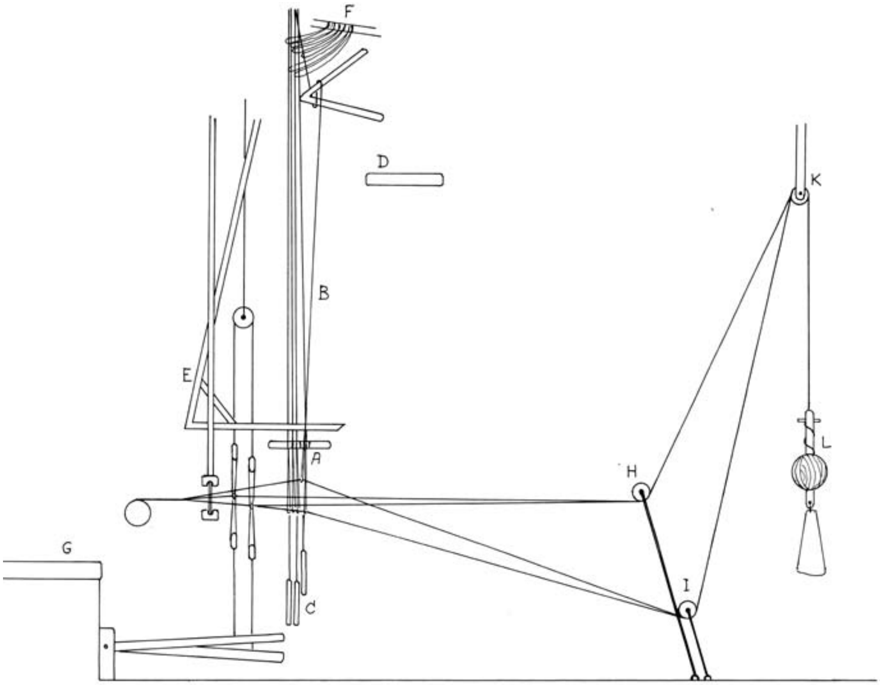


Figure 241 A side-view of the Persian loom with cross harness; this is fastened at A. The drawboy has lifted one of the vertical drawstrings B by means of the branch hook. The lashes for a pattern unit are shown at F. G is the weaver's seat. The horizontal binding warp goes under the rod H, and the main warp is stretched slanting to the ground under rod I. Both warps go up over the rod K. Each section of the warp is rolled up into balls, L, weighted down by sand-bags.

Instead of pulleys to lift the binding shafts this loom is supplied with levers placed near the ceiling. Two cords can be seen leading down to treadles in the pit below the loom.

Unlike the Persian and Syrian weavers described above, the Indian weaver uses a real warp beam, not round but of a four-sided form, onto which the warp is rolled, see Mookerjee (1966, figs. 40–42). As a sort of shed rods a couple of cotton threads are inserted at certain intervals while the warp is prepared.

Photographs in Mookerjee (1966) from modern Banaras weaving shops show that the old cross-harness system is still used, but in some cases supplied with apparently small and outmoded Jacquard machines. These are not used in the general way, lifting single cords with weighted leashes: instead each hook in the machine is connected to one cord in a cross

Figure 242 Horizontal loom with the treadles in a pit. The length of warp is fastened on the wall behind the weaver. Azaz, North Syria, 1961.
Photo: Margrethe Hald.

harness by two strings. Thus this is a halfway-house between ancient and modern methods.

The very important part of the drawloom, the patterning lashes (Persian *naqšeh*, Hindi *naksha*) is generally scantily described. But an article by Pupul Jayakar (1967) gives extensive descriptions from silk weavers in or near Banaras.

The making of these Nakshas is a very intricate affair; they were normally executed by members of a family highly talented for drawing silk designs. Evidently a great deal of experience is demanded of the artist; he must know beforehand which effect will appear from every binding point with his silk material. For a detailed description see Jayakar (1967).

Briefly, a number of strings corresponding to the number of warp ends in a pattern unit are strung on a frame. The design is drawn in actual size and placed under the frame. In earlier times the design was drawn on mica (*abrak*) with a steel pen, but today paper is used. A number of loose strings, corresponding to the number of wefts in the pattern unit, are plaited across the suspended strings following the drawing. Afterwards these plaited strings are knotted into loops and placed onto the drawcords in the loom. There is considerable variation in the methods for knotting up the Naksha, but it is always a specialist's job to make the first example. If the same pattern is wanted for another loom it is rather easy, by means of a new group of drawcords, to copy the first Naksha.

Jayakar (1967) discusses the question of the origin of the art of Naksha making and says:

> It is likely that Naksha Bandhas or designers familiar with the art of producing integrated patterns in various colours with the use of mechanical contrivances were brought to this country in the time of Muhammad Tughlak. Tradition in Banaras, the main centre where the Naksha Bandha tradition prevails, indicates that the Muslim invaders from Central Asia brought in their wake Iranian Naksha Bandhas who were great masters of the art of tying designs on to the loom. The Memoirs of a Damascus traveller – Shahab-ud-din Abul Abbas-Ahmed who came from Egypt to this country in the reign of Muhammad Tughlak (AD 1325–1350) mention – 'The Sultan keeps in his service 500 manufacturers of golden tissues, who weave the gold brocades worn by the wives of the Sultan, and given away as presents to the Amirs and their wives'.

In India this drawloom cannot be historically traced back farther than to the beginning of the 14th century.

Presumably drawlooms of a similar construction were used in Sassanian Iran already from the 5th – 6th centuries. The Sassanian silk from Uppsala (see Chapter 5) needed ca. 100 different pattern cords in each half of the symmetrical design. The Pegasus silk in Lyon, dated to the 6th century (see Chapter 5) needed ca. 200 cross-cords for the extant pattern unit.

Drawlooms in China
Individually weighted harness cords

Among finds made along the Silk road is a considerable number of patterned silks, dated to early Tang (AD 618–906) or possibly earlier. These silks are woven with a weft-faced technique, taqueté or samitum (see Chapters 4 and 5). The motifs are obviously influenced by Persian ornamentation, but often Chinese characters are woven in. This in connection with a slightly foreign style of drawing shows that they were woven by Chinese weavers, though not necessarily in China proper. Thus a sort of drawloom must have been known to Chinese weavers in the 6th or 7th century.

Figure 244 shows a drawloom from a Song-period (960–1279) painted scroll. Another Song painting of a drawloom, preserved in the Nanjing Museum, is presented by Chen Weiji (1984, pl. 61). Both Song paintings show a drawloom with what appears to be two shafts and a draw harness. In overall structure these looms are very similar to later drawlooms for which we have better descriptions.

An album of paintings titled *Geng zhi tu* 耕織圖, 'Scenes of ploughing and weaving', prepared by Lou Shou 樓璹 in the 12th century but known only from later copies, contains a picture of a drawloom. Franke (1913) reproduces two versions of this album, dated 1676 and 1739. The earlier version is unfortunately useless; it appears to be extremely corrupt, degraded in the process of copying and recopying. The later version is much better, and a good deal of technical detail can be discerned in it; however it is doubtful that it reflects the original of the 12th century. The picture of a drawloom has so little in common with the 1676 version that we suspect it was drawn anew rather than copied from an earlier version. It would thus show a drawloom of its own time rather than one of the 12th century.

Possibly the earliest description of a drawloom anywhere in the world is that of Song Yingxing 宋應星 in his famous technological encyclopedia *Tian gong kai wu* 天工開物, 'The products of nature and man', published in 1637. This has been translated by E-tu Zen Sun and Shiou-chuan Sun (1966, pp. 55–58). The description is rather brief, but the loom appears to be essentially identical to later ones for which we have better descriptions.

← **Figure 243** A drawloom belonging to a family of silk weavers in Banaras. The cross harness is apparently fastened outside the wall on the right. The angle hooks are pushed under a few cross-cords. The drawboy sits on a bench behind the vertical drawstrings, and several nakshas can be seen on both sides of his head. The photograph was taken by Stig Erikson in 1980.

The French Physiocrats of the 18th century took a great interest in China, and collected a great deal of information about Chinese arts and sciences. A large amount was published, and many times more remains in manuscript form, preserved in libraries and archives in France, especially the Bibliothèque Nationale, Paris. This material is listed and described by Huard and Wong (1966, esp. pp. 200–201). Without doubt a search through all this material would provide important information on drawlooms.

A good deal of the material described by Huard and Wong consists of albums by Chinese artists in Guangzhou (Canton) who mass-produced pictures of Chinese life for sale to foreigners. These were the 'picture postcards' of the time. Two of these albums are reproduced by Bussagli (1980), and they include a watercolour painting of a drawloom (part 2, pl. 20). Another 18th-century illustration of a drawloom is reproduced by Dermigny (1964, fig. 32).

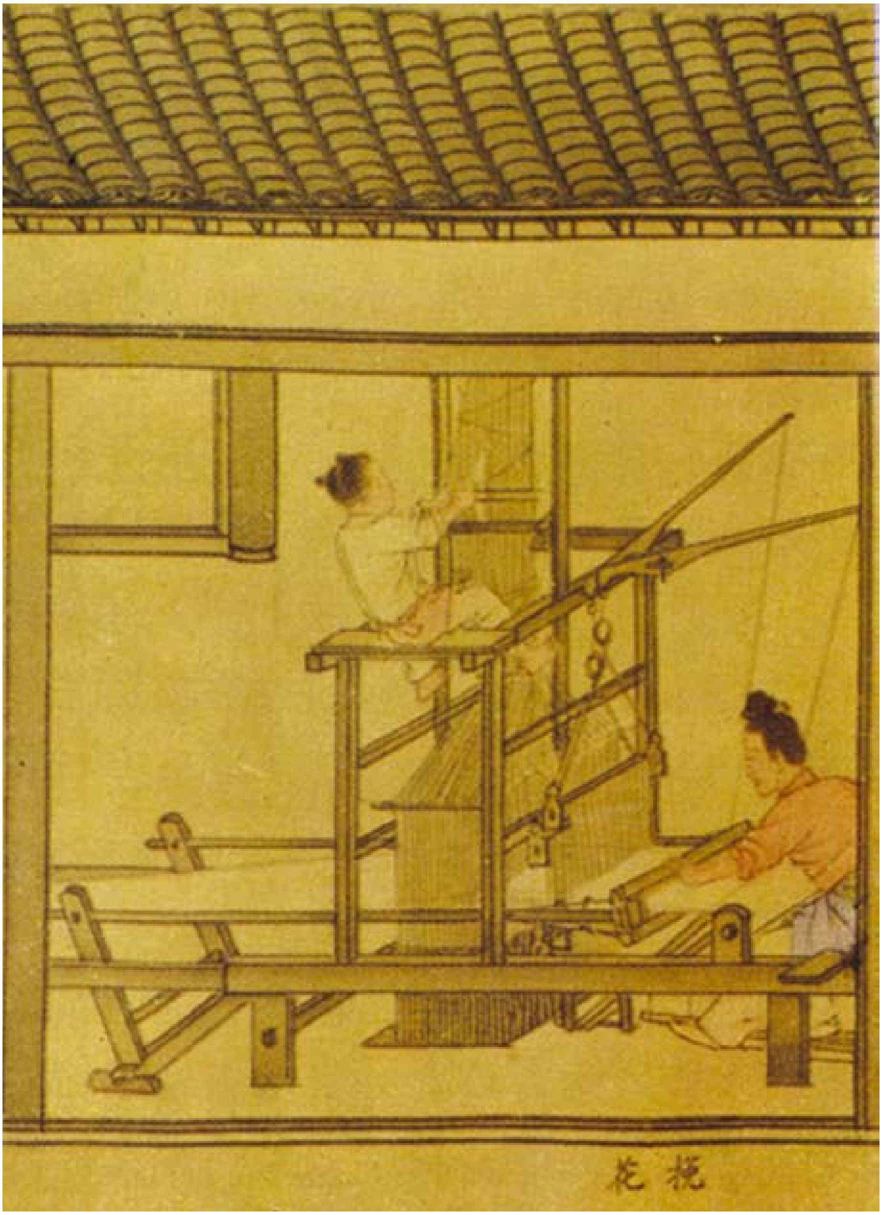
Our most important source is a detailed description of a drawloom in Sichuan by Alexander Hosie (1922, pp. 123–37), originally published in 1904. In the preface to this book he states that it does not 'profess to be interesting reading', and this is an understatement. The description of. the drawloom is detailed to the point of obsession; nearly every part of the loom and every aspect of its operation is described verbally, without a single diagram or other illustration. Read with great care and attention it provides nearly all the technical information one could want on this particular drawloom.

Some of the best illustrations of Chinese drawlooms are contained in a book on silk published in English by the Chinese Maritime Customs (*Silk* 1881). Most of this book is taken up with commercial matters (prices, production statistics, etc.), but it also contains a series of illustrations of production techniques. These appear to be drawings by a Chinese artist, printed by wood-block and hand-coloured. Among these is the picture of a loom for weaving *gongchou*, 'palace silks', reproduced in Figure 245; it has been chosen here because it corresponds very closely to Hosie's description.

A modern working reconstruction of a traditional Chinese drawloom is shown in Figure 246; the photograph gives a more vivid impression

→ **Figure 244** Detail from a Song-period scroll showing a drawloom. The full scroll measures 513 × 27.5 cm (Lin Guiying & Liu Fengtong 1984).

of a similar loom in working order in our day. The original on which the reconstruction is based is on display at the Museum of Chinese History in Beijing, see Figure 247; it was built in Chengdu, Sichuan, in the early 19th century.



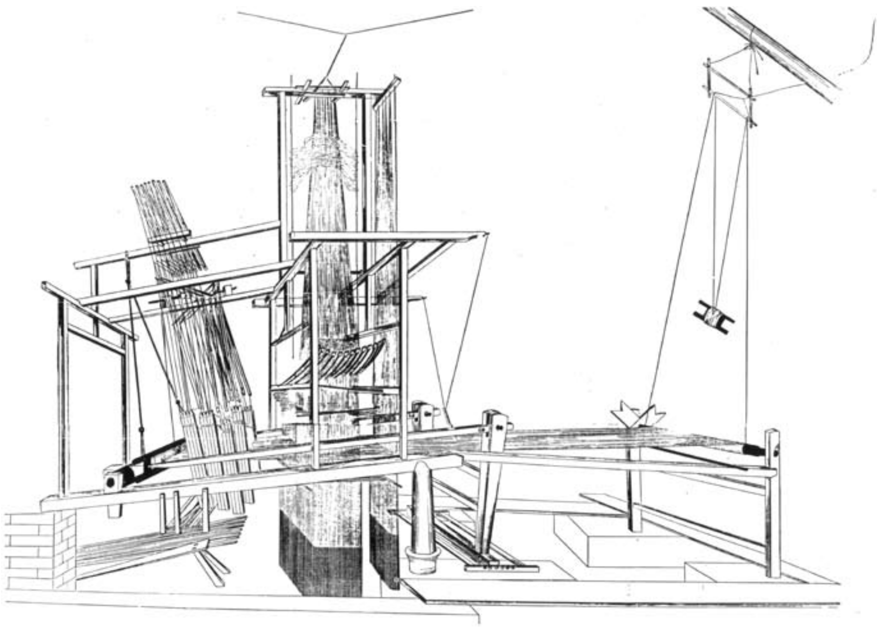


Figure 245 Loom for the manufacture of *gongchou*, 'palace silks', in Zhenjiang, Jiangsu (*Silk* 1881, fig. 26).

With these illustrations and Hosie's terribly exhaustive description at hand it is possible to show the most important parts of the Chinese drawloom as it perhaps was used for centuries.

The horizontal Chinese loom used for professional production of fine silks, whether or not a patterning device is included, seems always to be built on similar lines. The beater is hung on ropes from the upper frame of the loom; one rod on each side connects the reed to a heavy pivoting frame near the warp beam. This helps to strengthen the beating-in and also to keep the reed in proper position.

Each of the depression shafts, nearest to the weaver, is connected to a sort of bow near the upper frame of the loom. A bamboo rod forms the bowstring; when a shaft is pressed down the bow is strongly bent, and when released it straightens out and lifts the shaft to its former height. Each of the lifting shafts, placed behind, is connected in the middle to a top lam which reaches out at the right side of the loom frame. Below the shafts is a corresponding number of lams also reaching out at the side of the loom. One upper and one lower lam are connected, either by a cord or by a thin bamboo rod.

Figure 246 A modern working reconstruction of a Chinese drawloom (exhibition catalogue from Ontario Science Centre, 1982). Note that the six depression shafts, nearest to the weaver, are supplied with bows to bring up the shafts to their former position when they are released. Inthis case the shafts are fastened to the horizontal upper rods (bow strings) and the lower bows help to straighten out the upper rods.

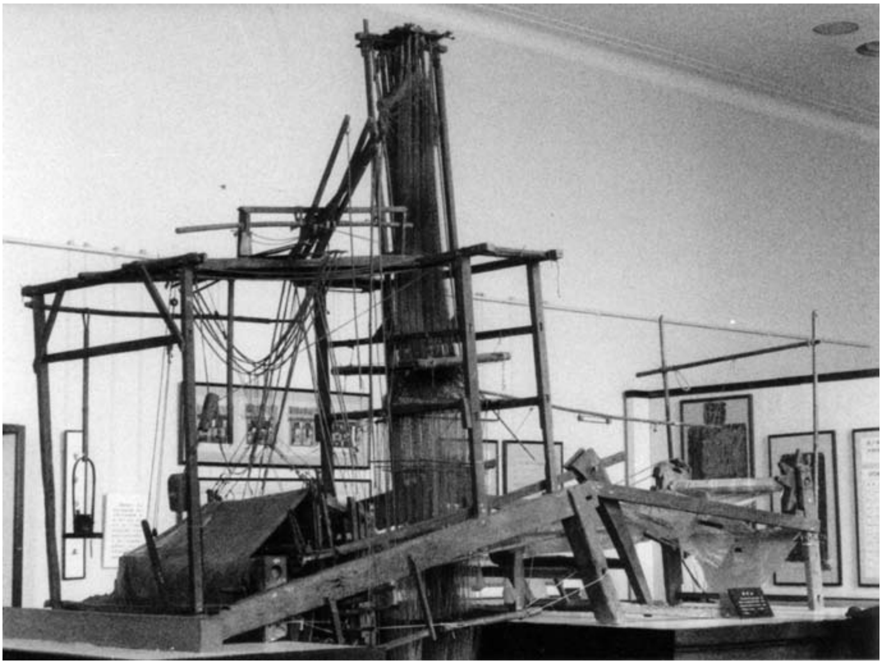


Figure 247 The original loom in the Museum of Chinese History in Beijing; photograph by Donald B. Wagner, 1984. In this case the depression shafts are hung directly to the bows. Was this a misapprehension on the part of museum workers setting up the loom? In other drawings of drawlooms depression shafts are generally fastened to the upper horizontal rods. It is problematic whether these thin bows were able to raise the shafts to their proper height.

The treadles in the pit below are, depending on the binding used, connected respectively to depression shafts or to the lower lams. When the treadle is released the lifting shafts go down by their own weight and the depression shafts are lifted by their bows. Such a loom is shown in the *Geng zhi tu*; see Franke 1913, pl. 92.

For the patterning device a framework is built up just behind the shafts. Onto the uppermost bar groups of drawstrings are hung. They are kept in proper order by means of cross cords and here the lashes for pattern are placed. The drawboy's seat is placed here at the left of the vertical drawstrings which are of a considerable height to give space for the lashes to be drawn and to be pushed down step by step after use.

Lower down the drawstrings are separated and led past several grids of bamboo; see the detail in Figure 248. The lower end of each draw cord is supplied with some sort of heddle weighted down individually by strips of bamboo; these are hung only a few centimetres above the bottom of the weaving pit. This is as far as we have seen the earliest example of individually weighted draw cords.

In the early illustration from *Geng zhi tu* (Franke 1913, pl. 99) no pattern units can be seen. The entire row of draw cords is placed across the warp and the drawing of lashes is done behind the harness cords.

Figure 248, the detail from the loom in the Museum of Chinese History, Beijing, shows the method of repeated pattern units. A number of extra cords are knotted onto the first vertical ones. As far as can be seen, eight pattern units are employed; but it is not clear whether each of the vertical cords is supplied with eight extra cords. Certainly this is in agreement with Burnham's observation (1965) that there cannot be any accurate and automatic repeat so long as no comber board is used. On the other hand the width of the silks was probably not very large and the lesser exactness was not too important.

Three persons are always employed with this drawloom: first and foremost the weaver, then the drawboy, whose job it is to pull out the lashes and to lift for the row of pattern, and finally a person whose job it is to take care of the warp ends and to control that sheds are always clear for the weaver.

Hosie (1922) tried to get some information from the weavers on the making of the lashes for patterns. The answer was every time that it was cheaper to employ the expert than to buy the quantity of silk cord necessary for a pattern. Hosie mentions one design in which the vertical silk cords number 360 and the lashes 515; this for only the upper half of the figure. Presumably the method for knotting lashes was similar to the method described for the Indian loom, and also here only experts were able to make them.

The French explorer Isidore Hedde travelled in China in 1843–1846 and brought home a large collection of different products of Chinese origin. An exhibition was arranged in St-Etienne in 1848. Among the numerous items in the exhibition catalogue is:

> No. 614 *Tiao-hwa-shi*, French: *mise en carte chinoise.* Four simple rods form a frame similar to that used for embroidery. A piece of gauze or canvas is stretched on this frame: the number of apertures corresponds to the thread count of the material to be made and with the number of squares on the ruled paper. Upon the gauze is sketched with India ink [*encre de Chine*] the motif which is to be reproduced. Care is always taken

> to limit the number of squares in accordance with the number of harness cords in the loom on which the motif is to be executed.
>
> Under the frame silk cords are stretched in the same number as the squares. These cords represent the draw cords or the warp ends for one pattern unit. At the lower end of these cords the Chinese attach tubes of lead as weights in order to facilitate insertion of the lashes and the location of a point anew.
>
> Below the frame, underneath the sketched motif, a cord is stretched from right to left meant to enclose the strong cord [*guide*]. It is onto this cord that each weft or each pattern row is fastened with a piece of string [*gavacine*] when the pattern unit is made. This weft or pattern row is pulled into the gauze by means of a needle. One takes care to use the same number of cords as the design comprises squares in the gauze.
>
> Different thread counts are obtained, when forming the pattern unit, by using a gauze weave of greater or lesser tightness in warp and in weft. When the pattern unit is counted in, the artisan takes the loops which represent the lashes and pulls them onto the strong-cord [*guide*]; he controls which are to go up and which to stay down.
>
> This method, simple and ingenious, is reliable and demands no correction; but it is extremely time-consuming.
>
> This model was built according to illustration no. 93 in the large album by Sun-kwa, by Monsieur Marin, professor of theory in Lyon.
>
> (Hedde 1848, p. 209).

The 'album by Sun-kwa' referred to here is listed as no. 1087 in the catalogue (pp. 360–365). It is an album of 144 black-and-white sketches showing in great detail all stages of the production of silk textiles; the catalogue entry gives a brief description of each sketch. The present whereabouts of this marvellous album is unknown; it may possibly be one of the 14 albums in the Bibliothèque Nationale, Paris, listed by Huard and Wong (1966, pp. 200–201).

Jean Marin also constructed most of the the miniature model looms in the Conservatoire National des Arts et Métiers for the Paris World Exhibition in 1855 (*Conservatoire National* 1942, pp. 99–112).

The European drawloom

The principle of the drawloom used in European weaving centres is shown in Figure 249. This is the foundation upon which later developments were

Figure 248 A detail of the drawloom in the Museum of Chinese History, Beijing, which shows how repeats of pattern units are obtained.

Photograph by Donald B. Wagner, 1984.

made up to the very sophisticated drawloom of the 18th century generally used by French and other silk manufactories of high quality.

Upon a solid frame placed uppermost on the side-frames of the loom is built up the pulley box A. A number of pulleys, according to the number of draw cords, are placed in a slanting frame. For better clarity only four draw cords are shown here. The horizontal cords, B, are called *tail cords* and are fastened to the wall at some larger distance than shown here. Cords below the pulley box are called *pulley cords*, here numbered 1–2–3–4. Each of the pulley cords is in this case supplied with four *necking cords*, C, a little way below the bottom of the pulley box, the *neck*. This means that the *monture* has four pattern units repeated over the width of the weave. To keep the necking cords in their proper order a *comber board*, D, is placed

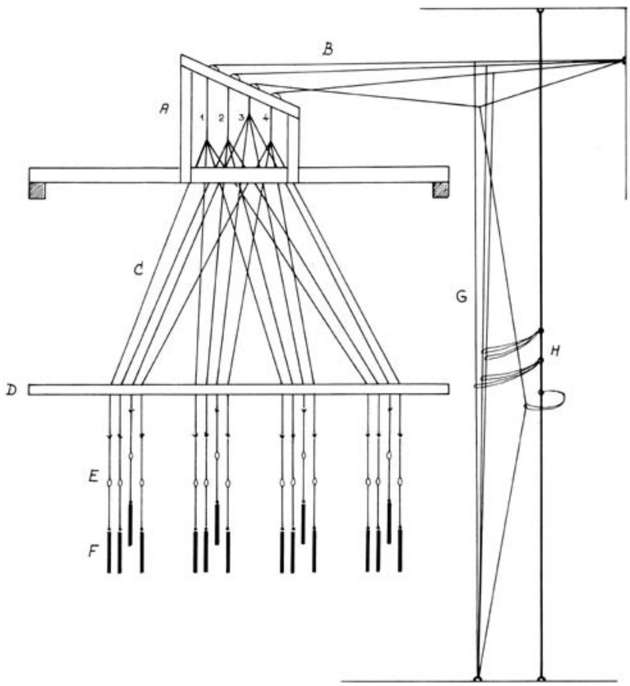


Figure 249 A simplified outline of the principle of the European drawloom. One tail cord is pulled down and pulley cord no. 3 is lifted with its four connected necking cords.

across the warp. The comber board generally consists of a frame enclosing a number of perforated slits of fine hard wood. It is a very important part of the monture; the number of holes in each row determines the tightness of the warp and the size of the pattern. In Figure 250 two ways of entering the necking cords into the comber board are suggested. At A is shown the *comber repeat*, in which the pattern units come out in straight repeat; at B is shown the *point repeat*, in which the pattern unit comes out symmetrically turned over and gives a larger effect to the design.

Each of the necking cords is supplied with one or more *leashes*, E. Eyes of metal, called *mails*, were generally used for the leashes. Silk-weavers in the 18th century used mails made of glass. The leashes are weighted down by *lingoes* F.

Onto each of the horizontal tail cords is knotted a vertical *simple cord*, G, fastened to the floor at the right of the loom. Pattern is counted in on these simple cords. Each line of the pattern is supplied with loops of string, the *lashes*. The lashes are fastened in numerical order by means of short loops of cord (French: *gavacine*) to one or two strong cords, the *guides*, stretched from ground to roof, see H in Figure 249. When a tail cord is pulled down by its simple cord the pulley cord lifts its group of necking cords; see pulley cord no. 3. It is the drawboy's job to pull out the lashes according to the weaver's requirements and thus to pull down the current tail cords; these in their turn lift the pulley cords and the necking cords. When the pattern row is woven he releases the simple cords and the lingoes pull down the warp ends to their former position. Then the next row is lifted and so on.

In Figure 251 is shown Murphy's specific method.

The development of the drawloom

Three types of drawlooms have now been shown: the Persian and Indian with cross harness, the Chinese drawloom, and briefly the principle of the European drawloom.

Real facts concerning the construction of ancient looms for figured weaves are not known, but detailed technical studies of textile artifacts can in many cases give useful information. In some Iranian silks, woven with samitum technique, some irregularities are found: the outer pattern units nearest to the selvedges are narrower than the others. This suggests that a reed was not used. The outer sides are drawn in, as is always the case when a reed is not utilized, but the number of warp ends in each pattern unit is the same throughout. In a few examples selvedges consisting of groups of thick cords are preserved; these were presumably used to hold out the weft and to keep an even width.

It is a question where and when a sort of comber board was at first utilized. Some silks of Byzantine and Islamic origin from about the year 1000 are in existence in their full weaving width, which measures up to 250 centimetres (Müller-Christensen 1960, p. 37). It would be barely possible to use a drawloom of such a width without some sort of comber board to hold out the harness cords. Otherwise the harness cords should have had to be many metres high, and still the outer parts of the warp would have been subject to excessive wear.

Although only a few highlights from the imperial workshops in Byzantium are in existence they suggest that drawlooms at this early age must have been developed to a high degree. For example the famous Mozac silk in Lyon (27386), dated AD 671, described in detail by Guicherd (1963), needed ca. 800 drawcords for half of the symmetrically repeated design, ca. 40 cm. For the height, ca. 90 cm (not complete), 2700 different rows of pattern were needed.

Italian weaving centres were founded during the decline of the Eastern Roman Empire, 12th to 13th centuries; from then on and well into the 18th century Italians played a leading role in European silk weaving. Richly designed silks from the 13th–15th centuries are amply represented in churches and museums.

Presumably drawlooms were widely developed in these weaving centres; still more so during the 15th century from when existing material shows that new techniques were taken up which demanded specific equipment on the looms.

Little is known of the development of Italian looms and their equipment from these centuries. The weaving centres were rival business houses, each guarding inventions and technical improvements as business secrets. On the other hand silk-weaving manufactories in France (Tours and Lyon) were state-subsidized and it was considered useful that the technical inventions should become known to as many craftsmen as possible (Geijer 1979, p. 104).

The great inventor Jacques de Vaucanson (1709–1782) left at his death a large collection of tools and implements to the French state. This collection was later greatly extended and became the foundation of the 'Conservatoire National des Arts et Métiers' in Paris as a museum and academy for technical education. The looms are exhibited as miniature models, most of them made for the Paris World Exhibition, 1855. The historical accuracy of the models may be open to question, but this collection gives an illustration of the development of weaving technology in France, and at the same time is also important for the rest of Europe.

The earliest type of loom for mechanical patterning, *le métier à petite tire* or 'the button drawloom' is mentioned in the catalogue from the museum (*Conservatoire National* 1942) and ascribed to Jean le Calabrais, an Italian from Calabria, 15th century. Note that this system is not analogous to the shaft draw system shown above. Paulet (1789, pl. 103, fig. 1), see Figure 252 upper part, shows another *métier à la petite tire*, presumably further developed in his time. Lashes are placed directly onto the horizontal tail cords and combined in pattern rows attached to small wooden handles (buttons) placed below a board on the side of the loom. 'The button drawloom' was still used for smaller repeated patterns on materials intended for costumes and upholstery simultaneously with the more sophisticated drawloom.

'The' drawloom
Le métier a la grande tire

In 1606 the silk weaver Claude Dangon in Lyon succeeded in reconstructing a loom which he had used in Italy in his earlier years (*Conservatoire National* 1942, p. 99). According to tradition Dangon supplied the horizontal tail cords with a new set of vertical cords, the simple cords. This was a considerable improvement; it was now possible to use very large pattern units, and the counting in on a vertical group of cords was more conveniently done. The model shown in the museum as Dangon's loom cannot represent the original loom from 1606. This model is supplied with a lifting arrangement which was constructed by Caron in 1717 (*Conservatoire National* 1942, p. 102), see Figure 254 below.

In the old manuals two types of this drawloom are shown. One has the horizontal tail cords fastened to a wall at some distance and the simple cords placed vertically near the side of the loom as shown in the outline above, Figure 249. This type is shown by Diderot et d'Alembert (1772, vol. xi, pl. 60) and also by Paulet (1789, vol. 7 part II, pl. 103, fig. 12); see Figure 252a. In the other type of drawloom the horizontal tail cords, when leaving the slanting pulley box, go through another oppositely slanting pulley box and then vertically down to the ground as shown in Figure 253.

The drawboy's fork

The drawboy, the weaver's assistant, had to pull forward by means of the lashes the simple cords for the current row of pattern. He not only had to pull them forward, but downward, in order to raise the leashes. He had to hold them down while the weaver worked in three, four, or more wefts. For larger patterns on a wide loom the weight was considerable; with the frictional resistance added to the actual weight of the lingoes it

→ **Figure 250** At A is outlined the 'comber repeat', in which the pattern units come out in straight repeat. At B is shown the 'point repeat'; the pattern unit comes out symmetrically turned over, with the axis of symmetry in warp direction. Note that only one necking cord is attached to the pulley cord in the middle to avoid repetition. As a comparison six normal shafts are diagrammed below entered respectively in straight repeat and point repeat.

was necessary to use a mechanical aid to hold the cords down for the time required.

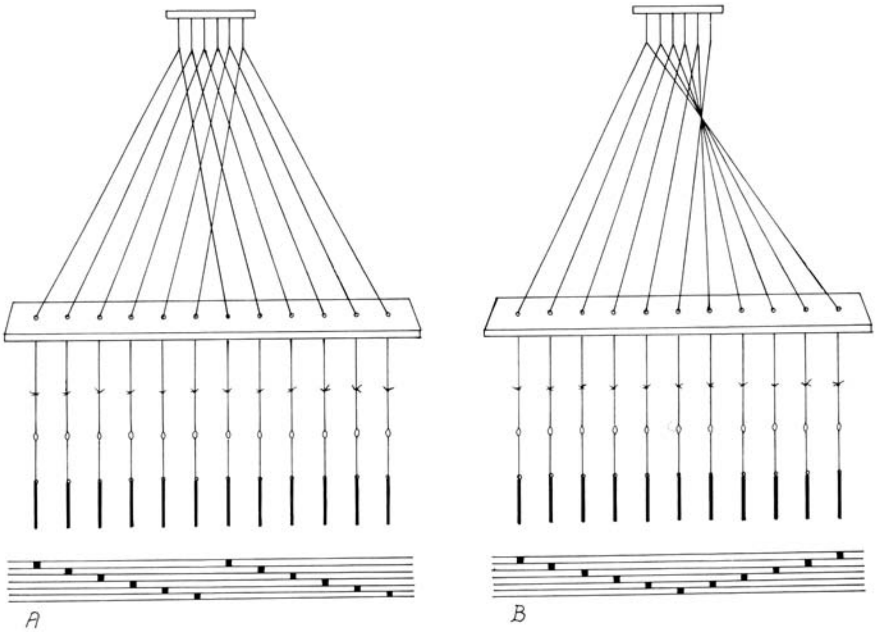
The outline in Figure 254 shows a drawloom fork. A solid stand, A, is fixed along the loom a little behind the simple cords. A heavy block, B, supplied with two prongs, C, can be freely moved along the round rod, D. When a row of pattern is to be used the block is moved back until the fork is free of the simple cords. Then the drawboy with one group of lashes pulls forward the next row of pattern and carefully inserts the upper prong behind the lifted cords, see cross section F. When this is ready he grasps the lever, E, and pulls it down to a horizontal position as shown at G. The leashes are then lifted to the correct height (Hooper 1953, pp. 262–264).

The Jacquard loom

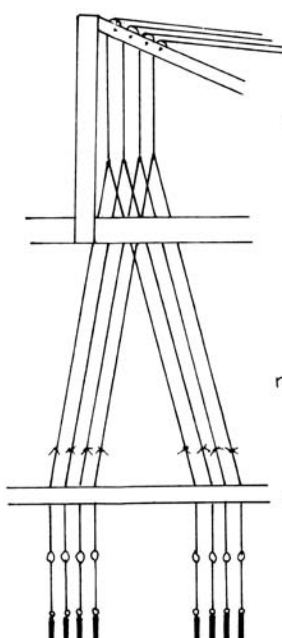
During the 18th century the drawloom was undoubtedly brought to its highest sophistication and the effort was now concentrated in finding easier and less time-consuming methods for weaving intricate patterns and possibly eliminating the drawboy.

The development of the Jacquard loom involved essentially the perfection of a precise and reliable mechanism to control the opening of a useable shed, using punched cards for the patterning.

As early as 1725 the punched card was invented by Bouchon but he did not obtain any useful results, although a system of needles and hooks, similar to the later systems described below, was also constructed. The inventor Falcon in 1728 succeeded in improving the system; he used pasteboard instead of Bouchon's paper and constructed the apparatus shown in cross-section in Figure 255. This is fastened at the side of the loom, and the simple cords are connected to the upper ends of the metal hooks, A. The hooks are arranged in four rows; below these four 'knives', B, are fastened into the lower wooden frame, C. The frame can be pulled down with a treadle by the drawboy. When it is pressed down the knives pull down the metal hooks and the simple cords lift the corresponding leashes. Each hook passes through a loop in a horizontal needle, D. The



→ **Figure 251** Murphy (1850) in his very extensive manual on weaving techniques shows another method (pl. 11). His outline of a drawloom is frequently reproduced (among others by Dorothy Burnham 1980, p. 49) and therefore a section is shown here to make clear the terms used by Murphy for the different parts of the monture. The leashes were here not prepared finally to be hung up but only the lower part of the leashes, the 'hangers', were taken through the lower holes in the mails and knotted to the lingoes. Then a double thread, called a 'sleeper', was taken through the upper hole in the mail and both ends put through the comber board beneath and knotted to the necking cord as suggested by the knots above the board. Apparently it must be a little difficult to adjust the leashes this way but presumably the method had its advantages. Luther Hooper (1953, p. 253) describes a similar method; perhaps this method was specifically used by English weavers.



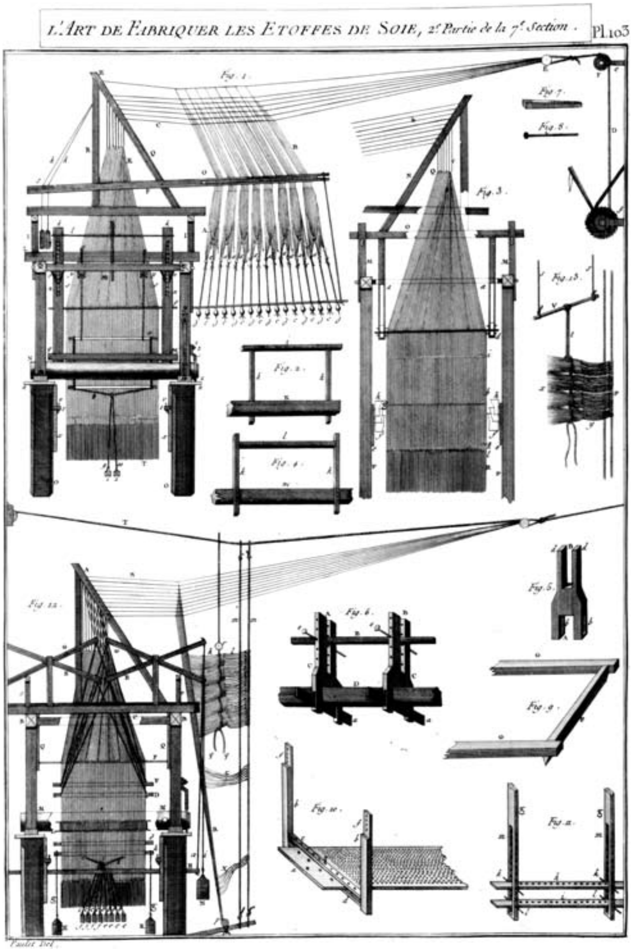


Figure 252 Planche 103 from Paulet (1789). In the upper half is shown the button drawloom, 'le métier à petite tire'. In the lower half is shown 'the' drawloom, 'le métier à la grande tire', supplied with horizontal tail cords and vertical simple cords.

→ **Figure 252a** Detail, lower left part of Figure 252.

needles go through holes in the board, E, in strict order according to the punched cards and protrude a bit in front of the board. The needles are supplied with small springs at the opposite ends. F suggests the punched cards. Each card represents one row of the pattern. The entire set of cards for the height of the pattern unit is sewn together and hung over a wooden prism placed above.

The drawboy presses one card against the needles with the wooden plate G. Where there is no hole the needle is pushed back and moves aside the hook so that it cannot be pulled down by the knife, see the two lower needles. Where the needle meets a hole in the card it goes through; the hooks keep their vertical position and are pulled down by the knife when

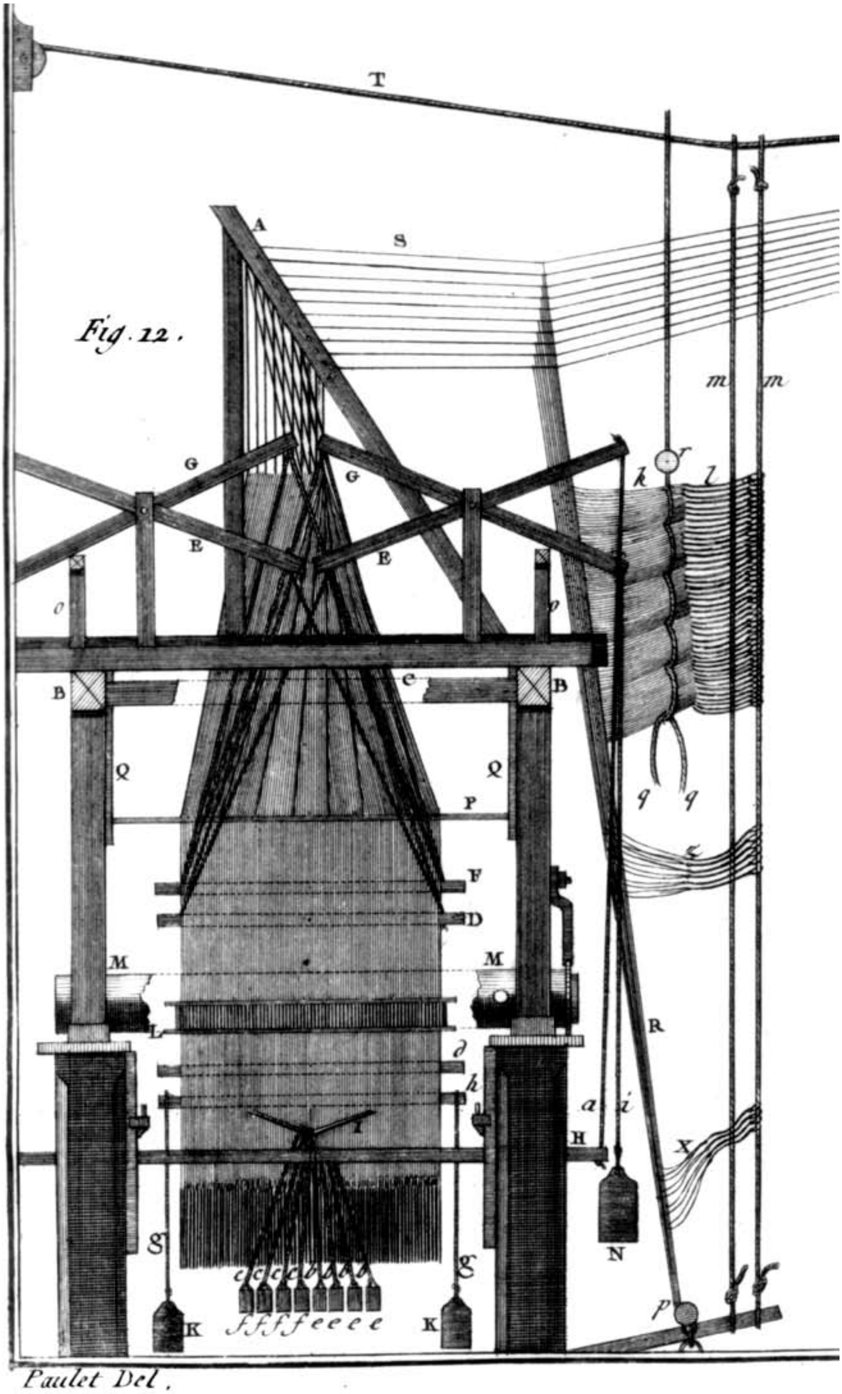

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Figure 253 Philippe de Lasalle's drawloom reconstructed by F. Guicherd according to descriptions from the 18th century. This is an example of the other type of drawloom with two oppositely slanting pulley boxes. The loom is now on exhibition in 'la Maison des Canuts', Lyon, together with other old looms and implements in working order.

The photograph belongs to École de Tissage, Lyon, reproduced by kind permission from M. Vial.

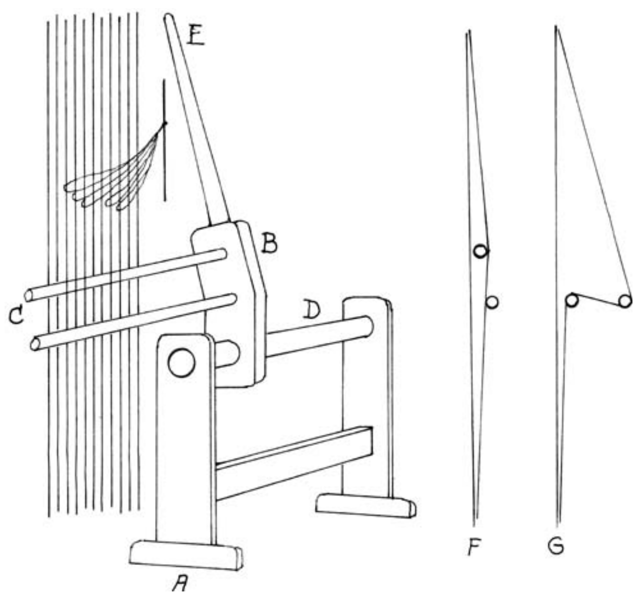
the drawboy depresses the lower frame. Thus simple cords lift the leashes where holes are punched in the cards.

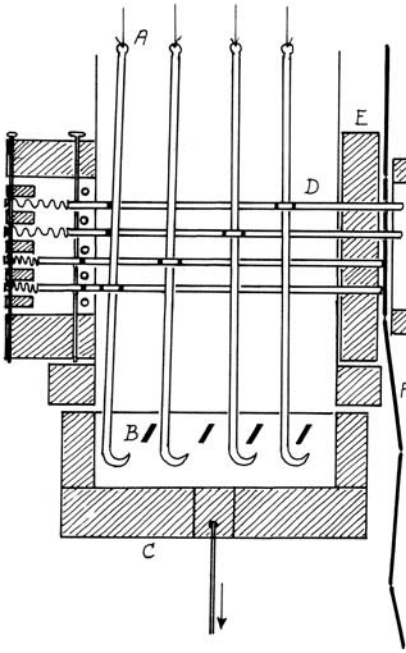
Falcon's loom was never generally used. Presumably it did not function with sufficient precision, and a drawboy had still to be employed. It is described in detail here because it evidently was one of the forerunners for Jacquard's loom. So also was the loom constructed by Vaucanson in 1745. His loom could be operated by the weaver himself without the assistance of a drawboy. Vaucanson also utilized punched cards and took them over a barrel placed uppermost on the loom. The barrel could be moved stepwise by the weaver with a long treadle. This loom likewise never obtained any practical success (*Conservatoire National* 1942, pp. 99–103).

Joseph-Marie Jacquard was born in 1752, the son of a silk weaver in Lyon. He had been known for the invention of a machine for making fishing nets and, according to tradition, was summoned to Paris in 1801 and installed at the Conservatoire des Arts et Métiers. There he found the remains of Falcon's and Vaucanson's looms, and succeeded in constructing a useable machine which was ready for use about 1804. For a better and more detailed study of Jacquard's life and work see the extensive article by Rita J. Adrosko (1982).

The principle of Jacquard's machine is shown in the cross-sections, Figure 256. The wooden hooks A are placed in four rows at the bottom

Figure 254 The drawboy's fork. The solid stand A is fixed at the side of the simple cords. When the upper prong is pushed under a group of simple cords as shown in the cross-section at F it is easy, by means of the long handle E, to lift and hold open a pattern shed.





← **Figure 255** A cross-section of Falcon's apparatus for lifting pattern sheds by means of punched cards; invented in 1728.

↓ **Figure 256** The principle of Jacquard's machine shown in cross-sections. At the left is shown the closed position; note that the two middle hooks are pushed back because the needles meet solid card. At the right in the lifted position can be seen that the two middle hooks stay below; only hooks 1 and 4 are lifted by the knives C.

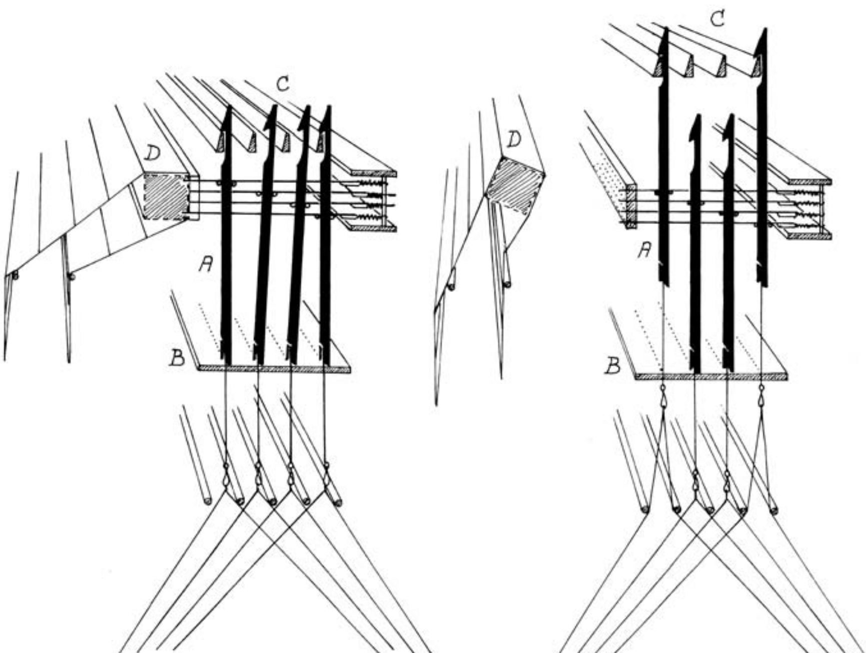


Figure 257 A Jacquard loom in our workshop set up for damask tablecloths. Note that the weaver has pressed down the long treadle which lifts the current row of pattern. At the same time the pivoting frame with the prism is pressed outward and a new card for the next row is turned out. Five shafts and five treadles are used for the satin weave.

Photo: Mathias, Copenhagen.

of the machine B. The inner part with the knives C in their frame are lifted by a long lever connected with a cord behind the weaver's back to a long treadle operated by the weaver himself; see the photograph in Figure 257.

The endless row of punched cards is hung over a four-sided prism D placed into a frame at the side of the machine pivoting at a point uppermost on the machine. By means of a large hook (see Figure 258) the prism is turned 90° and each time a new card for the next row of pattern is ready to go onto the needle-ends.

At the left in Figure 256 is shown the closed position. The two middle needles meet solid card and push back the two middle hooks while numbers 1 and 4 stay vertical ready to be lifted by the knives. Two metal rollers are fastened to the inner part of the machine; the rollers go within straps of steel fastened on the prism frame. When the weaver presses the treadle and lifts the inner part with the knives, the vertical hooks go up. At the same time the rollers, by means of the steel straps, press the prism outward. The prism makes a quarter turn and brings out a new

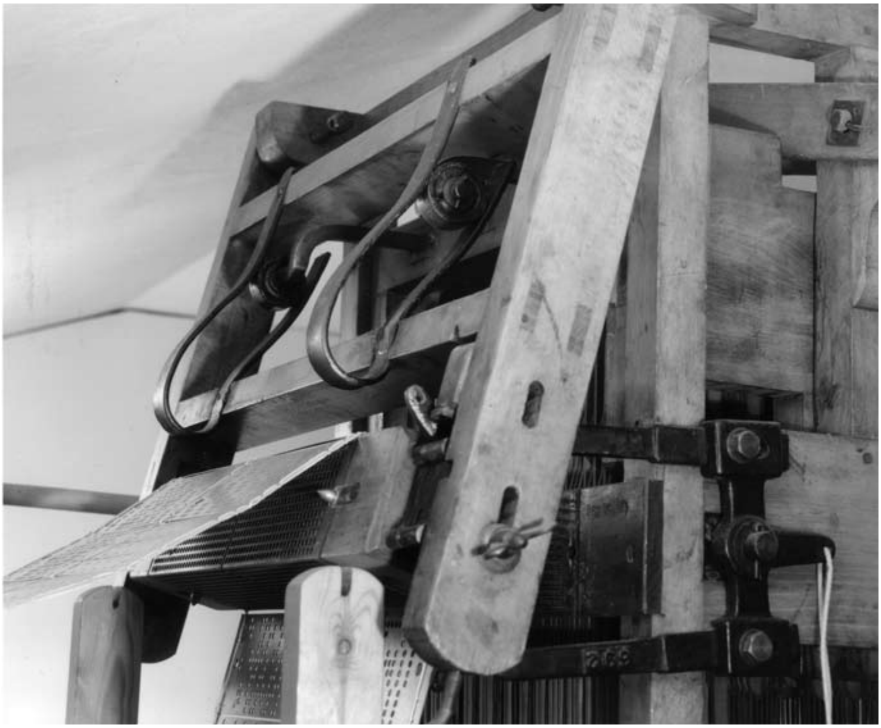


Figure 258 Our Jacquard machine seen from the side. The metal rollers on the inner part of the machine can be seen within the straps of steel fastened to the pivoting frame. Note here the large hook which turns the prism when the frame is pressed outward.

card, Figure 258. This position is shown at the right in the sections in Figure 256.

Figure 258 shows a side-view of our old-fashioned Jacquard machine. The pivoting frame with the prism and the steel straps and rollers can be seen here. Larger holes are punched at the ends of each card. These engage metal pegs on the prism and keep the cards in alignment.

When the weaver releases the treadle the considerable number of weighted leashes causes the inner part of the machine to fall heavily and at the same time the rollers within the straps of steel press the prism with the new card onto the needle-ends ready for the next shed to be lifted.

In principle each hook with its harness cord and leash is meant to lift one single warp end, and for each weft one new card is needed. Binding shafts are unnecessary. The weaver has only one treadle to use and shoots in a weft for each change of cards.

The Jacquard machine is used in different sizes, i.e. containing different numbers of hooks and needles. The example shown in Figure 257 has 400 hooks placed in eight rows with fifty in each row and an extra on each side for selvedges. If for instance four pattern units are needed, each hook is supplied with four harness cords entered into four groups in the comber board; then the warp contains 1600 threads besides the selvedges.

Patterns are drawn on ruled paper as described for the drawloom. Then cards are punched, one for each row of squares, and sewn together in an endless ring.

For certain sorts of handweaving each of the leashes lifts more than one warp end; this is for example the case in damask weaving. Here the punched cards are needed only for the design, and the ground weave is done with shafts and treadles as described in Chapter 9 on damask. The loom shown here (Figure 257) is used for damask table cloths.

Of course Jacquard's machine was very much improved upon in later years, especially when it came into use for industrial weaving. Nevertheless the system is the same and Jacquard's invention was of the greatest importance to textile industry everywhere.

Chapter 12
Our drawloom – some weaving implements

The Jacquard loom is of course a useful and effective tool in a handweaving workshop but its economic use presupposes a large production of the same pattern. In addition to the Jacquard loom a more flexible patterning device is useful for certain unique textiles. For this purpose we formerly used the harness drawloom (*dragrustning*) used by Swedish damask weavers, described in Chapter 9. In this type of loom the harness cords are placed horizontally above the weaver's head; but the counting in of patterns with the arms stretched upwards became more and more tiresome and we got the idea of taking the entire harness vertically down in front of the weaver. This was partly inspired by Hindson (1958) and her descriptions of Luther Hooper's drawlooms.

After many unsuccessful attempts we succeeded in constructing a device for drawing patterns which could be added to a normal handloom equipped with countermarch; see Figure 259.

For weavers interested in building a similar drawloom attachment we include here two working drawings, a side view in Figure 260 and a front view in Figure 261. The drawings are made with the proper dimensions and the scales show the true measurements.

The details appear clearly in the drawings. The length of the loom must be at least 180 cm to give sufficient space for pattern lift as well as for binding shafts. The back beam is inserted between two longer boards, A, on each side braced up to resist the pressure of the warp. The height must also be increased to give space for the counterweights for the shafts; a board, B, is fastened onto each side of the loom. The countermarch frame, C, is solidly attached to these higher sides.

The main part of our drawloom device, the slanting frame D, must be sturdily made from wood of good quality. This frame is bolted to the countermarch frame; it is able to carry the weight of the harness and its lingoes and to resist the continued lifting and releasing of pattern sheds.

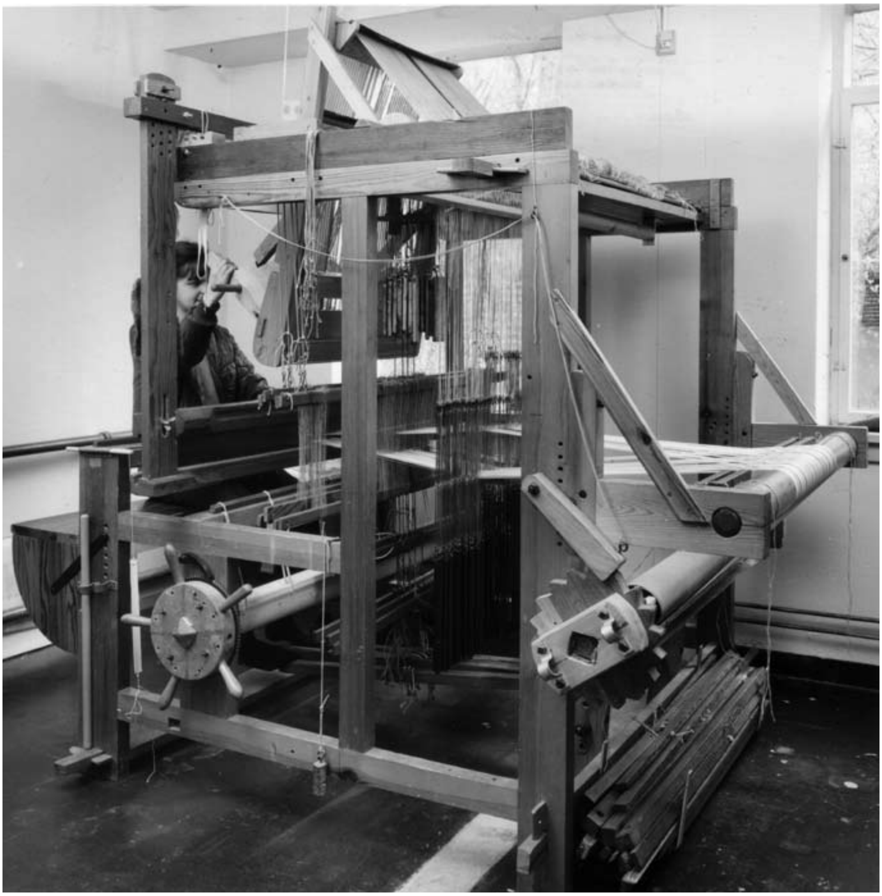
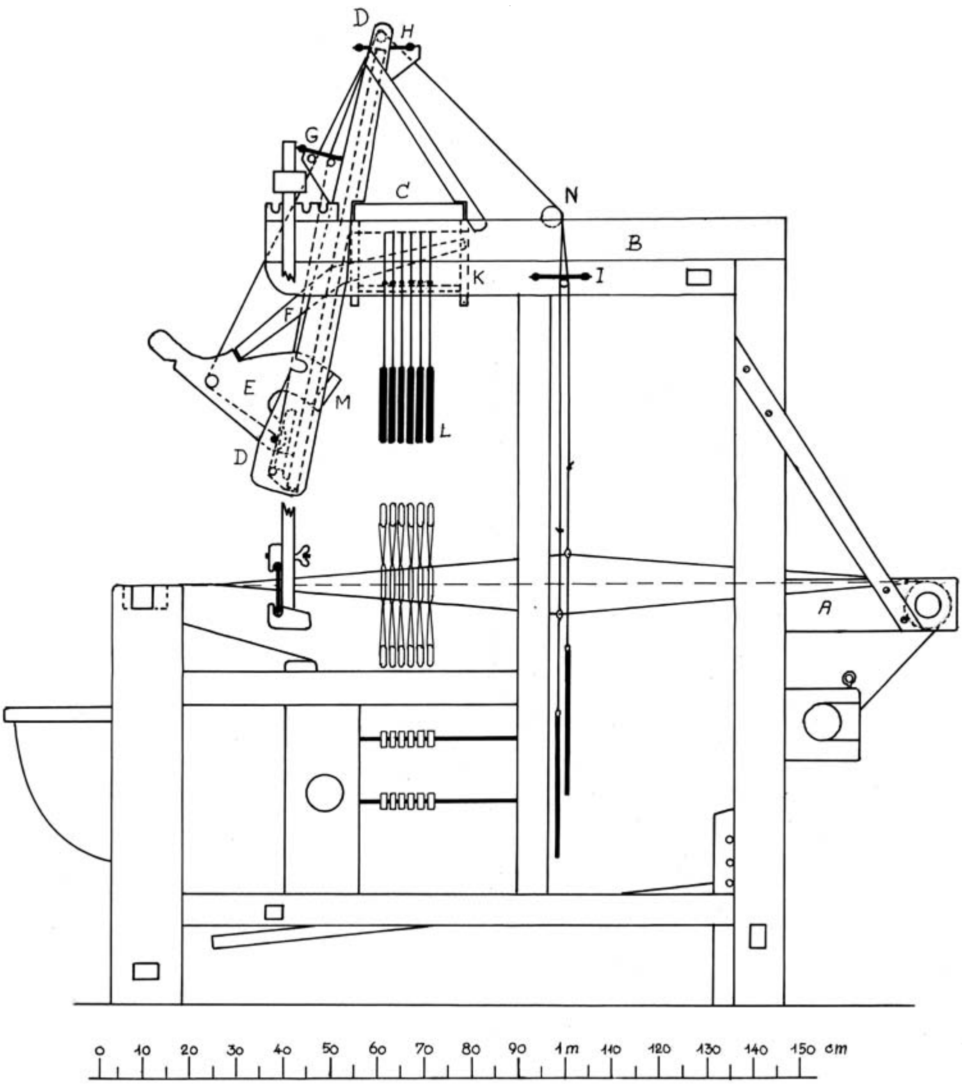


Figure 259 Our drawloom attachment mounted onto a countermarch loom. The shed lifter is here pulled forward to open a pattern shed. Extended space for the warp is obtained by inserting the back beam between two longer boards. Side frames are raised to give space for counter-weights for shafts.

The shed lifter, E, pivots on a steel rod in the lower side of the frame; see the photograph in Figure 262. The side pieces are connected by a strong wooden board, M, behind the harness cords.

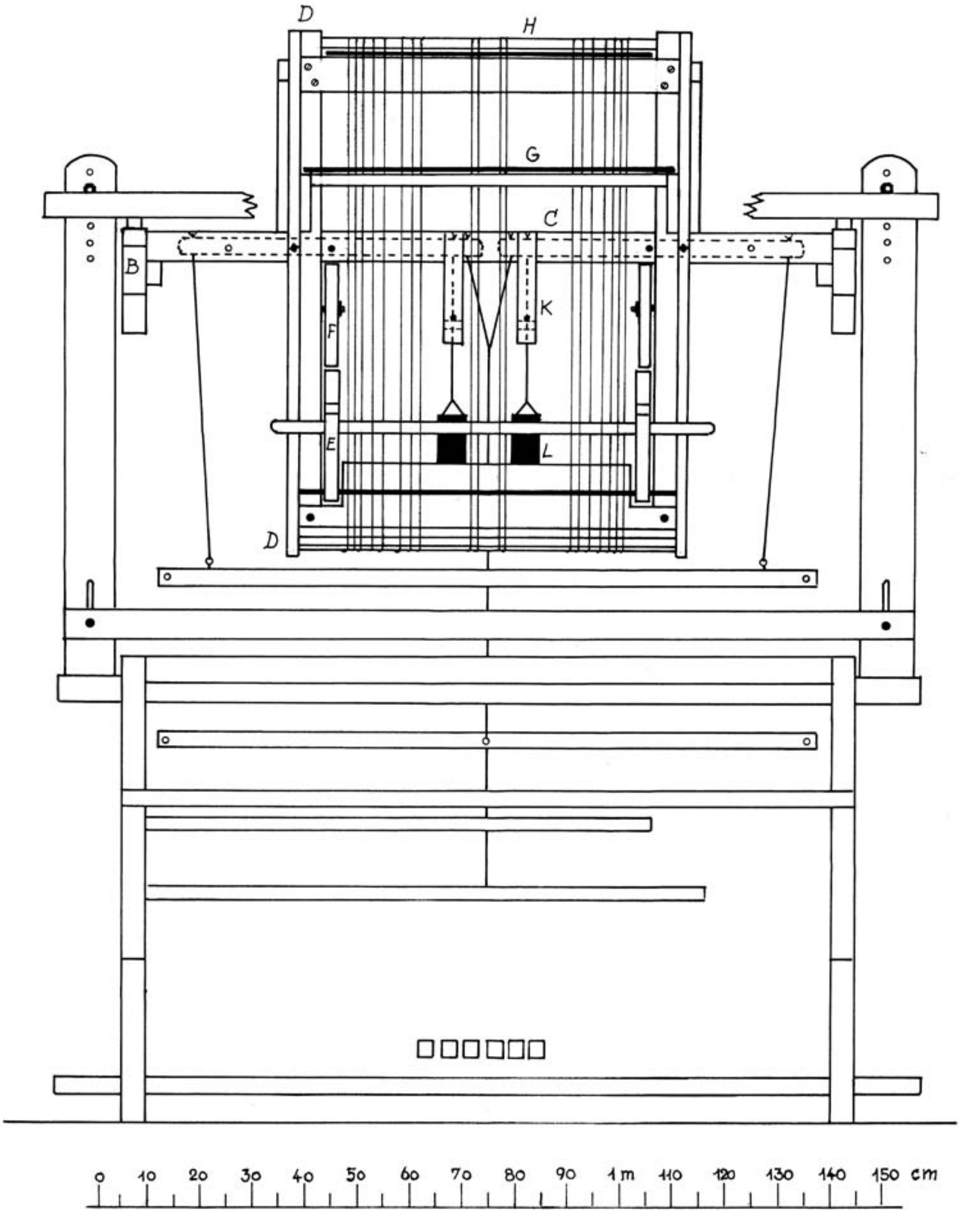
The smooth round rod inserted through the holes in the sides is pushed in behind the current pattern lift. The shed lifter is pulled forward by the handles and kept in its proper position by two angle-formed pivoting stops, F, which fall into the indentations in the sides. When the stops are released the weight of the lingoes pulls the shed lifter up to its former position.



The rather strange form of the sides is due to another possibility. In some weaving techniques, for instance double cloth, two-coloured taqueté, or samitum, one group of harness cords is lifted for one coloured weft. For the alternate differently-coloured weft the cords, which previously were below, must be lifted. For this purpose our shed lifter can be pressed the opposite way, into the loom; the other ends of the pivoting stops, F, fall into the indentations near the handles. The proper height for the shed is then obtained, as can be seen in Figure 263. This method was very useful for weaving experiments of a narrow width. Unfortunately we have so far

← **Figure 260** A working drawing for our drawloom attachment shown as a side view similar to the photograph in Figure 259. It is drawn to scale and by means of the diagram it it is possible to build a similar drawloom attachment.

↓ **Figure 261** Working drawing, front view of our drawloom. Our loom is used for a weaving width of 75 cm. For larger widths the dimensions must be increased accordingly. Our arrangement for binding shafts in a drawloom is also shown here. Below the countermarch frame C the two small frames K support the knots connected to the weights L.



not succeeded in finding a method to facilitate this much too heavy lift for a larger width.

Binding shafts in a drawloom do not work in the usual way, with some warp ends lifted and the rest pulled down. In a drawloom one shaft may be lifted, another pulled down independently, and the rest left in their middle position. Figures 260–261 show how binding shafts work in our drawloom. Two small frames, K, are fastened below the countermarch

frame under the inner ends of the top lams. Holes are drilled at the bottom of the frames, and flat iron weights (each ca. 1 kg) are hung by cords from the inner ends of the top lams. Thick knots at the bottom of the small frames adjust the position of the top lams and consequently of the shafts. When a shaft goes down the inner ends of the top lams with the weights are lifted; when the treadle is released the weights fall down as far as the thick knots allow. A lifted shaft moves down by its own weight. Shafts which are not to be used are kept in their middle position by the weights.

In our drafts a tie-up for binding shafts is marked by a cross for depression shaft; a knotted cord is put in at this point in the upper side lams. A circle means a lifted shaft, and a knotted cord is put in at this point in the lower side lams. Empty squares in this tie-up mean that no connection to treadles is established.

Setting up the harness

Strongly twisted cord of ramie was in earlier times used for the harness. Nowadays plaited cord of nylon may be obtained from suppliers to the textile industry. The harness in the loom shown here has a width of 75 cm with four cords per cm, in all 300 ends. The length of the harness is ca. 250 cm. The harness is made on a warping mill and cut open at one end. The closed ends are knotted into small loops taken onto a narrow list of wood. This is screwed onto the underside of the slanting frame. It is easier to manipulate a group of harness cords of a narrower width than the entire width of the comber board; therefore two reeds with 65 dents per 10 cm are used to keep the cords in proper order. The first reed, G in Figure 260, is placed upon two round rods fastened onto small shelves on the sides of the frame. The cords are taken up between the round rods and sleyed into the reed: eight cords into eight adjacent dents, then one empty dent, and so on. The parting up in groups of eight is in accordance with the ruled paper generally used for patterns. It is useful to leave out 3 cm in the middle of both reeds in order to give space for the countermarch cords and also to mark the centre of the harness, as patterns of different widths must be counted from this point.

← **Figure 262** Our drawloom seen from behind the weaver. The parting-up of drawcords and the woven band near the bottom of the slanting frame can be seen. The strange form of the shed lifter with its handles comes out clearly here.

The upper reed, H in Figure 260, of the same density, is sleyed in the same way with groups of eight. Above this reed is a smooth round rod; a glass tube is best because friction is reduced. When the cords have been sleyed upwards they are taken over the glass tube and put down through the same dents again.

The cords are then taken over a smooth round rod, N, and through a comber board, I, with four holes per cm. A reed of the same density can do duty as a comber board.

We used metal heddles for leashes, four to each cord supplied with a 60 gram weight (lingo). Small oval rings are used to hold the heddles above and below with the lingo. Metal heddles, rings, and lingoes may be obtained from suppliers of equipment for the textile industry.

The sufficient number of rings with heddles and lingoes is prepared beforehand and one is slung lightly onto each cord below the comber board. When the entire number is hung onto the cords the loops on the list under the lower side of the frame are adjusted evenly and the list is finally fastened.

A string is stretched from breast beam to back beam (see the horizontal broken line in Figure 260) in order to determine the correct position of the heddle eyes and warp. The height of the pattern shed is planned to be 14 cm. As the cords can only be lifted, the eyes of the leashes are placed in accordance with the lower shed face, half the height of the pattern shed, 7 cm below the stretched string.

It is of the greatest importance that the heddle eyes are hung in a straight horizontal line over the width of the harness. Two boards, longer than the width of the loom, are fastened one on each side of the leashes. The height 7 cm below the stretched string is carefully measured, and the boards are adjusted horizontally. A thin needle is placed across the boards. Every cord is individually straightened, the correct height controlled, the eyes at a level with the needle. Then the cord is finally knotted to the upper ring and surplus cord cut off.

The harness with its leashes is now ready for use. We found it useful to weave (with the fingers) a narrow band of tabby with some coloured yarn near the lower side of the frame.

In the middle of the band two cords are taken alternately over and under groups of eight cords with a twist in between, see the photograph in Figure 262.

→ **Figure 263** The shed lifter pushed the opposite way lifting the harness cords behind the round rod to the correct height.

Counting up a pattern

The pattern is drawn on ruled paper and fastened to a board. A transparent ruler is placed along the current row of squares. For each filled square a harness cord is lifted and little by little taken over the round rod in the shed lifter, see Figure 264. After a row has been counted up it is woven to control the pattern before the lashes are finally made.

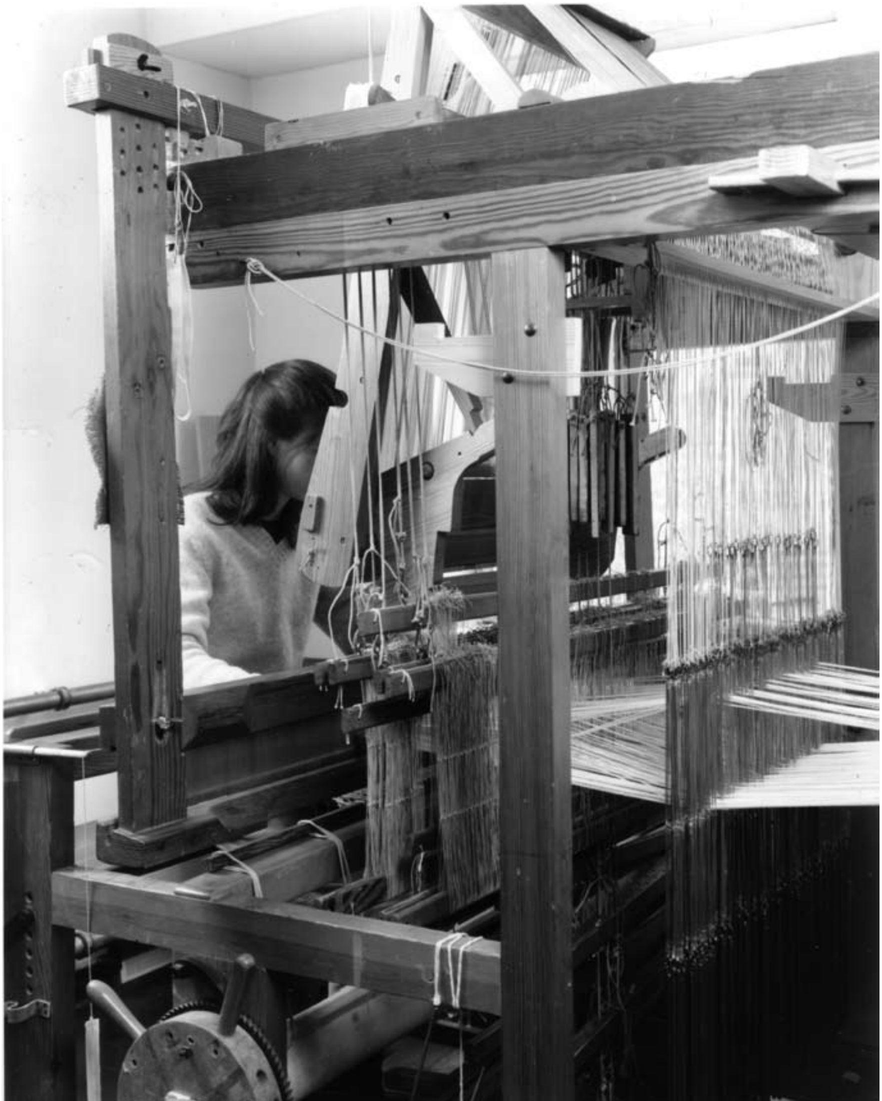


Figure 264 A pattern is counted up following the design on ruled paper. Each row is taken onto the round rod in the shed lifter.

A fine highly twisted cotton cord is used for the leashes; it is rolled onto a cone-shaped bobbin from which it is easily pulled out. The first end is taken over a hook at the right of the loom and into the counted-up shed along the round rod. The cord is faintly to be seen in the photograph, Figure 265. The end is wound round a left-hand finger and by means of a pointed stick (tapestry bobbin) a loop is pulled out from between the lifted harness cords and taken onto the finger. When a row is finished both ends are knotted and a loop knot is made with the entire bundle of lashes. A piece of thick cotton cord (gavacine) (thrums from a cotton warp are useful) is taken through the loop and knotted onto the 'guide'. This is momentarily loosened below and hung aside in the photograph, Figure 265. The guide or strong cord is a smooth plaited cord in front of the harness. When the entire pattern unit is finished the guide is fastened under the frame and the lashes are secured in the correct order.

When the weaver uses his pattern he can easily pull out one lash and let the round rod slide in behind the lifted harness cords. Lashes can be taken downwards one by one or the opposite way. When a pattern unit is finished the entire group of lashes is pushed back to its first position and used in straight repeat. It is also possible when one unit is woven to go on the opposite way and obtain a transversally symmetric pattern.

Heddles

Heddles of some sort are always an important detail of a weaving implement. Several types have been used throughout the ages from prehistoric times.

Type A in Figure 266, the single open loop, must be the earliest type from all parts of the world. It has been described by several scholars (Hald 1962a, Roth 1950, and others).

Figure 265 The making of lashes. Note the thin string at the right. A loop is pulled forward between lifted harness cords. Each of the lashes is secured by a cord (gavacine) knotted onto the guide momentarily hung up on the right.

For tabby weave a fixed rod is placed below odd-numbered ends and forms the natural shed. The heddle loops go under even-numbered ends and lift for the countershed, see Figure 267.

A slanting loom for silk tabby from a Chinese watercolour drawing is reproduced as an example, Figure 268. When this loom, presumably from the 18th century, is compared with the slanting looms from Han tomb-reliefs (see Chapter 1) it can be seen that the essential working parts are analogous. The same type of heddle rod was undoubtedly used for tabby in the Han.

Heddles of this type are knotted continuously with a thread taken round warp ends below the fixed rod and knotted to a cord stretched above the heddle rod. This is generally done on a warp already set up on the loom.

We have presumed that this sort of heddle was utilized for pattern heddle rods in the Han (Chapter 1).

Note in the Chinese drawing the thin round stick placed within the loops above warp ends. This presumably helps to open up the loops when the shaft rod is raised and lowered. It would also facilitate the entering of a new warp into the same loops.

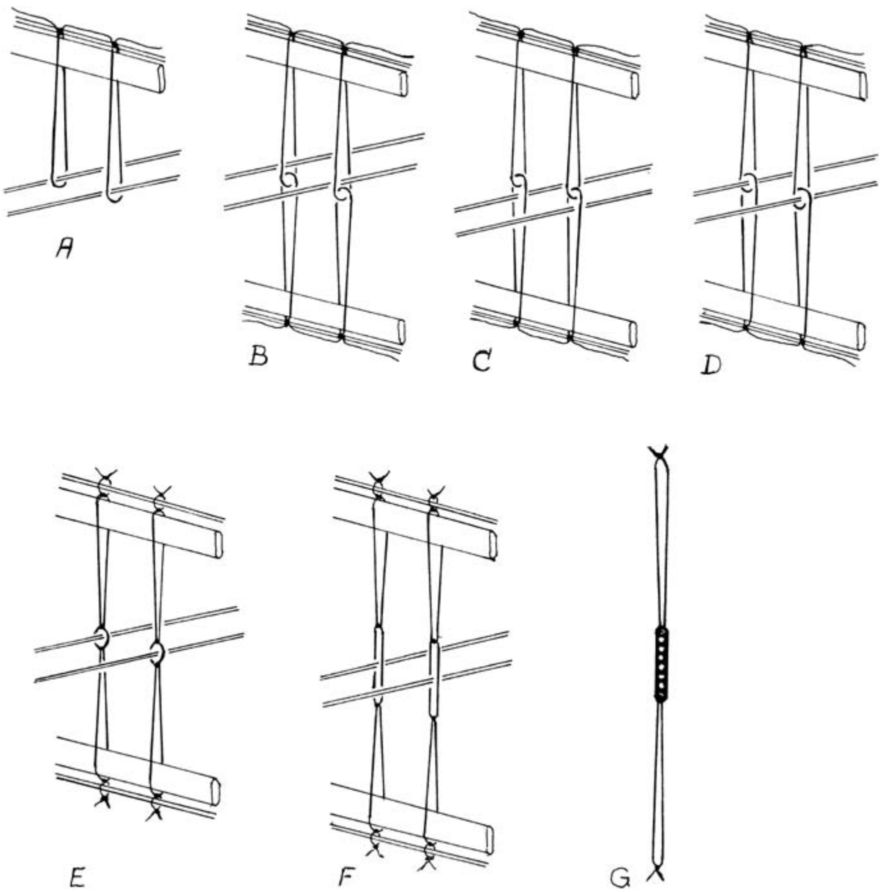
Heddle rods for the warp-weighted loom were knotted in a similar way (Hoffmann 1964). For the vertical tapestry loom this type of heddle is still utilized for opening a shed.

The clasped heddle

On a horizontal treadle loom set up with two shafts for tabby the open loops A (Figure 266) on the lowered shaft are slackened and apt to become entangled with the lifted ends. Interlocking another loop into the first would solve the problem. Without doubt experienced silk weavers of an early age realized this and brought the method into use. It is not known where the method was invented; presumably it was so obvious that it was spontaneously used in weaving centres in many countries.

We have suggested that Chinese weavers in the Han used clasped heddles for binding shafts on the pattern heddle rod loom; the warp ends are entered above the clasp, see B in Figure 266, and are lifted.

The clasped heddle is still used by Persian weavers (Wulff 1966) and by Syrian weavers (Hald 1967); see Figure 269. The rather primitive method for knotting still used indicates a long tradition.



↑ **Figure 266** Diverse types of heddles.

A: the open loop.

B: clasped heddle entered above for lifting.

C: clasped heddle entered below for depression.

D: clasped heddle entered through both loops.

E: common heddle with a knotted eye.

F: long-eyed heddle for binding shafts.

G: heddle for leashes with several holes in the metal eye, mail.

↓ **Figure 267** Sketch showing the natural shed and the countershed.

A board the width of one-half of the heddle is fastened to two uprights. One heddle rod is placed above the board and a cord, the *running cord*, is stretched along the rod. The yarn for the heddles is wound into a little ball and one end is knotted to the running cord. The ball is taken round the board and again knotted to the running cord and so on. When the first half of the shaft is finished it is loosened from the board and hung beneath. A

Figure 268 Watercolour drawing showing the slanting Chinese loom for weaving silk tabby. The shaft is supplied with open heddle loops, type A. Note the thin round rod placed into the heddles. The drawing belongs to The Royal Library, Copenhagen, Department of Manuscripts (New Royal Coll. 346 a).

new rod with running cord is placed above the board; this time the ball of yarn, every time it goes round the board, is also taken through one loose loop from the first rod below. Finally the running cords are straightened and a shaft is ready for the weaver.

The clasped heddle became the ideal type for weaving fine silks with tightly set warps. Knots on heddles are always calamitous for a fine warp and are avoided with this heddle. Two groups of shafts are employed: one group entered above the clasp as shown at B in Figure 266 for lifting shafts and one group entered below the clasp as shown at C for depression shafts; see Chapter 9.

This method was used for all sorts of fine silks for centuries. Two shaft groups can be seen in several Chinese watercolour drawings and the method is still used by silk weavers in Lyon (Hayot 1980, p. 59, fig. 6).

At D in Figure 266 are shown the warp ends entered into both loops. This method has been noted from several countries (Roth 1950, among others from Africa p. 60). During the 19th century, village weavers in Denmark and other places in Europe used this entering for weaving linen but complained of the difficulty of pulling forward a new length of warp (Andersen 1950–51). Murphy (1850, pl. 1, fig. 4) shows how to avoid this trouble. A thin rod is placed into the lower loops on each shaft. Cords

Figure 269 Old weaving woman knotting clasped heddles for a horizontal treadle loom.

Photo: Margrethe Hald, Nebk, Syria, 1961.

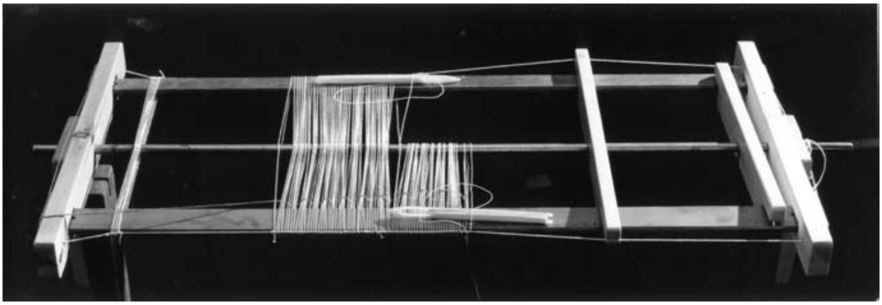


Figure 270 Our reconstructed frame for knotting clasped heddles. One-half of the heddle is started, the nearer part of the frame. For the other half the knotting needle is again taken round the metal rod and this time also through a loop from the first half.

are fastened to the ends of the rods, taken over pulleys uppermost in the loom, and connected to a handle. When the rods are pulled up to the clasps of the heddles by the handle the clasps are opened and the warp ends are permitted to pass without obstruction. Though the comparison is not really correct, it is still interesting to draw attention to the round rod in the heddles on the Chinese loom shown in Figure 268.

Poul Andersen (1950–51) shows several implements for knotting heddles. As an experiment we reconstructed the commonly used type of heddle frame for clasped heddles shown in Figure 270.

Two shaft rods are fastened into the sides of the frame. A thin metal bar is fixed in the middle. The running cord is stretched along the outer sides of the shaft rods. Two moveable wooden blocks secure the correct distance between the rods; one a little longer to keep the running cord away from the rod. Twisted cotton yarn is wound onto two knotting needles. One-half of the heddles are started, the cotton yarn is knotted to the running cord, taken below the shaft rod and round the metal bar, and again knotted to the running cord.

In this way the heddles are fixed and the number of heddles per cm for each shaft must be calculated beforehand. When the first half is finished the frame is turned or another person meanwhile starts from the opposite side. This time the needle, when going round the metal bar, is also put through the loop from the first half.

When a sufficient number of heddles is finished the metal bar is pulled out, the running cord is knotted tightly onto each shaft rod, and the finished shaft is loosened from the frame and hung up on the loom.

Heddles with a knotted eye

At E in Figure 266 is shown the eye heddle commonly used by modern hand weavers. These are generally bought ready made, sometimes supplied with metal eyes. These heddles are not 'fixed' and any number may be used on each shaft in accordance with the material to be woven. It is useful to thread a cord into the small extra eyes at each end so that they cannot slide over each other. In earlier times such heddles were knotted on a heddle block similarly to the long-eyed heddles described below.

Instead of two shaft groups for binding shafts, the long-eyed heddle shown at F in Figure 266 may be used when the warp is not too fine and there is no risk of the knots damaging the warp ends.

The height of the eyes, normally 7–8 cm, allows the pattern shed to open through the binding shafts. The lower part of the eye lifts the warp end and the upper part depresses it.

Generally the weaver has to knot such heddles himself on a heddle block, see Figure 271. Cotton twine is cut in a number of equal lengths by winding it round the base of the block for instance 50 times and cutting at

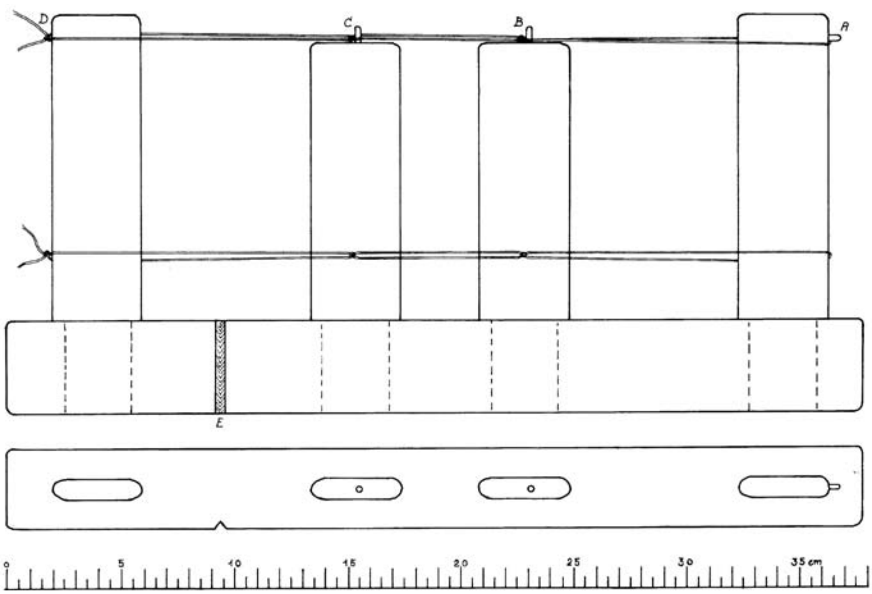


Figure 271 Heddle block for knotting long-eyed heddles.

The drawing is made to scale and by means of the diagram it is possible to make such a heddle block.

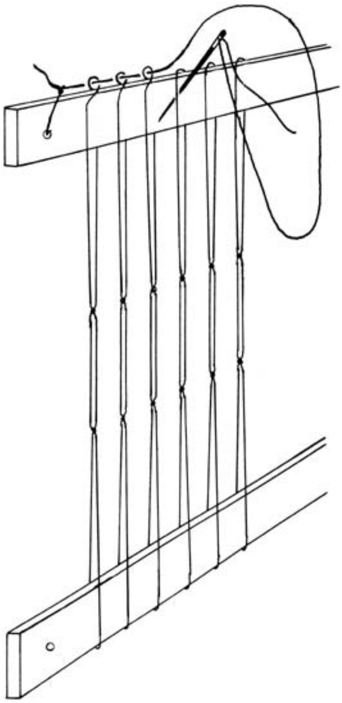


Figure 272 Our method for keeping heddles in correct order on the shafts.

A cotton twine is taken with a needle through each heddle so that a little eye is formed. The twine is afterwards straightened along the shaft and knotted at the other end.

the notch E. One end is laid round the first upright, the middle of the end below the peg A, then knotted with a reef knot over peg B, and again over peg C; the long eye is then ready. The ends are knotted with an extra knot round the last upright at D. The heddle eye is lifted off the pegs and the heddle pushed down. When 50 heddles are finished strings are tied round the loops and the bundle is removed from the block.

It is very time-consuming to knot extra eyes at both ends, and long-eyed heddles are apt to slide over each other; to avoid this trouble a cord is pulled with a needle through every heddle along the upper as well as the lower shaft rod as shown in Figure 272. When the cords are straightened small eyes are formed on the heddles.

On a drawloom several warp ends are often lifted by a single leash. However when more than one end of a fine yarn is entered into one eye the ends are apt to become twisted and cause faults in the weave. Therefore it is preferable to use either several steel heddles on each harness cord or to supply the leashes with metal eyes with several holes, see Figure 266 G.

Bibliography

Abbreviations

AAC	*Acta archaeologica*, Copenhagen.
AHB	*Acta historica*, Budapest.
AI	*Ars Islamica*.
AM	*Arkiv og Museum*, Copenhagen.
BM	*The Burlington magazine*.
BMFEA	*Bulletin of the Museum of Far Eastern Antiquities*, Stockholm.
BR	*Beijing review*.
BNBC	*Bulletin of the Needle and Bobbin Club*, New York.
CIBA	*CIBA-Rundschau*, Basel.
CIETA	*Bulletin de liaison du Centre Internationale d'Etude des Textiles Anciens*, Lyon.
EC	*Early China*, Berkeley.
FL	*Folk-liv*, Acta Ethnologica et Folkloristica Europea, Stockholm.
FV	*Fornvännen*, Stockholm.
IT	*L'industrie textile*.
JEA	*Journal of Egyptian archaeology*.
JITH	*Journal of Indian textile history*.
KG	*Kaogu* ('Archaeology').
KGXB	*Kaogu xuebao* ('Acta archaeologia Sinica'), Beijing.
KM	***Kulturminder***, publ. by Selskabet for Dansk Kulturhistorie, Copenhagen.
LSYJ	*Lishi yanjiu* ('Historical rescarch'), Beijing.
NA	*Nationalmuseets arbejdsmark*, Copenhagen.
OA	*Oriental art*.
OS	*Orientalia Suecana*, Uppsala.
R	*Rig: Tidskrift utgiven av Föreningen för Svensk Kulturhistoria*, Stockholm.
RAA	*Revue des arts asiatiques*.
TI	*Tidsskrift for industri*.
TK	*Textilkunst*, Hannover.
TMJ	*Textile Museum journal*, Washington, D.C.: The Textile Museum.
TZ	*Trierer Zeitschrift für Geschichte des Trierer Landes und seiner Nachbargebiete*, Trier: Rheinischen Landesmuseum.
WW	*Wenwu* ('Cultural relics'), Beijing.
ZSAK	*Zeitschrift für Schweizerische Archäologie und Kunstgeschichte*.

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