THE ARTISTIC CRAFTS SERIES
OF TECHNICAL HANDBOOKS
EDITED BY W. R. LETHABY

HAND-LOOM WEAVING

Domestic Loom *From a Lyonnese Woodcut*, 1510

"A winter garment now demands your care,
To guard your body from th' inclement air;
Soft be the inward vest, the outward strong,
And large to wrap you warm, down reaching
long:
Thin lay your warp, when you the loom prepare,
And close to weave the woof no labour spare.
The rigour of the day a man defies
Thus clothed, nor sees his hairs like bristles rise."

"The matron cheerful plies the loom at home."
Hesiod "Works and Days"

HAND-LOOM WEAVING PLAIN & ORNAMENTAL

BY LUTHER HOOPER : WITH LINE DRAWINGS BY THE AUTHOR & NOEL ROOKE: ALSO SEVERAL ILLUSTRATIONS FROM ANCIENT AND MODERN TEXTILES

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PREFATORY NOTE TO THE 1920 REPRINT

Prefatory Note

It was unfortunate that the first edition of "Hand-loom Weaving" became exhausted at a time when the difficulty of producing such books was almost insurmountable, especially as its success and the increasing demand for it called for an immediate reprint. Happily the lengthy period of delay has come to an end, and the present volume, which is an exact replica of the first edition, except for a page or two of necessary addenda, is now ready for the use of students and others interested in the fascinating textile arts.

The favourable opinions of "Hand-loom Weaving" so generally communicated to the author have been highly gratifying, and have more than compensated for the care and labour bestowed on the preparation of the work. These communications are hereby gratefully acknowledged.

LUTHER HOOPER.

EDITOR'S PREFACE

In issuing this volume of a series of Handbooks on the Artistic Crafts, it will be well to state what are our general aims.

In the first place, we wish to provide trustworthy text-books of workshop practice, from the points of view of experts who have critically examined the methods current in the shops, and putting aside vain survivals, are prepared to say what is good workmanship, and to set up a standard of quality in the crafts which are more especially associated with design. Secondly, in doing this, we hope to treat design itself as an essential part of good workmanship. During the last century most of the arts, save painting and sculpture of an academic kind, were little considered, and there was a tendency to look on "design" as a mere matter of *appearance*. Such "ornamentation" as there was was usually obtained by following in a mechanical way a drawing provided by an artist who often knew little of the technical processes involved in production. With the critical attention given to the crafts by Ruskin

and Morris, it came to be seen that it was impossible to detach design from craft in this way, and that, in the widest sense, true design is an inseparable element of good quality, involving as it does the selection of good and suitable material, contrivance for special purpose, expert workmanship, proper finish and so on, far more than mere ornament, and indeed, that ornamentation itself was rather an exuberance of fine workmanship than a matter of merely abstract lines. Workmanship when separated by too wide a gulf from fresh thought—that is, from design—inevitably decays, and, on the other hand, ornamentation, divorced from workmanship, is necessarily unreal, and quickly falls into affectation. Proper ornamentation may be defined as a language addressed to the eye; it is pleasant thought expressed in the speech of the tool.

In the third place, we would have this series put artistic craftsmanship before people as furnishing reasonable occupations for those who would gain a livelihood. Although within the bounds of academic art, the competition, of its kind, is so acute that only a very few per cent. can fairly hope to succeed as painters and sculptors; yet, as artistic craftsmen, there is every probability that nearly every one who would pass through a sufficient period of apprenticeship to workmanship and design would reach a measure of success.

In the blending of handwork and thought in such arts as we propose to deal with, happy careers may be found as far removed from the dreary routine of hack labour, as from the terrible uncertainty of academic art. It is desirable in every way that men of good education should be brought back into the productive crafts: there are more than enough of us "in the City," and it is probable that more consideration will be given in this century than in the last to Design and Workmanship.

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This volume on Weaving, the seventh of our series, is an interesting account of a very ancient and a very remarkable art. With weaving from early days has been associated the making of patterns which repeat a given unit, and the commerce in such fabrics has been the chief means of disseminating patterns over the world. Considering the utility, the universality, and the wonderful nature of the art at its simplest and the splendid triumphs of its maturity, weaving must have a strong claim for being the most extraordinary of man's inventions.

W. R. LETHABY.

ARMS OF THE WEAVERS' COMPANY
LONDON 1700

AUTHOR'S PREFACE

NOTWITHSTANDING the competition of its formidable rival the power-loom, the hand-loom still survives, and seems likely to continue in use for the weaving of the best webs, in several branches of textile manufacture.

In various districts of Great Britain, as well as in France, Germany, Italy, and other European countries, hand-loom weaving continues to be, though much decayed, an important industry. In the East—in India, China, and Japan—the hand-loom weavers outnumber by several millions the workers employed in attending to the textile machinery of Europe and America.

The fact that hand-loom weaving has so long survived gives hope, that, now that there is a growing demand for the best in all departments of workmanship, the future may see an extensive revival of this beautiful and ingenious art.

There is more hope for such a revival since numerous handicraft societies and guilds, as well as many independent art workers, have been led to

study and practise weaving, and have met with much encouragement, both as regards the quality of the work they have been able to produce, and its appreciation by the public.

It is a pity that the introduction of machine spinning and weaving should have had the effect of almost entirely superseding the domestic loom and its auxiliary the spinning-wheel. Spinning and weaving are ideal domestic occupations, especially in the country home. Since they ceased to be universally practised, no home industry at all approaching them in usefulness or interest has taken their place. It is true that some branches of the art, such as the weaving of fine silk into elaborate damasks or brocades, require special training and constant application in the worker. This has always been so; but the weaving of linen, cotton, woollen, and the coarser silk threads, into materials of strength and beauty for domestic use, can quite well be carried on intermittently together with other household occupations.

There can be no doubt of the superiority of well-made hand-woven webs, whether they be of the finest silk or of the coarsest wool. This is plainly shown if the best hand-made and the best machine-made productions be compared.

Hand-loom weaving, too, is superior to machine-weaving if judged by the effect it is likely to have

on the worker. The hand-weaver is employed in a pleasant, ingenious occupation which exercises all his faculties, while the attendant on a power-loom is engaged in a monotonous toil, in which no quality but intense watchfulness is required.

The object of the present volume is to inform the student of hand-loom weaving of the best methods of preparing warps, fitting up looms, and making or selecting the various appliances necessary for the work, as well as inventing, planning, and weaving plain and ornamental webs. The assistance of the domestic and the artistic weaver has been particularly borne in mind in the preparation of the book.

I hope that this volume will also prove of use to all who are interested in textiles artistically, commercially, or in any other way. The principles of weaving, traced out from their origins, to their greatest perfection in the eighteenth century, are identical with those of the most highly developed modern inventions—inventions which have succeeded in accelerating the speed of weaving at more or less cost to its artistic perfection.

For assistance in the preparation of the book my thanks are due to the authorities of the Victoria and Albert Museum, the National Art Library, and to the authorities of the British Museum, for facilities of research, and for permission to photograph

examples of choice textiles, &c., in their various collections ; to Miss Charlotte Brock and Mr. Noel Rooke for valuable assistance in preparing the illustrations, and to Mr. W. H. Abbott, M.A., and other friends for much helpful advice and many practical suggestions.

LUTHER HOOPER

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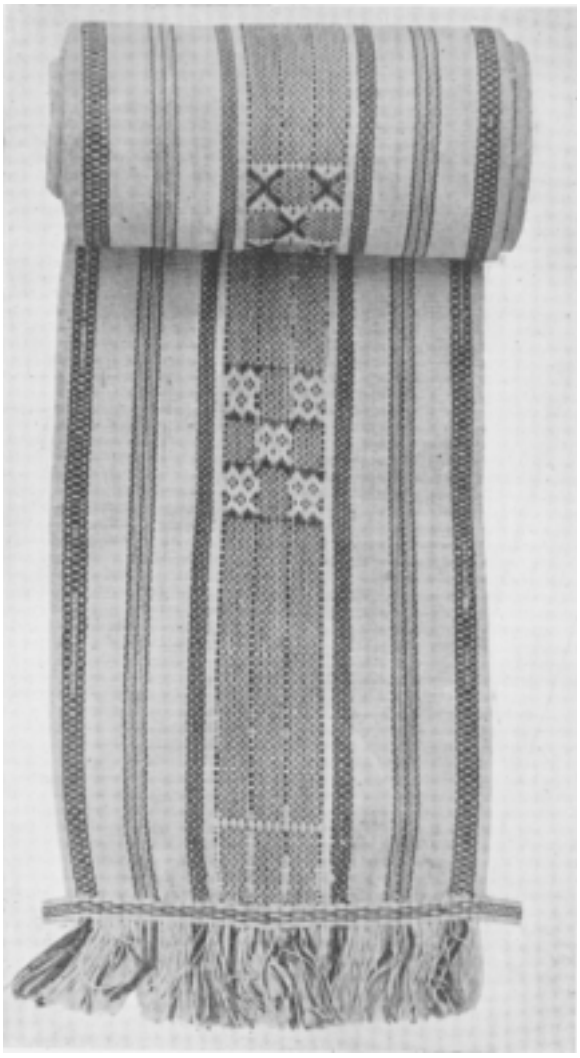


Plate I.—East African Weaving, illustrating Primitive Work.

See page 3.

British Museum, London.

PART I

PLAIN WEAVING

CHAPTER I

THE RUDIMENTS OF SPINNING AND WEAVING

The Comparative Importance of the Weaver's Art—Scope of Hand-loom Weaving—Weaving Universal—The Construction of Plain Cloth—The Warp—The Weft—Relative Size of Warp and Weft—Preparation of Threads for Weaving—Flax and its Use Prehistoric—Retting and Skutching of Flax—Preparation of Cotton, Wool, and Silk—Carding, its Purpose and Method—Fine Spinning by Machinery—Ancient Spinning with Distaff and Spindle—The Distaff—The Spindle.

The Scope and Value of the Weaver's Art

It may be confidently affirmed that the art of weaving occupies a place of importance and usefulness to mankind second only to that of agriculture. We shall reach this conclusion whether we take into consideration the number of persons engaged in the various branches of the art, the universal practice of weaving in ancient and modern times, or the necessity and value of the productions of the weaver's craft and industry to society in general.

The Scope and Value of the Weaver's Art

If necessary it could be proved by statistics that at least one-fifth of the working world is occupied either with weaving and its allied trades, or in the distribution of its finished materials. It would be found also that a similar proportion of the general expenditure is for woven goods of one kind or another.

It is not only, however, from an economic point of view that the art of weaving is of such interest and importance, but also on account of the vast amount of invention and ingenuity, both of a mechanical and an artistic kind, that it has been the means of calling forth. These qualities have been shown during the course of its development from the elementary and laborious attempts of primitive tribes to the elaborately finished and swiftly wrought, though complicated webs woven on the modern power-loom. It is this aspect of the subject—viz., the development of textile art from its earliest beginnings—that the present volume is intended to set forth. A clear account of the principles and practice of the art of weaving, and the possibilities and limitations of the loom and its accessories, cannot fail to be of interest and value to the antiquary and to the collector of ancient textiles, as well as to the designer, the weaver, the distributor, and the purchaser of the various kinds of modern woven fabrics.

Possibilities of Hand-loom Weaving

It will not be necessary, nor, indeed, would it be possible within the compass of this handbook, to follow the subject of weaving beyond the point when it ceased to be a handicraft, owing to the introduction of the Jacquard machine and the application of steam-power to the loom, which

events took place at the end of the eighteenth century. These changes in the construction and mechanism of the loom did not alter the principles of weaving in the least, nor add any new effects of combinations of threads to those previously in use. The inventions only affected the exactness and speed of the weaving, the motive power by means of which the loom was driven, and rendered easy a frequent change of pattern. No real advance in weaving technique has taken place for a hundred years, as nothing more perfect is possible in the weaver's art than the sumptuous webs of silk, of exquisite texture, which were deliberately woven by hand on the perfected draw-looms of Europe during the seventeenth and eighteenth centuries.

Possibilities of Hand-loom Weaving

The first principles and practice of the art of weaving, wherever they are found, are universally similar. Primitive peoples of to-day follow the same methods and use the same appliances as those of ancient times. And as it is on these that all later textile developments are based, it will be necessary in the first place to define them clearly. A visit to the ethnographical department of any of our museums, and an examination of their contents, will prove that there is scarcely a savage tribe, however primitive, which has not some more or less proficient acquaintance with the art of making thread and of utilising it in the weaving of cloth (see plate I). Also, the specimens of ancient handicraft, such as those shown in plate II, which remain to us, as well as other less direct evidence, will show decidedly that the people of antiquity were familiar with the arts of spinning

Universality of Weaving

Universality of Weaving

and weaving, which they practised with a great deal of skill and carried to a high pitch of perfection. Indeed, so universal and so ancient are the occupations of making thread and weaving webs that they appear to be instincts as natural to the human species as to the caterpillar and the spider.

The Construction of Plain Cloth

If we look carefully at a piece of plain cloth we find it to consist of a number of longitudinal threads placed side by side, and intersected, or interlaced, by a continuous single thread. This thread passes alternately before and behind the longitudinal ones, and has been introduced between them from edge to edge, by some means and in such a manner as to bind them together and hold them in position. When thus united the threads are woven into a flat, orderly, and uniform-surfaced material, of more or less durability, according to the strength of the threads of which it is composed and the closeness and evenness with which the crossing thread has been pressed down and beaten together. By means of plate III the arrangement of the longitudinal threads and the continuous thread crossing and intersecting them should be made quite clear.

The Warp

The longitudinal threads of a woven material are always called the *warp*, because, in order to allow of their being intersected conveniently by the continuous crossing thread, they have to be *warped*—that is, tightly strained in their position on some kind of frame prepared for the purpose. The longitudinal threads are known as the *warp* and by no other name, but the continuous crossing thread has several technical names, the most usual being

The Weft

weft, *woof*, or *shoot*—sometimes spelt *shute*.

The Relative Size of Warp and Weft

In the magnified piece of plain cloth (plate III) the warp threads are seen at once to be much finer than the weft thread. This is always the case, except in the most elementary attempts at weaving. And the threads differ not only in size, but in the manner in which they are prepared for use. The warp threads need to be hard, having thin strands strongly twisted together. The weft thread is only slightly twisted; this makes it soft and yielding, and enables the weaver to press it well down and to beat both warp and weft together into firm, good material. The selection of properly proportioned threads is of the highest importance in weaving, for the good appearance of the finished work depends almost entirely upon it, as also does its durability.

Various Threads and their Preparation for Weaving

The simple methods and appliances for making thread and weaving adopted by different ancient peoples and by primitive tribes of to-day are remarkably similar in kind. But the raw materials used and the manner of preparing them differ considerably, and depend, of course, on the natural products with which the particular people happen to be familiar, and the inventive skill which they possess. The most obvious and simple of all raw materials for weaving were the long grasses and rushes, or other plants, with which the weaver was acquainted, which could be readily split into filaments or used entire. But the rudest people readily become aware that many animal and vegetable substances are capable of being drawn out and twisted together into a continuous thread, of more or less firmness and strength, and they accordingly soon invent for themselves some simple appliances for performing this operation.

Flax and its Preparation Prehistoric

Previous to the introduction of cotton from India and the marvellous development of the cotton industry in this country during the last century, the most important of all the various kinds of thread for weaving purposes was obtained from the stems of the family of plants known as the *Linum* family, of which the flax has always been the chief member. Animal wool and silk—the only natural continuous thread—have been chiefly used for ornamental fabrics, but flaxen or linen thread has always been the most used and the most useful for ordinary purposes. The earliest specimens of knitted and woven thread at present known are fragments that were found amongst the remains of the lake-dwellings in Switzerland, and which are attributed; by the most reliable authorities, to the age of stone. These venerable relics are therefore prehistoric. They consist of small bundles of flax fibre, both raw and twisted into threads of various thickness. Some are made into ropes and nets and others knitted or woven into pieces of cloth (see plate IV). In Egypt, in Greece and Rome, and, with one or two exceptions, in all the more or less civilised countries of the ancient world, flax was used and preferred above all other fibres for weaving purposes. It is remarkable that the cultivation and preparation of flax, even at the present day, is almost identical with that in use in ancient Egypt four or five thousand years ago. Probably the reason why cotton has, within the last century, almost superseded the use of linen, is because it is better adapted for preparation and weaving by machinery and takes more kindly to all sorts of abominable adulteration, so that it can be more cheaply put upon the market.

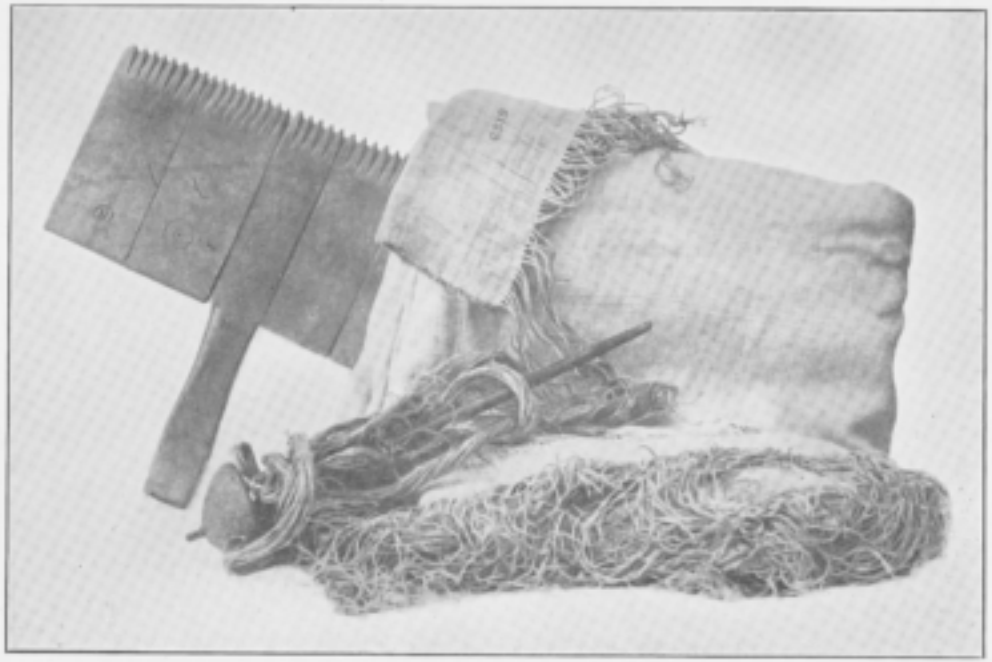


Plate II.—Ancient Egyptian Weaving, 2,000 B.C. and later. The heavy comb shown was used for beating the wool together.

See page 3.

British Museum, London.

Flax and its Preparation

The valuable portions of the flax plant are the dark brown seeds, usually called *linseed*, and the inner fibres of the stems, which by a severe course of treatment become linen thread. After the flax has been pulled up by the roots the seeds are first shaken out. The plants are then made up into small bundles and immersed in water until they begin to ferment. As soon as the fermentation has begun they are taken out of the water and allowed to dry in the open air. This process is called *retting*, and when it is complete the leaves and outside membrane of the stem are easily removed. The roots and small stems are next cut away, and the main stems are then ready for the next operation, called *skutching*. The purpose of the skutching process is to thoroughly clear away all remains of the outer membrane and the short, useless veins of the leaves, and to straighten out the inner fibres and lay them all in

FIG. 1
Flax Plant

one direction ready for twisting into thread. Sharp toothed combs of various sizes are used for this

FIG. 2.—Stripping Hemp in Burgundy.

skutching, coarse ones at first and finer ones afterwards. The fibres are finally made up into convenient bundles. By this process the filaments of

the flax are thoroughly cleaned and separated, and converted into a fine, silky kind of tow. This, in brief, is the manner in which the best flax is prepared for the linen thread of to-day, and there is evidence to show that it was in just such a manner that the flax was prepared for the thread of the state robe of "fine linen" given by Pharaoh to Joseph in ancient Egypt as a mark of his royal favour.

Flax and its Preparation

The down of the cotton plant and the fleece of the sheep need much less preparation than the fibre of the flax. The former only have to be cleaned and the fibre cleared by the process of *carding*, which will presently be explained, and the cotton or wool is ready to be operated upon by the *spinster* who makes it into thread.

The Preparation of Cotton and Wool

Silk is produced ready spun by the silkworm in a continuous double thread, and only requires to be unwound from the cocoon, as the case is called which the caterpillar twists and winds curiously around itself when ready to change into the chrysalis form. When unwound the cocoon is found to consist of a continuous double thread of silk about one thousand yards in length, but of such exceeding fineness that it takes from ten to twelve hundred cocoons to weigh one pound. So fine, indeed, is the natural filament that twelve strands have to be twisted together in order to make the finest thread of silk that it is practically possible to use for weaving. The twisting and cleaning of these threads of silk is technically called *silk-throwing*, and is a most delicate and elaborate process.

Silk Thread produced by the Silk-worm ready spun

The operation of carding by hand requires the use of a pair of implements called *cards* (fig. 3A).

Carding

Fig. 3.

Fig. 3a.—Pair of Cards.

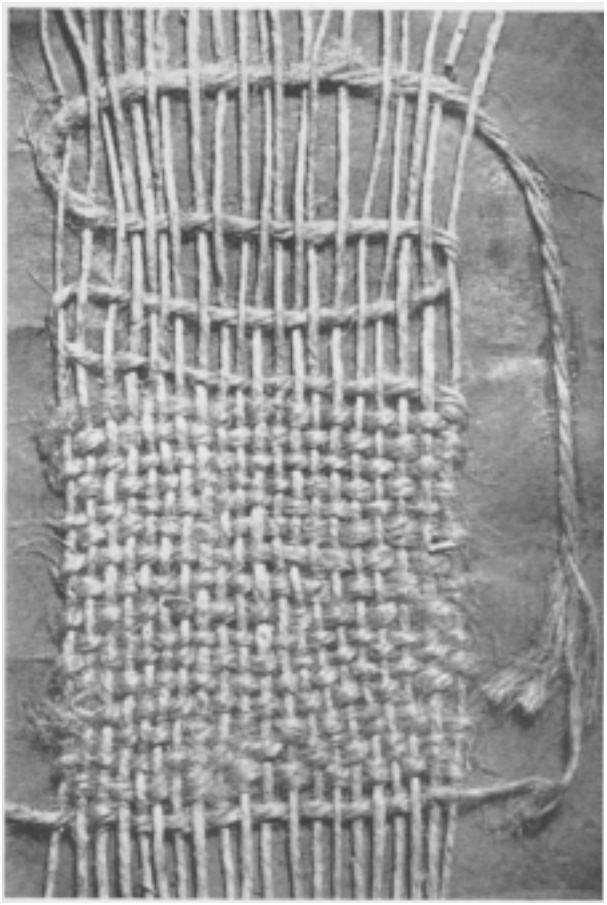


Plate III.—Illustration of Warp and Weft intersected.

See page 5.

Carding

They are made of hard wood, and each has one of its flat surfaces covered with tough leather, into which a large number of points of thin steel wire have been very strongly and evenly fixed. A small quantity of clean cotton down or fleecy wool is spread as evenly as possible on the steel points of one card. This card is then held by the handle, with the points upward, in the left hand of the operator, who sits to the work and rests the implement flat upon her knee. The other card is then taken in the right hand, and its points pressed firmly down upon the fibre to be carded. The right-hand card is then drawn smartly over the left-hand one in the direction shown in fig. 3, which movement tears the fibres apart and straightens them out. When this action has been repeated a few times the straightened fibres will be found lightly attached to one edge of the lower card. They can then be transferred to the smooth back of the other card, and with a few deft taps of the back edge of the one from which they were taken, may be made to assume the curled shape shown at the foot of fig. 3A. When it has been worked into this neatly curled form the carding is ready to be drawn out and twisted into thread.

Spinning

Spinning, as its name denotes, is the process by which the short filaments that have been separated and combed into order by the carder or skutcher, are drawn out and joined by being twisted or spun together into a continuous thread, or *yarn*. This yarn can be spun to an astonishing degree of fineness. The finest ever known to be made was spun by machinery and shown at the great Exhibition

Spinning

of 1851. It was a cotton yarn, and a single pound of it, it was said, would measure one thousand and twenty-six miles in length. This yarn was only made for exhibition, and was of no practical use. The finest cotton yarn used in weaving is spun by machinery, and *runs*, as it is called, three hundred miles to the pound weight. Needless to say, the ancient method of spinning by hand could never produce a thousand miles of thread from a single pound of cotton, but the hand-spinners of India spin, for use in the Dacca muslin industry, one pound of cotton fibre into a length of thread which measures two hundred miles. The Eastern spinners can also spin wool or flax into yarn of a hundred miles to the pound weight. These figures have been approached if not quite reached by good spinsters of Europe.

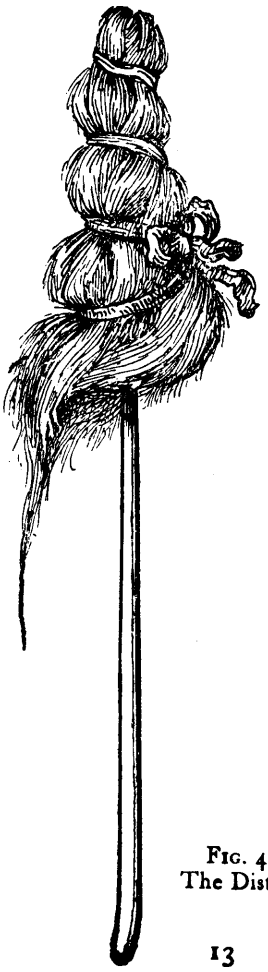
Spinning with Distaff and Spindle

The figure of a spinster (plate v) is copied from a painting on a Greek vase preserved in the British Museum. It gives a fairly good general idea of the method of spinning by the primitive means, viz., by the use of the *distaff and spindle*. It is not wise, however, to put much faith in the details of ancient pictures of this kind, as we shall have occasion to notice particularly when we come to consider the representations of ancient looms. Artists and poets, in ancient times, seem to have been content if they succeeded in conveying a general impression of a figure or scene they intended to represent, without much regard to accuracy of detail. In this case the graceful figure is holding up a stick, the distaff, on which a tightly wound ball of thread is fixed; and at the end of the thread, which passes through the right hand of the figure,

a spindle is turning. All that we can learn from this figure is that the distaff and spindle were used in ancient Greece for the purpose of making thread, but neither the details of the process of spinning are explained nor is the position or action of the figure suitable for the work. When only the distaff and spindle are used for spinning, the distaff is usually fixed under the spinster's left arm, so that the prepared flax, loosely wound upon its end, may project in front of her. By this method of fixing the distaff the hands of the spinster are both left free, the one to twist the thread and the other to keep the spindle duly rotating.

The *distaff* (fig. 4) is simply a round stick of wood about fifteen or eighteen inches in length, at one end of which the flax, or other raw material prepared for spinning, is loosely wound in such a way that

Spinning with Distaff and Spindle



The Distaff

FIG. 4
The Distaff

The Distaff

Fig. 5.—Spinning with Distaff and Spindle.

the fibres can be readily drawn out and twisted together by the spinster. The distaff is sometimes, although not generally, used for cotton and wool—these are for the most part spun from the cardings, which are joined on as required ; but the distaff is always used for the spinning of flax. When the distaff is fitted up, or the cardings ready to the spinster's hand, she deftly draws out a few filaments, sufficient, in her judgment, for the thickness of the thread required, and gradually twists them into an even thread without detaching them from the distaff or carding. When a sufficient length of thread is thus twisted it is attached to the spindle, which is then made to revolve, and as it spins it assists in evenly twisting the gradually drawn out thread. As the length of thread increases, the twisted yarn is wound upon the spindle from time to time, until it is conveniently full ; then the thread is cut, and a fresh spindle attached in place of the full one (fig. 5).

The spindle (fig. 6) is simply a slender metal or hardwood rod, from six to ten inches in length, having at one end, or in the centre, a round weight, and at the other end a hook, or notch, for the purpose of holding it in a vertical position

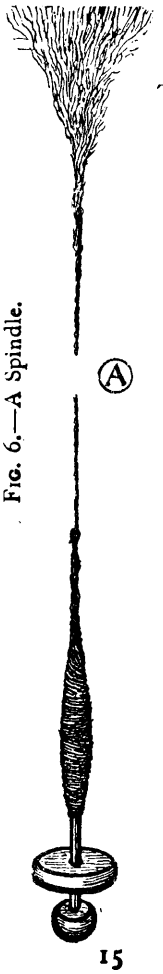


FIG. 6.—A Spindle.

The Spindle

FIG. 7.—Spinning with Wheel.

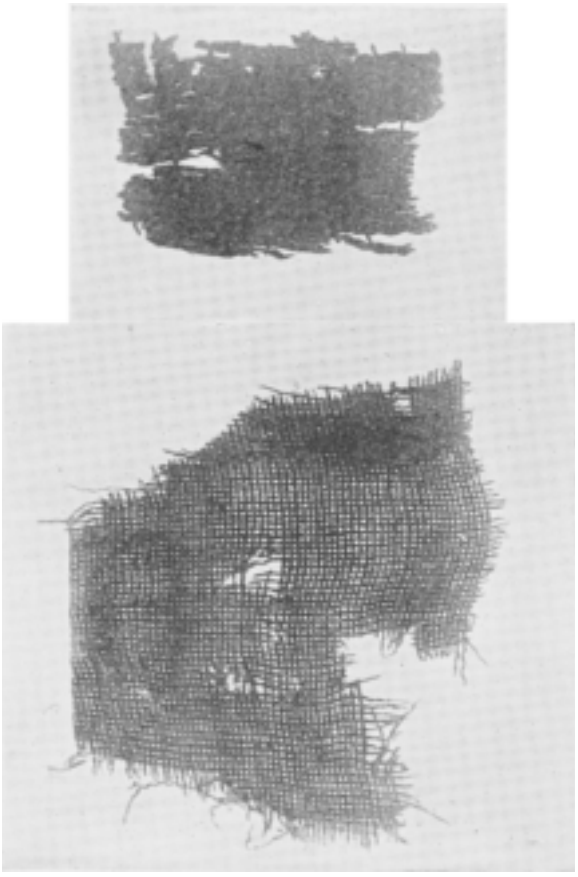


Plate IV.—Fragments of Linen Cloth, woven by the Prehistoric Lake-dwellers of Switzerland.

See page 6. *British Museum, London.*

Plate V.—Figure of a Spinster. Vase Painting of Ancient Greece, 500 B.C.

See page 12.

British Museum, London.

when the thread is attached to it. Spindles are of various weights and dimensions, according to the size of the yarn for the spinning of which they are used. Plate VI shows ancient spindles preserved in the British Museum. The Spindle

This method of spinning with these simple appliances, the distaff and spindle, seems to have been universal. It is still used by primitive peoples, and the best, strongest, and most durable thread is even now produced by its means. The method also illustrates perfectly the essential principles of the making of all thread. The use of machinery for spinning, whether it be only the simple, picturesque, mediæval spinning wheel (see fig. 7), or the elaborate machinery of the cotton-spinning industry of the nineteenth century, did not alter the principles of the process in the least. These only enabled the work to be carried out with increased speed and with greater exactness of result.

CHAPTER II

THE INDISPENSABLE APPLIANCES FOR SIMPLE WEAVING

The Origin of the Loom—Looms in Ancient Art and Literature—Egyptian and Greek Looms—The Essential Part of the Loom—The Cross in the Warp—The Simplest Practical Loom—Demonstration of the Cross—Special Need for the Cross in Long Warps of many Threads—Preparation of the Warp—Ancient Warping—A Simple Method of Warping for Domestic Looms.

Origin of the Loom

THE weaving of mats and baskets from natural grasses and rushes can, of course, be manipulated without the use of any special appliance for holding or stretching the materials whilst in working. But as soon as pliant thread has to be woven, and any considerable length of web is required, it becomes necessary to devise some kind of frame to hold and stretch the warp threads upon, so that the weft may be readily interlaced with them. The more or less elaborate frame constructed for this purpose, with the properly arranged warp mounted on it, together with the various contrivances added from time to time by the weaver's ingenuity, has by universal consent been called a *loom*.

The representations of looms in ancient sculp-

tures, paintings and drawings, are exceedingly scarce, and what few there are, are for the most part so incomplete, not to say incorrect, in detail, that it is difficult for the most expert weaver to see how they could have been used effectively. Textile art seems to have been a more attractive and interesting subject to the ancient poets than to the artists, as their allusions to the loom, the needle and the various operations of weaving and needlework are frequent and interesting, and prove beyond doubt that the weaver's and embroiderer's occupations were held in very high estimation and were very extensively practised in the ancient world. These literary allusions to the loom and to textile art will be considered in a subsequent chapter, but a reference to the available pictorial representations is necessary at this point.

The Loom in Ancient Art and Literature

The most ancient illustrations of looms and weaving are to be found amongst the wall-paintings in a tomb at Beni Hasan, in Egypt. Fig. 8 represents a warp apparently stretched on the ground, and a figure in an impossible attitude weaving what may be supposed to be a mat. Fig. 9 shows an upright frame having a few threads fixed to it, at which two women are working. One of the women may be presumed to be introducing the weft between the warp threads, and the other beating it together. A later Egyptian painting represents a loom of more elaborate construction (fig. 10). This painting is at Thebes, and shows a weaver very actively at work at an upright frame, on which he is evidently weaving cloth by means of a stick having a hook at its end. No threads, however, in this instance are shown, either of warp or weft. These are all the instances

Egyptian Looms

Egyptian Looms

at present discovered of representations of Egyptian looms, except that there is a kind of hieroglyphic on a sarcophagus of an early period which is supposed to stand as a sign for a loom, or weaving. The scarcity of these pictorial records is remarkable when we consider that Egypt was the seat of a great

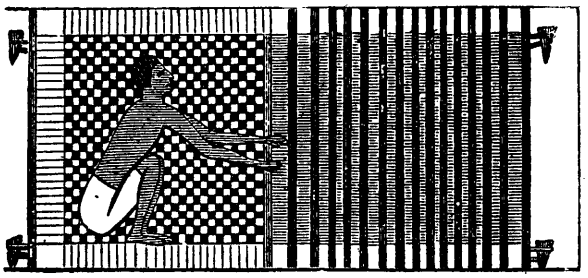


Fig. 8.—Egyptian Loom.

linen-weaving industry, which not only supplied the large domestic market with woven materials, but was famous throughout the ancient world for the manufacture of "fine linen," and exported great quantities of it to contemporary nations with whom the Egyptians traded.

Although in ancient Greece and Rome weaving was a common domestic occupation universally practised, as we gather from many classic literary allusions, drawings or other representations of looms seem to be even more rare than are those of Egypt.

Greek Looms

It appears that only in two Greek vase-paintings is there anything of the kind to be found. One of these (fig. 11) represents the loom of Penelope, and the other that of Circe (fig. 12). They are

both upright looms, and differ from those of Egypt in that the warp strings are stretched by means of a weight being hung on each separate string, instead of the threads being tightly stretched all together on the frame, as were those of Egypt.

Greek Looms

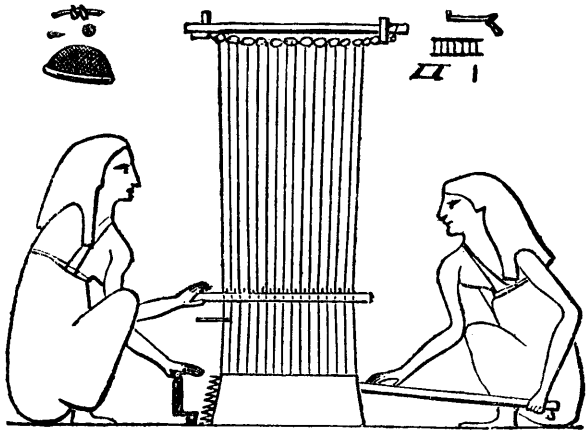


FIG. 9.—Egyptian Loom.

There are a few other ancient drawings extant, purporting to be of Roman looms, but these are absolutely unreliable, as they are from Byzantine and Eastern manuscripts of later periods, and only show the kind of weaving appliances in use at the time when, and in the places where the drawings were made. In all these ancient pictures of looms the artists have shown the stretched threads of the warp, and suggest the insertion of the weft thread. We can also gather that, owing to the

What may be learned from Ancient Pictures of Looms

different methods of stretching the warp peculiar to Egypt and Greece, the Egyptians beat the weft together down from *above*, whilst the Greeks beat

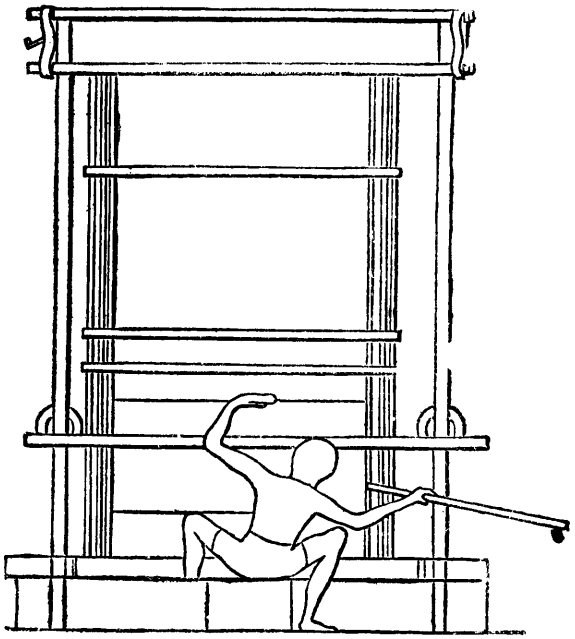


FIG. 10.—Egyptian Loom.

theirs up from *below*. This is an important difference, and was noticed by the Greek historian Herodotus when he visited Egypt. Beyond these meagre details we can learn nothing definitely from the ancient pictures. We may conjecture and

argue, as learned authors and antiquarians are constantly doing, as to the methods by which the ancient weavers obtained the fine results which they certainly did, but the pictures are no help in the matter to anything beyond conjecture. It is

What may be learned from Ancient Pictures of Looms

FIG. 11.—Greek Loom.

remarkable that all the artists have neglected to observe and show one simple but universal and indispensable contrivance used in weaving, the ONE thing we know must have been there, and without which no loom, however simple or complicated, could be set to work or kept in order by the weaver.

By means of fig. 13 the nature and value of this simple but essential part of the loom can be readily explained. The figure represents a board, which may

The Essential Part of a Loom

The Essential Part of a Loom

be of any convenient size; for the present purpose we will say it is four inches wide by sixteen inches long. The construction is shown at no. 1. At the ends A, a and b, B a piece of beading, having a rounded edge, is fixed. The beadings are four and a half inches long, so that when fixed on the ends of the board they project slightly beyond its edges. No. 2, is a section of the board, showing the position of the rounded edges of the beadings. This

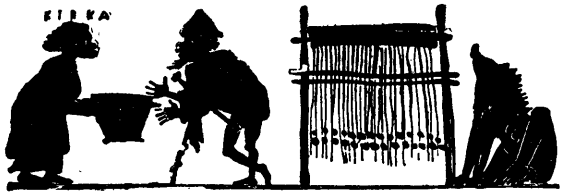


Fig. 12.—Greek Loom.

The Simplest Loom

board, when fitted up with a warp, is perhaps the simplest possible form of loom. But notwithstanding its simplicity many beautiful and ingenious narrow webs suitable for braiding and other trimmings may be made on it, as will be shown in a subsequent chapter. At no. 3, the board has a string wound upon it lengthwise. In this case it is wound so as to make a warp of nine strings, but these may be of any number possible to the width of the board. Before the string is wound on to the board a loop is made at its end, which is caught on to the projecting end of the beading at A, no. 2. The string being looped on to the beading, the winding proceeds, and when the desired number of strings is complete the string is carried down the back and tied to the other

Practical Demonstration of the Cross in the Warp

projecting end of the beading B. At no. 4, the strings on the board are shown intersected by the two rods C, in such a way that alternate strings go over and under each rod. In the space between the rods, the alternate strings cross each other in regular succession. This cross is clearly shown in the diagram between

Practical Demonstration of the Cross in the Warp

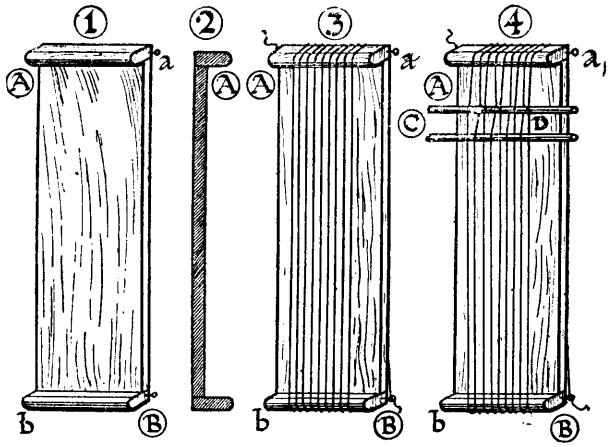


FIG. 13.—Cross in the Warp.

the points marked C, D. It will now be understood that whilst the rods C, are kept in their position in the warp, it is impossible for the threads to get out of place or to get hopelessly entangled, as they otherwise would certainly do. This cross in the warp, sometimes called the *lease*, is really the one indispensable part of the loom. It is no doubt prehistoric, and is universally used in weaving. All other parts and appliances of the loom may vary,

The Cross in the Warp

and be of either the most complicated and elaborate or of the rudest possible description, but this simple yet perfect contrivance for keeping the warped threads in order cannot be dispensed with, and is never likely to be superseded.

Special Need of Cross in Long Warps of many Threads

The difficulty of keeping the warp from getting entangled when only a few threads are used in it, and when the finished work is not required to be longer than the loom itself, is not so very apparent. But when in place of the fixed bars, or other limits between which the warp is stretched, rollers are used, and it is desired to make several yards of material, and, added to this, the warp is to consist of a great number of fine threads, the difficulty, it is clear, will be considerably increased, and, but for the contrivance of the crossing of the alternate threads of the warp, as described above, would be found to be insurmountable. This would especially be the case with warps many yards in length, consisting as they often do of several hundreds of threads of fine linen, cotton, or wool, or, it may be, of several thousands of threads of fine silk.

Preparation of the Warp

A length of warp much longer than the loom itself cannot, of course, be prepared upon it, as a short one may readily be. This being the case, some contrivance has to be resorted to in order to build up a series of threads of exactly the required number, and of the length determined upon; and not only this, but to keep the threads as nearly as possible at the same tension, so that when transferred to the loom and stretched between its front and back rollers they shall give the weaver as little trouble as possible with loose and uneven threads. This process of preparing the threads for the loom

is, obviously, called *warping*, and is a very important one, requiring great exactness and care in the doing—as, indeed, may be said of all the operations connected with weaving, from beginning to end.

Preparation of the Warp

The ancient method of warping, a method that is still practised in India, where weaving as a simple domestic art still survives, is as follows. A row of sticks in pairs, fixed upright in the ground, is set out, of the required length. The warper, holding two reels of thread, in such a way that they will readily unwind, ties the thread to the first pair of sticks, and then passes along the line from end to end, backwards and forwards, crossing the threads at each pair of sticks, in order to keep the tension even. When he has the required number of threads piled upon the sticks, he inserts a cord in the place of the last pair but one, at both ends of the row, tying it up securely so that it cannot slip out of the cross. Finally he binds the warp firmly together at both ends, looses it from the sticks, and winds it upon a hand-stick, or rolls it into a ball convenient for carrying it to the loom and turning it on to the rollers.

Ancient Warping

A more compact and convenient, though similar, method of warping to the ancient one, is by means of a board fitted up with a number of pegs, in place of the row of sticks planted in the ground. As this is a very easy and effective way of warping a moderate number of threads, such as would be required for a domestic loom, and at the same time perfectly illustrates the principles of warping, which it is necessary for the student of weaving to understand clearly and definitely once for all, it will be well in the next chapter to carefully describe it and demonstrate its use.

A Simple Method of Warping

CHAPTER III

THE WARPING BOARD

The Warping Board—The Necessity for Strength in all Weaving Appliances—The Warping Board in Use—Securing the Crosses in the Warp—Warping Several Threads at Once—The Reel- or Bobbin-carrier, and its Use in connection with the Warping Board—The Portee Cross—Taking off the Warp—The Hand-stick.

The Warping Board

THE board with its arrangement of pegs for warping is shown in fig. 14, nos. 1, 2, and 3. It may be of any convenient size, according to the place where it is fitted up, but it should not be less than six feet long by one foot broad, and it must hang firmly on a wall at such a height from the ground that the operator can reach to any part of it without difficulty. On a board of the size indicated a warp of ten yards in length, and of any reasonable number of threads, can quite easily be warped. A longer length may be warped either by increasing the length of the board or by increasing its width and adding to the number of pegs with which it is furnished. One peg added below each of the pegs 2, 3, and 4, will add four yards to the length possible to be warped on the board. The pegs, indicated by the letters and

numerals, must not be less than six inches long, and not more than nine inches in projection from the surface of the board. The pegs must be made of

The Warping Board

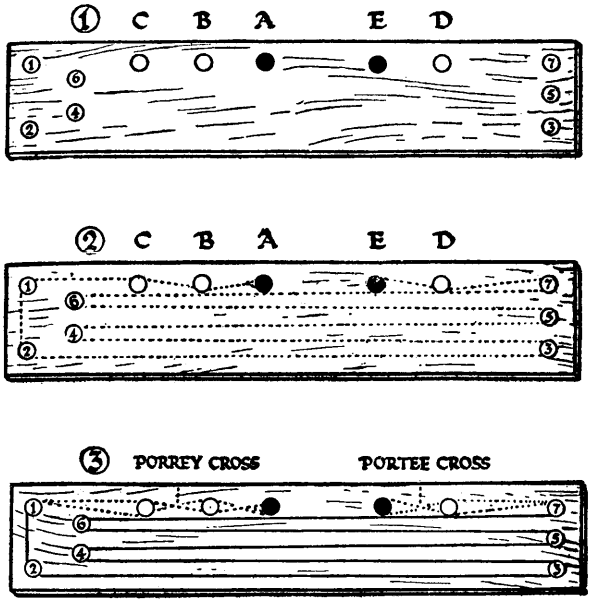


Fig. 14.—Warping Board.

hard wood, not less than one inch in diameter, as they have to bear a great strain when some hundreds of threads are stretched upon them, and they must be well made, be perfectly smooth and have nicely rounded ends. The board itself must also

The Warping Board

be strong and smoothly finished, and must not be less than one inch in thickness if six feet in length, and an inch and a half, if longer. It may be remarked here—and it cannot be with too much emphasis—

Necessity for Strength in all Weaving Appliances

that, EVERY APPLIANCE CONNECTED WITH THE LOOM REQUIRES TO BE MUCH STRONGER THAN WOULD AT FIRST APPEAR NECESSARY. THE WEIGHT OF THE REPEATED BEATING OF THE WEFT TOGETHER, AND THE MULTIPLIED STRAIN OF THE MANY THREADS OF WARP, ARE MUCH GREATER THAN WOULD BE SUPPOSED. The pegs marked A and E, and filled in solid black, must be movable, but all the others should be firmly fixed in the board. The space between the pegs A and B must not be less than one foot, and the space between B and C six inches. The space between pegs D and E should also be one foot.

The Board in Use

The board being ready and fixed in its place on a wall, we may now proceed to use it. We will suppose that we require quite a small warp, of say twenty threads, ten yards long. We take a reel of thread and, placing it on a short rod of thick wire, in order that it may turn freely, we begin operations by tying one end of the thread to the movable peg A (no. 2, fig. 14). Now, holding the wire with the reel on it in our left hand, with our right hand we guide the thread *under* peg B and *over* peg C. Then, following the dotted line shown, we carefully guide the thread outside pegs 1, 2, and 3 back to peg 4, then to pegs 5, 6, and 7 in succession until it reaches peg D, which it goes *under*. The thread must now be carried *over* and *under* peg E, and thus begin its return. Before returning, however, it will be well to compare the

thread on the board with the dotted line of the drawing, in order to make sure that we have exactly followed in its course. Having ascertained that all is well, we may now carry the thread *over* D on to peg 7, and so back in the same course till we again reach peg 1. Having carried the thread over peg 1, it must be taken *below* C over B and arrive *below* A; this will complete one course. We have now warped two threads, and the warping board should be as represented at no. 3, with the threads crossed between pegs B and C, and D and E. Taking into consideration the size of the board, it is clear that we have warped two threads of a length of ten yards between the two crosses. The second thread being carried round and over peg A, goes *under* B, following exactly the course of the first thread, and duly arrives at E; then, following the second thread back, it reaches A, goes under and over the peg, and four threads, out of the twenty required, are warped. By the time ten forward and ten backward journeys are made our sample warp of twenty threads will be finished, and may be removed from the board as soon as the crosses we have taken so much trouble to make are secured. This important matter of securing the crosses is easily done, but if forgotten, and the warp be removed from the board, it will be irretrievably spoiled, especially if it consists of a great number of fine threads. Not only the labour, but the thread itself will be wasted. Fig. 15 will make clear the method of operation. The letters A, B, C, D, and E, are the pegs of the warping board. The thick lines are the threads of a warp, which may be of any number, large or small.

The Board in Use

Securing the Crosses

Securing the Crosses in the Warp

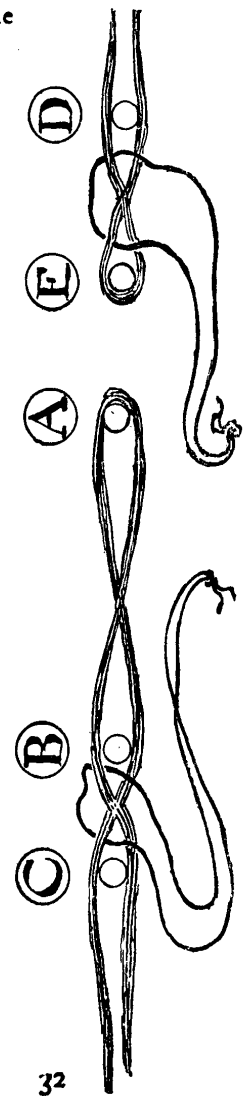


FIG. 15.—Method of securing the Crosses in Warps.

Between C and B, and D and E, are the two important crossing places of the alternate threads. The thin lines represent two pieces of strong, pliable cord, each about two yards long, which have been inserted from the front in the openings of the warp made by the pegs C and E. These cords have then been passed between the first thread and the board, and brought through from the back in the openings made by the pegs B and D. The ends of the cords have been firmly tied together, and by their means the cross is perfectly secured, whatever may happen to the warp. It will be noticed that there is another cross in the warp between pegs B and A, but this is not so important. It is useful, however, to pass a short cord through the loop at peg A and tie the threads all together. If our small warp of twenty threads were now taken off the board and the cords which secure the crosses stretched out, the two ends of the warp would be represented by fig. 16.

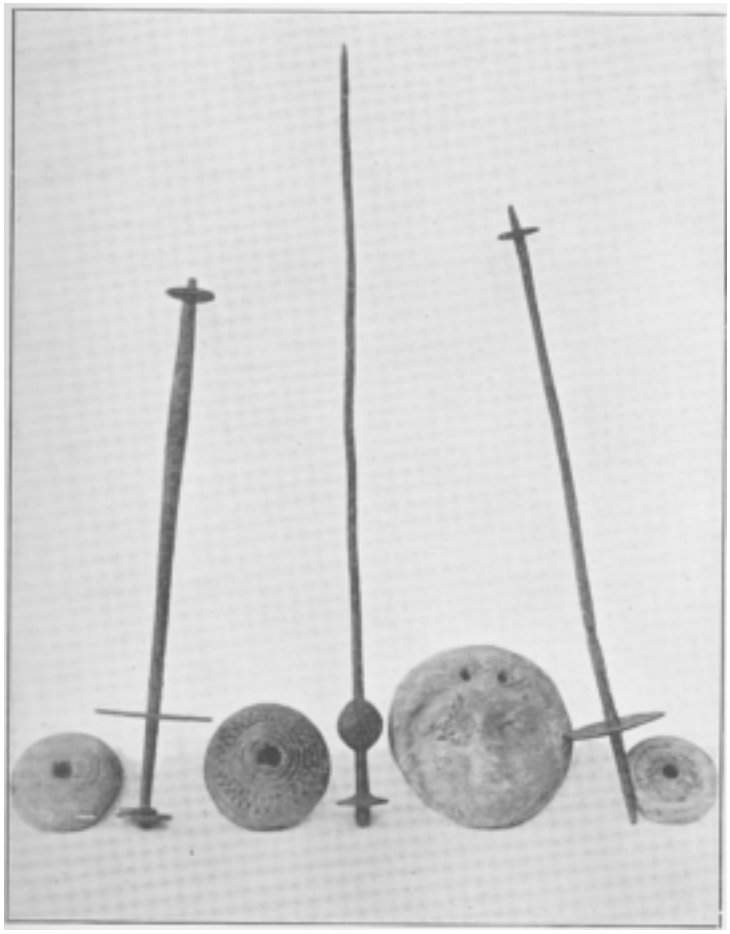


Plate VI.—Spindles, Whorls, and Loom Weights, Ancient Greece.

See page 13.

British Museum, London.

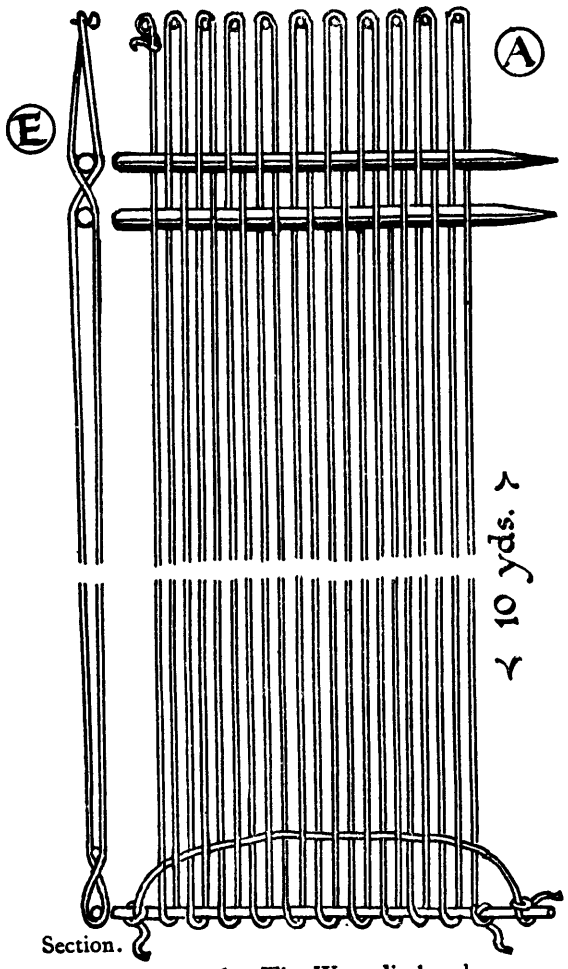


FIG. 16.—The Warp displayed.

To warp several Threads at once.

It would be a very tedious proceeding to warp a great number of threads, one at a time, and it was only suggested as advisable to do so in order that the principle of warping might be made clear. Eight threads can quite easily be warped together, so that when the warper has carried them once from the peg A to peg E and back again, sixteen

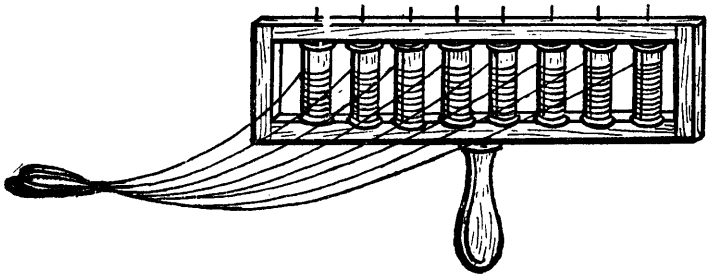


Fig. 17.—Bobbin-carrier.

threads will be placed in order. To effect this saving of time and labour we must use a *reel- or bobbin-carrier* (fig. 17). The bobbin-carrier is an oblong frame, in which there is room for eight bobbins to stand and turn, when they are fitted up with wires for the purpose. A convenient handle for holding the frame is firmly fixed to it at the bottom. The top of the frame is pierced with eight holes, and in the bottom, corresponding holes are drilled about half through the thickness of the wood, so as to fix the eight wires and not allow them to fall through. The wires are passed through the top

The Bobbin-carrier.

edge of the frame, through the bobbins, and are then caught and fixed by the holes in the bottom edge. As the frame is held upright, the weight of the bobbins standing in the frame will be found to give the tension to the thread which is required for warping. When placing the reels in the carrier care must be taken so to fix them that the threads all unwind on

The Bobbin-carrier

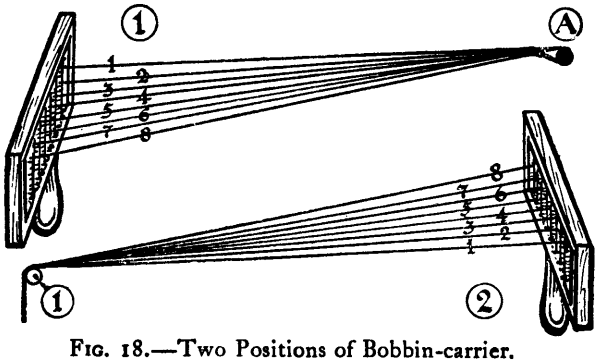


FIG. 18.—Two Positions of Bobbin-carrier.

the same side, and cause all the reels to revolve in the same direction.

Having got the bobbins properly set up, the ends of the threads must be gathered together and tied in a convenient way for fixing on to peg A of the warping board (fig. 14). The threads being fixed to the peg A, no. 1, fig. 18, and the carrier held in the left hand of the warper, in an upright position, it must be taken past the pegs B and C and held there a little above their level, so that the threads are well separated and taut. Then with the first finger and thumb of the right

The Bobbin-carrier

hand the warper must pick out and draw downwards the second, fourth, sixth, and eighth threads, as numbered in no. 1, fig. 18, and place them *below* peg B in the same position as the first thread in the warp of ten was placed. This will leave threads 1, 3, 5 and 7, above the peg. Again tightening the threads by a slight further movement of the carrier, taking care that they do not slip off peg B, the first, third, fifth, and seventh threads must be picked out and pulled downwards so as to place them *below* peg C, leaving threads 2, 4, 6, and 8 above it. It will now be found that we have a crossing of alternate threads between pegs B and C. After making quite sure that the crossing is correct, the eight threads must be grasped by the right hand of the warper and carried steadily round the seven pegs in exactly the same course as the single thread was carried when guided by the dotted line, no. 2, fig. 14. After having traversed the seven pegs the carrier arrives at the peg D. It is not necessary to take a cross of single threads here, as at B, C, but altogether, the eight threads must be taken *below* peg D, *over* and *under* peg E, then *over* peg D, and so back again the whole round to peg 1. When arriving at peg 1 the carrier must be transferred to the right hand, without twisting the threads, so as to leave the left hand free to manipulate the return cross between pegs C and B. The position of the carrier and threads is now represented at no. 2, fig. 18, and the threads marked 1, 3, 5, and 7 must be pulled down and placed *below* peg C, leaving threads 2, 4, 6, and 8 above it. Again with a slight movement, the threads must be tightened, and

threads 2, 4, 6, and 8 placed below peg B, leaving threads 1, 3, 5, and 7 above it. The crosses are now complete, and it only remains to take the group of eight threads *below* and *over* peg A in order to finish the first PORTEE, as such a collection of threads warped in one round is called. The use of the portee cross (no. 3, fig. 14) will be explained later on. Before beginning the second round it will be well to examine the threads between pegs C and B in order to make sure that the sixteen threads are all "in the cross" in proper succession, as they will certainly be found to be if the above directions have been accurately followed. After a little careful practice it will be found that, the portee of eight threads can be warped in the same time as that taken for warping one thread. As soon as a few portees have been warped it will be found difficult to remember how many threads are gathered together on the pegs, so it becomes necessary to use some contrivance for readily counting them, in order that we may know exactly when the warp is finished. This account can be quite easily kept if half a yard of narrow tape or coloured cord be attached to the top edge of the warping board above the portee cross (no. 3, fig. 14). The tape has to be turned back until five portees have been made; then it must be allowed to hang over the front until five more have been built up, and so on, forward or backward, after every fifth portee. By this means the number of portees can at any time be counted. Thus, five portees of sixteen threads contain eighty threads, and these multiplied by the number of fives warped will give the total number of threads reached. The warp, of any required number of portees, being

The Bobbin-carrier

The Portee Cross

Keeping Account of the Number of Threads warped

Taking off the Warp

finished and the crosses secured, as directed at p. 32, it may be taken off the board and wound on to a stick, for convenience in transferring it to the loom. For reasons which will afterwards be explained, it is necessary in winding on to a handstick, to begin at the beginning of the warp, peg A, fig. 14; this will leave the portee cross

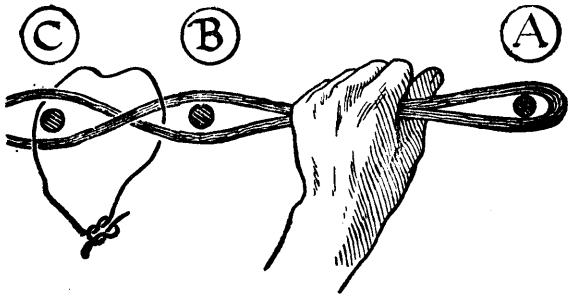


Fig. 19.—Taking off the Warp.

outside when the warp is all wound on to the stick. The handstick should be a short round stick, smoothly finished and with rounded ends, in size about an inch and a half in diameter by eighteen inches long. This being ready, the warp must be firmly held by the left hand of the warper at the point shown in fig. 19. The peg A is then to be removed and the loop of warp taken in the right hand, the fingers being thrust through it. The loop being securely held, the left hand is free to remove the warp from pegs C and B and from peg 1. The cross having been previously secured, the loop between A and B may be made of a

convenient length for the next operation, which a careful study of figs. 21 and 21A will make quite clear, so that it needs no verbal description. It may be remarked that the loop shown in this figure is a most useful one, and is much used in the fitting up of looms; it should therefore be well mastered once for all. The loop having been formed, the handstick must be inserted and the loop tightened as indicated in the bottom compartment

Taking off the Warp

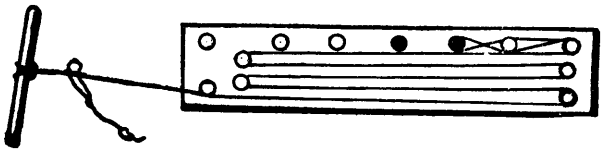


FIG. 20.—Handstick and Warp off Pegs A, B, C, and 1, 2 of Warping Board.

of fig. 21A. The warp looped on to the handstick ready for winding off the pegs is shown at fig. 20. It may be found advisable to enlist the help of an assistant in taking off the warp, especially to hold it at the pegs and prevent its coming off too freely. The warp may now be gradually and firmly wound upon the stick, care being taken to start the winding in the direction of the arrow, bottom compartment, fig. 21A. If wound in this direction the warp will not slip round the stick or come loose. When the portee cross is reached the warp may be taken off the pegs D and E, carried away and kept quite safely till the loom is ready to receive it.

Forming the Loop

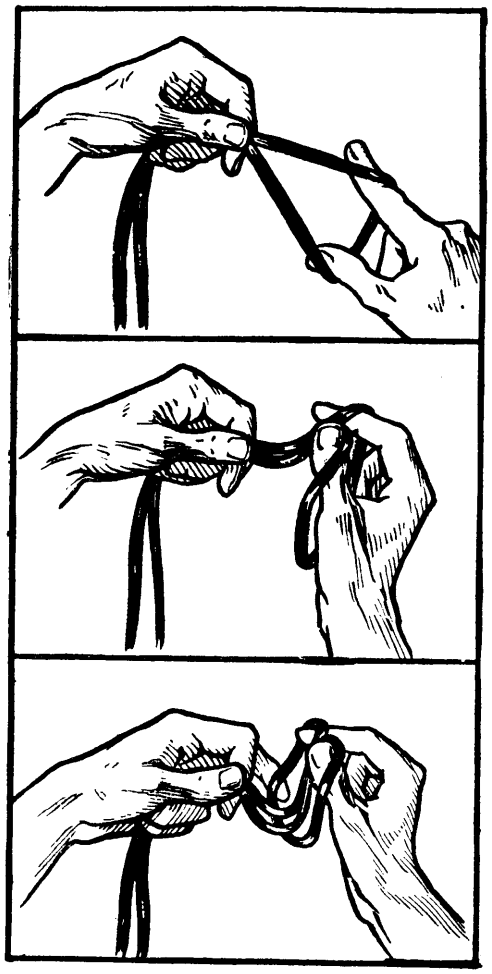
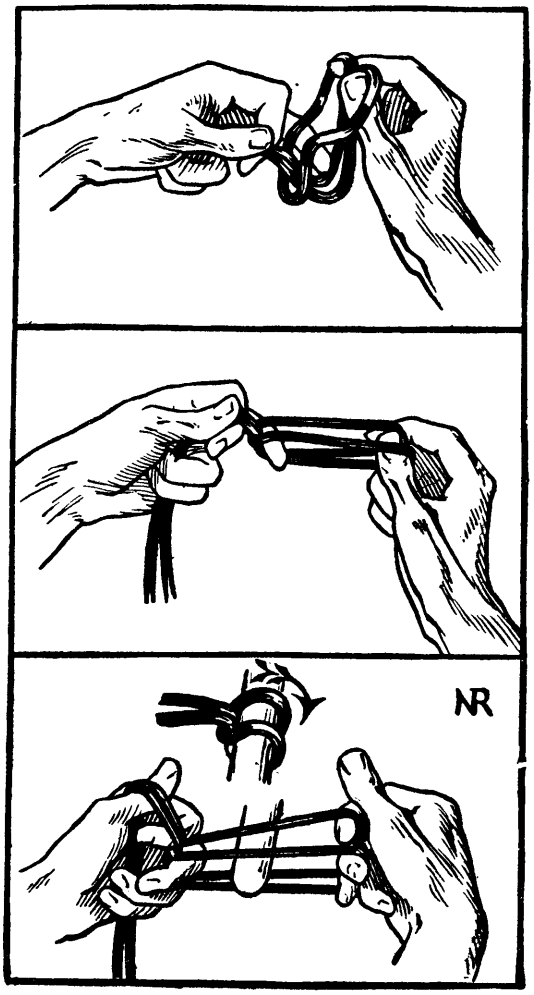


Fig. 21.—Making the Weaver's most useful Loop.



Forming the Loop

FIG. 21A.

CHAPTER IV

THE WARPING MILL

The Warping Mill necessary for Long, Full Warps—Description of the Warping Mill for Silk-weaving—The Bobbin Frame—The Heck-block—Demonstration of spreading a Warp—Regulating the Length of Warps—The Heck—The Gatherer—The Count and Length of Warps; how calculated—Threading the Heck—Beginning a Warp—Taking the Cross—The Rachet and Wheel of the Heck-block—Mending Threads.

The Warping Mill necessary for Long Full Warps

ALTHOUGH the warping board described in the last chapter is very useful for small warps of moderate length, such as would be used in a domestic loom, it would not be convenient for very long warps, or accurate enough for warping several thousands of fine silk threads. For such warps as these a warping mill is necessary, on which, if need be, as many as twenty thousand threads can be made into a warp of a hundred yards in length.

Description of the Warping Mill for Silk-weaving

The warping mill now to be described is of the kind used in conjunction with the silk-weaving draw-looms of the seventeenth, eighteenth, and part of the nineteenth centuries. It is perfectly adapted to its purpose, and, like the draw-loom itself, was the result of centuries of gradual development.

The warping mill, fig. 22, is made entirely of hard,

tough wood, perfectly smooth and strongly fitted together. Its chief feature is a large skeleton reel, AAAA, generally five yards in circumference, though sometimes seven and a half yards, and about two yards long. The reel has an axle, B, which has a long iron pin at each end, shown plainly at no. 2. A strong frame, consisting of two uprights, C, C, and two cross-pieces, D, D, is very firmly fixed up, and in the centre of the bottom cross-piece there is a socket to receive the iron pin, E, of the axle when the reel is set on end in its place, as in the diagram. The reel is kept in an upright position by the pin F, which passes through the upper cross-piece and terminates about ten inches above it. This arrangement allows the skeleton reel to turn freely on its axle. A grooved wheel, G, is strongly screwed to the end of the axle where the pin E enters it, and another wheel, H, also grooved, is attached to a handle which can be turned by the warper, who sits on the seat I. The seat I is movable, and may be placed in any convenient position, being kept there by heavy weights, J. The grooved wheels G and H are connected by a continuous cord, as indicated in the ground-plan, no. 3. It is now obvious that the warping reel may be turned at any required speed, and in either direction, by means of the handle K.

The front upright of the frame, C, is divided into two for the greater part of its length, and a solid block of wood, L, is fitted to it, so that it can slide up and down the frame opposite to any part of the reel. Fig. 23, which is an enlargement of the sliding block, will explain this mechanism. Between the uprights a pulley, M, is attached

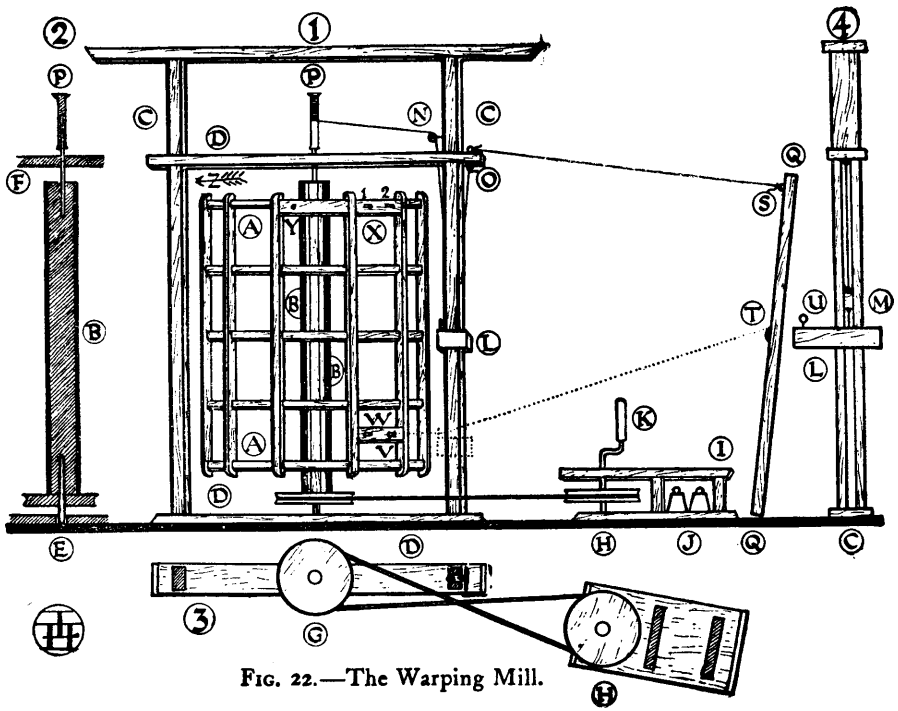


Fig. 22.—The Warping Mill.

to the top of the block. At the top of the frame (fig. 22, no. 1) is another pulley, N, and a strong

The Warping Mill

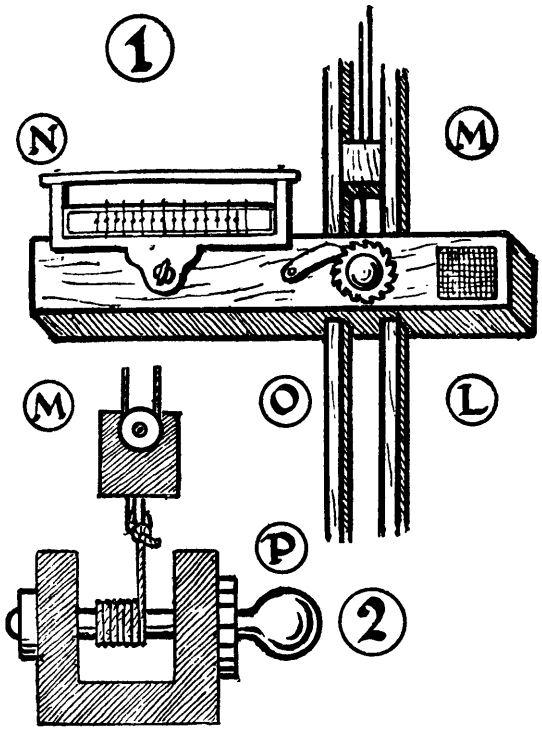


FIG. 23.—The Heck-block.

staple, O. The axle-pin F, no. 2, terminates in a small cylinder, P, which fits over it and is fixed

The Warping Mill

so that it will revolve with the reel. A hole is made in the cylinder near one end, a strong, smooth cord being passed through it, and a knot tied to prevent its slipping out. This cord is next passed over the pulley N, down to the pulley M in the block, then up again to the staple O, and tied there.

The Bobbin Frame

The side elevation of a frame made to hold a large number of bobbins of silk or other thread, is shown at QQ, no. 1, fig. 22. A front view of the frame is given in fig. 24. The wires on which the reels are placed are fitted into holes drilled half through the sides of the uprights of the frame. On one side a groove of the same depth as the hole is cut, of the shape indicated at RR, so that the wire can be removed by lifting it at one end and drawing it backwards. This is necessary for changing the bobbins as they become empty. The position of the frame, in regard to the warping mill, is clearly shown in the drawing. S, fig. 22, is a strong staple screwed to the mill frame, from which a cord passes to a similar staple fixed in the centre of the bobbin frame, fig. 24, S. This cord keeps the frame from falling backwards, and at the same time allows it to be readily adjusted. The frame stands freely on the ground, inclining backwards, and the weight of the bobbins of silk, added to that of the frame itself, gives just sufficient tension to the threads when in process of warping. Before going into further details, the action of the warping mill, in so far as it has been described, must now be noticed.

The Heck-block

In the block L, figs. 22 and 23, centres the whole mechanism of the warping mill. On it the

appliance for *taking the cross* is fastened. It is also the means of spreading the warp truly and evenly upon the large reel of the mill. The apparatus for taking the cross will require careful

The Heck-block

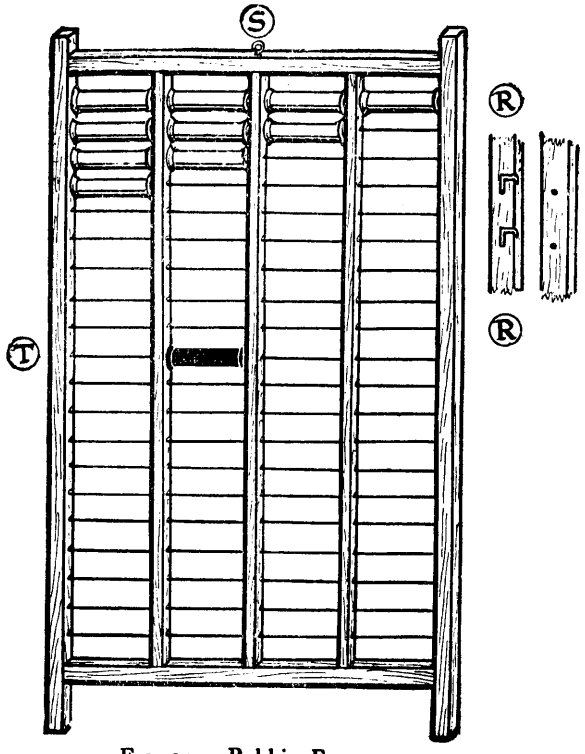


Fig. 24.—Bobbin Frame.

Demonstration of spreading a Warp

explanation of further details, but everything for spreading and regulating the warp has been described and is ready for demonstration. For this purpose a single reel of stout thread must be placed on the reel frame, fig. 24, at about the centre, T (see also no. 1, fig. 22). The dotted line passing from the reel at T, fig. 22, indicates the course of the thread. At the point in the block marked U (no. 4) a temporary screw-eye is fixed. Through this the thread is passed, and tied to one of the staves of the mill reel at V. By the turning of the handle K the mill reel will be made to revolve, winding the thread upon itself. The thread will not be wound horizontally, but rather diagonally, and will gradually rise on the reel, until it will be found, on the completion of one revolution, that the second round of thread will begin a little space above the starting point of the first, V. This is owing to the cord on which the block is suspended by the pulley M (fig. 22, no. 4) having been shortened by being wound upon the cylinder, P, at the top of the axle. The shortening of the cord has gradually raised the block L, and if the cord and cylinder are properly adjusted the block will have risen an equal distance at each revolution. Consequently the thread will be exactly distributed over the mill. Now, if the thread be fixed at the top of the reel and the handle turned backwards, the reel will revolve in the opposite direction, the cord unwind from the cylinder, the heavy block descend, and the second thread will follow exactly the same course as the first until it reaches the bottom. In the same manner, if a hundred bobbins were placed in the frame and all the threads drawn through the eye in the block and

tied together to the mill reel they would be laid and spread as easily and evenly as the single thread.

Demonstration of spreading a Warp

Again, any length of warp desired, from two yards to a hundred, can be measured and determined at the beginning, by the revolutions of the mill reel. For instance, we will suppose the block, carrying the warp, is wound to the top of the mill. This is always its position on starting. Let the warp be tied to one of the pegs on the top of the reel at X, no. 1, and the handle K turned so that the block descends. The mill being five yards round, at the end of one revolution there must be five yards of warp on it. It follows that we have only to count the convolutions on the vertical line from the starting point and multiply them by five to ascertain the length wound upon the mill reel. For instance, if twenty-five yards of warp are required, five revolutions of the reel must be completed in each direction. In order to make different lengths of warp at will, there must be provided some means of holding the threads at the beginning and end of the length required. The first and last of the pegs, five in number, shown in fig. 22, no. 1, at Y, W, and X, answer this purpose. The three pegs at the top of the mill, Y and X, are fixed in that position, as the warp always begins at the same place. The board in which pegs W are inserted, is movable, and is so made that it can be fixed by a wedge at any height on the reel between any two of the staves. The threads are first looped on to peg Y, and the mill caused to revolve in the direction of the arrow Z. When a place on the mill is reached where it is wished to terminate the warp, the peg board W is moved to the spot, the

Determining the Length of a Warp

Determining the Length of a Warp

threads are looped round the right-hand peg, and the motion of the reel reversed. As the block continues to fall and rise between the top of the mill and peg W, the threads of the warp will all be laid of an equal length.

The spaces between the rounds of thread formed by each revolution can be regulated by altering the size of the cylinder P, no. 1, fig. 22. An increase in the size of the cylinder causes the block to rise quicker. This lays the thread in a steeper diagonal and increases the space between each round. A smaller cylinder, of course, has the reverse effect.

Use of the Fixed and Movable Pegs

The pegs X, no. 1, fig. 22, correspond with the pegs B and C in the diagram of the warping board, fig. 14, and the pegs W with the pegs D and E of that appliance. The former are for use in building the cross of alternate threads at the beginning of a warp, and the latter for making and preserving the portee cross at its end.

The Heck

The next detail of the warping mill to be described is the important fitting which gives the name to the block L, fig. 23, by means of which the cross in the warp is made quite easily, however many threads are used. Fig. 25 is a representation of the HECK, which is the name given to this useful appliance. There are variously constructed hecks in use, but they are all made on the same principle. The drawing shows one of the simplest both to make and keep in repair. It consists of a strong, hardwood frame of an oblong shape, having an attachment, at the bottom, pierced with a hole, by means of which it is firmly fastened with a thumb-screw to the heck-block, as at N, fig. 23. On

the inside, at both ends, the heck frame is grooved (B, fig. 25), and two smaller frames are fitted into the grooves loosely enough to be easily moved up and down in them separately or together. Tied

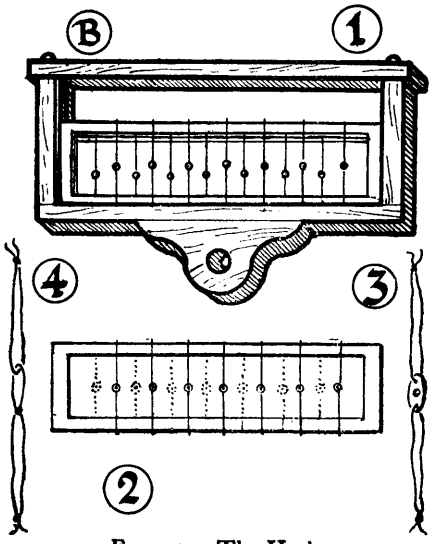


Fig. 25.—The Heck.

at regular intervals on the two small frames, are a number of loops of fine, strong thread, as in no. 2, which shows one frame detached. The loops are for the purpose of holding a row of eyes in the centre of the frame. These may be either smaller loops of string, as in no. 4, or smooth glass beads, or *mails*, as they are called in weaving (no. 3). These can be obtained perforated with three holes, one large for

The Heck

the thread to pass through and two smaller ones for attaching them to the loops (no. 3). For the sake of clearness, only seven loops are shown on the frame in the illustration. Any number, however, may be used, but each frame must have at least half as many loops as there are reels of thread on the bobbin-carrier. Thus, if eighty bobbins are to be used in making a warp there must be forty eyes on each frame. The position of the eyes and loops on the second frame is shown by the dotted lines in no. 2.

The Gatherer

The next appendage to the heck-block to be described is placed at the back of it, opposite the centre of the heck frame. It is shown screwed to the block in fig. 26, no. 1, A. No. 2 is an enlargement of it. It will be seen to consist of a block of wood (it should be boxwood), very smoothly finished, about five inches by three inches, and an inch and a half thick. Projecting from the top edge are two strong steel points, about three inches long, and two inches apart. Upon these points two round, hollow, boxwood pegs are made to fit. In the drawing one of these, B, is represented in its place on the point, but the other is shown separately at C. The pegs are not fixed on the points, but are fitted so that they will easily revolve on them. The reason for these pegs being loose, is to prevent friction when a large number of threads gathered together is passing quickly between them, from the reel frame, through the heck, to be spread upon the revolving mill.

The Regulator of the Heck-block

In the centre of the heck-block shown in fig. 23 at O a ratchet and wheel will be observed. This is to enable the warper to regulate to a greater nicety the spreading of the warp on the mill reel.

The section, no. 2, will explain its construction. The pulley M is attached to the axle of the ratchet wheel by a piece of strong catgut, which on the

The Regulator of the Heck-block

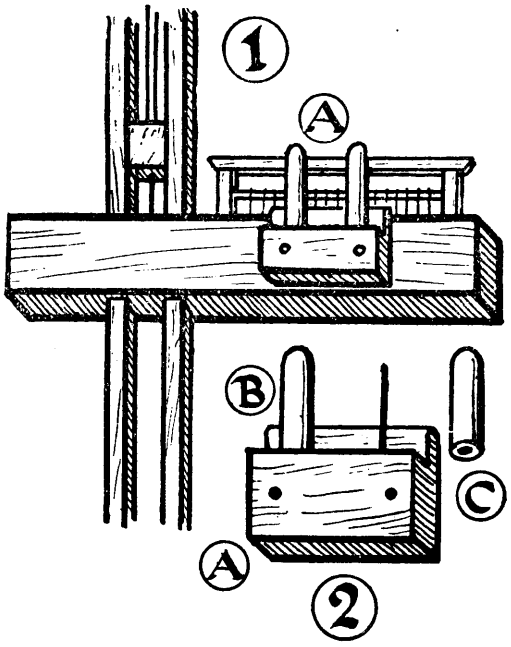


Fig. 26.—The Gatherer.

wheel being turned ever so slightly winds the cord on to the axle and brings the pulley nearer to the block. This has the effect of raising the block a little, and prevents the accumulating threads of the

The Regulator of the Heck-block

warp from piling up in one place on the mill, as they would otherwise do.

The Count and Length of Warp

The description of the warping mill is now complete, and it only remains to demonstrate its use in the preparation of a large warp of fine silk, say of twenty thousand threads fifty yards long. In warping, the first thing to determine is the number of bobbins of silk to be used, and to arrange them on the bobbin frame, fig. 24. The frame must be fixed in the position shown at QQ, fig. 22, no. 1, and all the other fittings of the mill must be in working order. Fifty bobbins will be a convenient number, as twenty thousand divides equally by fifty. This number of bobbins will make each portee consist of one hundred threads (see pp. 34–37). It must next be calculated how many portees of one hundred threads each, will make up the number required for the whole warp.

Calculations necessary in Warping

$$20{,}000 \div 100 = 200.$$

Two hundred portees, then, will be needed. In order to build this number up on the warping mill the heck-block must be caused to travel down and up the mill frame two hundred times, a cross being taken at the beginning and the end of each journey.

Order of Bobbins on the Frame

The bobbins of silk must next be arranged on the frame, which is shown to be capable of holding a hundred, so that the fifty we propose to use will just fill the upper half of it. It must also be noted that the reels are counted in rows, beginning at the top of the left-hand row. This order must be maintained in threading them through the

heck. When placing the bobbins on the wires care must also be taken that they will all unwind in the same direction (see p. 35).

Order of Bobbins on the Frame

The bobbins being ready on the frame the warper must stand between it and the mill with the right hand to the bobbin frame. The end of silk hanging from the first reel must be taken and threaded through the first eye of the heck, which will be seen by reference to fig. 25, no. 1, to be on the front frame of that appliance. The thread must be drawn well through the eye, taken between the revolving boxwood pegs, and left hanging there. In like manner the second thread must be passed through the second eye of the heck, which will be found on the back frame. The silk from the third bobbin must then go through the third eye, which is on the front frame, and this order of alternate threading must continue until all the threads pass in regular order from the frame through the heck, and hang all together between the boxwood pegs.

Position of Warper when threading the Heck

The heck-block, which has been standing at any convenient height for threading the silk, must now be worked gently up to the level of the pegs at the top edge of the mill, and all the loose ends of silk, hanging from the heck, being tied together, must be looped on to the peg Y, fig. 22, no. 1. On the mill being now moved a few inches in the direction of the arrow Z all the threads will be tightened, and the heck must be examined in order to see that they all pass in regular alternation through the eyes of its front and back frames. Any error in the threading will be at once detected if the frames are lifted in succession so as to raise

Position of the Heck-block at Beginning of a Warp

Position of the Heck-block at Beginning of a Warp

first one half and then the other of the fifty threads. This being found correct, the collection of threads which passes between the frame and the heck must also be examined. They should come off the bobbins in five distinct vertical rows, so that the warper may be able to see at any moment that the reels are all revolving properly, and detect at once threads that require mending or any other attention.

Taking the Cross

It will next be necessary to remove the silk from between the revolving pegs of the heck-block, gently turn the mill by hand until the peg Y stands about two feet to the left of the heck, and then all will be ready for the important operation of *taking the cross* which is done in the following manner. Care being taken to keep the threads all taut, the *front* frame of the heck must be first raised. This will lift half of the threads and make an opening through which a short glass rod or the finger and thumb of the warper's left hand must be passed. The opening thus made can then easily be moved along the threads and transferred to the first peg X, which is nearest to Y. By another slight movement of the mill the silk must again be tightened, the *back* frame of the heck raised, and the rod inserted in the opening, which is then to be transferred in like manner to the second peg X. The cross should now be complete and perfect, and as soon as it is seen to be so the silk must be replaced between the revolving pegs of the heck, and the warping may proceed. The length of warp is next to be arranged for and spread as described at p. 48. The fifty yards will need ten revolutions of the mill to spread, and these are to be made by turning the handle K, no. 1, fig. 22. Great care must be exercised

in order to turn the mill steadily and firmly and keep an unrelaxed tension on the threads of silk. When the ten revolutions are complete the movable board holding the pegs W must be wedged between the staves of the mill just below the termination of the tenth round of the warp. Here, as previously explained (p. 37), only the portee cross is required. Accordingly the fifty threads, taken all together, will pass above the first peg W, below the last one, then round it, and under the first, which completes the portee cross. The revolution of the mill must now be reversed, the silk being wound upwards in the same course until the heck-block again reaches the pegs at the top, and the mill is stopped gently for taking the return cross. This time, as the first opening has to be transferred to the second peg, the *back* heck frame must be the first raised for the insertion of the glass rod. When this has been done the front frame will be lifted, the opening transferred to the first peg X, and when the warp has been looped round peg Y the first portee will be finished, and a hundred and ninety-nine others will have to be done in exactly the same manner. An excellent way of keeping account of the portees as they are warped is shown at fig. 27. A stroke is made for every portee completed until nine are reached, and at the tenth one the nine are crossed out.

Laying the First Portee

On arriving at peg Y, fig. 22, after the last portee has been warped the half-portee must be divided and the threads cut from the heck and tied in such a manner as to loop over the peg.

As the warping proceeds it will be found necessary to make use of the ratchet and wheel

The Ratchet and Wheel of the Heck-block

marked O in fig. 23. Without the help of this extra means of regulating the length of the cord by which the block is suspended the threads would be piled up in one place in an unmanageable heap, and when stretched out in the loom would be of various lengths and cause great inconvenience to the weaver. After a few portees have been laid on the mill, therefore, the cogged wheel has to be turned so that the ratchet may catch the next tooth. This will

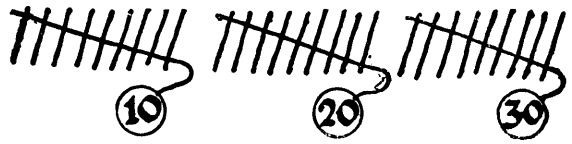


FIG. 27.—Method of Counting Portees.

obviously raise the block a little and cause the next round of warp to be laid a trifle higher on the mill. As this movement of the ratchet wheel is repeated from time to time the warp will gradually fill in the space between the rounds and lie flat in a spiral band on the mill. This filling of the space needs to be done judiciously, and must never be carried so far as to merge one round into the next. Warps of a high count naturally require greater space between the rounds. This is regulated, as has been described (see p. 50), by the size of the cylinder P, fig. 22, no. 1.

Mending Threads

However great the care taken by the warper may be, it is impossible to prevent threads occasionally breaking. These must be most carefully watched, and if possible detected before the broken thread has passed away through the heck. To find and mend threads

between the bobbin frame and the heck is an easy matter if done in the right way. The warper must reach down from the top between the vertical row of threads in which the broken one should be and the row nearer to him, bring both ends up, seeing that they come direct from the bobbin on the frame and from the heck, and tie them together. If this has been rightly done the thread will find its proper place as soon as the mill begins to revolve again. Should the thread have passed the heck it is more difficult to find and mend. In this case the end must be brought from the bobbin and threaded through the vacant eye in the heck. If the end to be joined has disappeared, as will be most likely the case, the half-portee must be unwound with the greatest care and searched for the missing end. As the silk is unwound from the mill the warper temporarily winds it upon his hand until the missing thread is discovered. When found, it is tied to the loose end from the reel, and the half-portee replaced gently and accurately in its proper position as the mill is turned by hand, until the heck is again reached, and the warping proceeds. This is rather a difficult and tiresome process, and needs to be avoided as much as possible by watchful care. Immediately on the warp being finished the crosses must be secured in the manner described at p. 32, the greatest care being taken that the cords pass clearly through the openings kept by the pegs.

Mending Threads

There are, of course, numberless points with regard to warping which only experience will teach, but enough has been advanced to explain the method itself and to indicate the uses of the various parts of the warping mill.

CHAPTER V

TURNING ON, OR BEAMING

Turning on, or Beaming—The Raddle, or Vateau—Selection of a Raddle for a particular Warp—The Cane Roller and Cane Sticks—The Raddle Stand for Small Warps—To separate the Portees—Distributing the Portees in the Raddle—Turning on in the Loom—Position of the Cane Roller in the Loom—Means of turning the Roller—Assistance required in turning on—Method of keeping the Warp hard on the Roller.

Turning on, or Beaming

In order that the warp may be stretched in the loom ready for the weaver to make into cloth, it has to be attached to a roller and spread out and wound evenly and tightly upon it. This roller fits into the back or top of the loom frame, and when spread out upon it the warp has to be a little wider than the web is intended to measure when finished. This process is called *turning on* or *beaming*—beaming because beam is the old name for the roller of a loom. When we read in history or poetry of a "weaver's beam" we may know that the roller is the part of the loom referred to.

In Chapter III. the use of the warping board was demonstrated, and a finished warp, with the crosses properly secured, was described as left wound

upon a hand-stick, with the portee cross exposed, and ready for beaming (p. 39).

Turning on, or Beaming

For the demonstration of turning on we will suppose that the width of material to be woven is twenty-two inches, that the warp contains nine hundred and sixty threads, and that this number is made up of sixty portees having sixteen threads in each.

The Raddle, or Vateau

We have first to spread the warp out evenly to a width of a little more than twenty-two inches. This must be done by means of an appliance called a *raddle*, or *vateau* (fig. 28, nos. 1 and 2). The raddle is simply a comb with a movable cap to cover the ends of the teeth (no. 1). The frame is made of wood, but the teeth are of hard brass wire. The cap has holes in it, near the ends, through which the sides of the frame pass in order to fix it on, as shown at no. 2. Metal pins or small wedges passing through the projecting ends secure the cap in its place. The cap also is deeply grooved above the range of teeth, and when fixed on the comb effectually separates all the divisions of the raddle. The teeth of the raddle are accurately spaced and marked, so many to the inch. A warper has to be provided with a set of raddles, so as to be able to deal conveniently with warps made up of different numbers of portees and various thicknesses of yarn.

Selection of the Raddle for a Warp

In order to determine the proper raddle required for a warp, the number of portees it contains must be divided by the number of inches it is to occupy on the roller. Thus, the warp with which we are dealing contains sixty portees, and as it is to make cloth twenty-two inches wide, it should be

Selection of the Raddle for a Warp

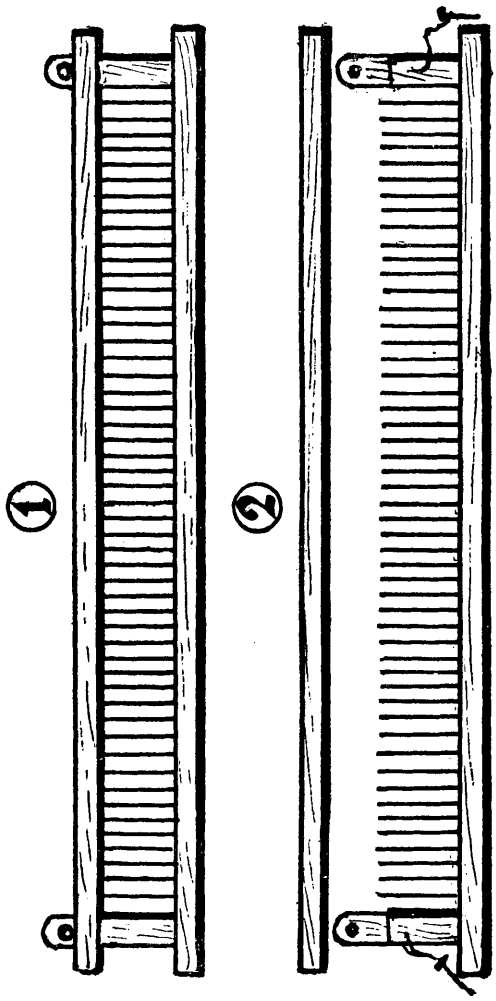


Fig. 28.—The Raddle.

spread out to at least twenty-four inches in the raddle. Selection of the Raddle for a Warp

$$60 \div 24 = 2\tfrac{1}{2}.$$

We find then that every inch of the raddle must have two portees and a half distributed on it. A raddle having five spaces to an inch will accordingly suit our purpose, and in every space we

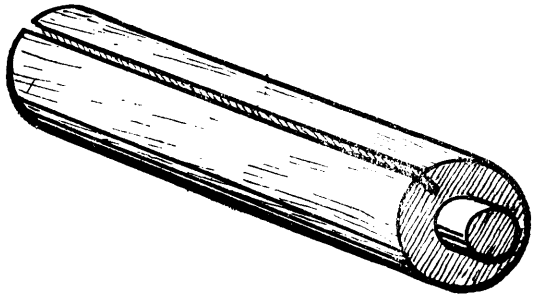


FIG. 29.—The Cane Roller.

must place half a portee. This can be quite readily done, as each portee is divided into two at the cross.

Fig. 29 represents the back or top roller of a loom such as the warp is to be spread and wound upon. It is called the *cane* roller, to distinguish it from the *breast* roller, in front of the loom, on which the woven cloth is wound. It has a groove ploughed in it from end to end deep enough for two smooth, wood or metal sticks to be placed easily one above the other in it. One of these rods we shall require to use at once in spreading the warp. The Cane Roller and Cane Sticks

The Cane Roller and Cane Sticks

The warp is shown on the hand-stick in fig. 30. Into the opening at A the cane stick must be inserted, and through the opening B, another cord, a little longer than the cane stick, has

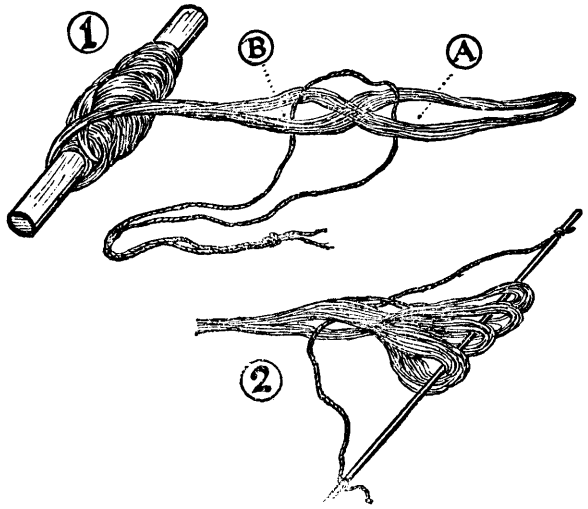


FIG. 30.—Portee Cross in Use.

to be passed and tied securely to the ends of the stick. As soon as this is done the first cord may be cut away. The portee cross will now be safely kept by means of the cane stick and the cord as at no. 2. Two little supports for the raddle will now be required in order to fix it in an upright position on a table, as shown in fig. 31. Fig. 32 shows the warp in the proper position for distribution in the raddle. A

Raddle Stands

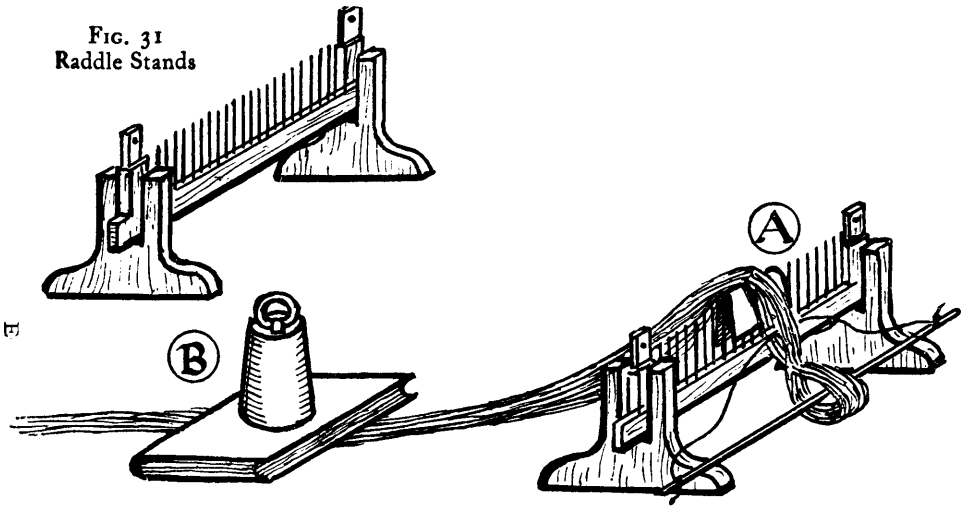


Fig. 31
Raddle Stands

Fig. 32.—Warp ready for distributing in Raddle.

Raddle Stands

heavy weight of some kind, B, is placed on the warp three or four feet from the raddle, and the portee cross, secured by the cane stick and cord, is on the opposite side. A piece of card folded as at A and placed on top of the teeth of the raddle, makes a handy rest for the warp while the portees are being

To separate the Portees

picked out and placed in order. It will now be found that on taking the cane stick in hand and gently pulling the warp tight the portees can readily be separated and entered in regular succession along it. By this means the warper is enabled to distribute the portees at will in the raddle spaces.

Distributing the Portees in the Raddle

The raddle will probably be more than twenty-four inches long, but that is quite immaterial. We must first find the central space and count off twelve inches to the right of it, marking it as the starting place of the distribution. The folded card may be moved to within a few inches of the mark, with the warp resting upon it. The first portee must now be separated from the bulk of the warp and divided, the first half of it, which will come out of the cross naturally, being placed in the first space, and the second half in the second space. The second portee, in like manner, will fill the third and fourth spaces, and so each portee will follow in succession, until all are distributed. It will be found necessary, during the distribution, to keep the cane stick as much below the level of the raddle as possible. If this be not done, the distributed portees are apt to escape from their appointed spaces, and the work of distribution has all to be done again. As soon as the whole warp is in the raddle the cap must be fixed securely in its place, and then all will be safe and ready for the actual turning on.

Such a warp as the one we are dealing with, made on the warping board, is just suitable for a domestic loom, so we will suppose it has to be turned on, in the loom, with the roller, on which the warp has been wound, fixed in its place. This can readily be done, but an important silk warp, such as the one described as made on the warping mill, requires the use of a special turning-on machine, with facilities for very heavy weighting and a means of keeping a steady and even tension on the multitude of fine silk threads.

Turning on in the Loom

This is not the place to explain the method of fixing the roller to the loom, that will be done when the whole construction of the loom itself is treated of. We must therefore, for our present purpose, imagine it bracketed to the loom-posts as shown in fig. 33, in which A, A are the back posts of the loom, B the cane roller, and C the groove in the roller into which the cane sticks fit. Two assistants will now be required, one to turn the roller and the other to hold on to the hand-stick, on which the warp is at present wound. Before we can actually begin the turning on, however, some means of turning the roller must be devised.

The Position of the Cane Roller in the Loom

Into the roller at the place marked D, fig. 33, a very strong, short screw or nail must be driven, deep enough to take firm hold but at the same time to leave the head about an inch out of the wood. About six feet of strong cord will also be wanted; this must be tied together at the ends so as to form a long loop. One end of the loop must be caught on to the screw-head, and the double cord wound round the roller two or three times, crossing itself

Means of turning the Roller

Means of turning the Roller

as it winds. It must be wound in the direction shown at fig. 33A, leaving the loop E for the insertion of the stick as at F, fig. 33B. By means of this stick and cord, the assistant will be enabled to turn the roller, hand over hand, and wind the warp upon it quite easily, although a good deal of strength be exerted at the other end in order to pull the warp tight on the roller.

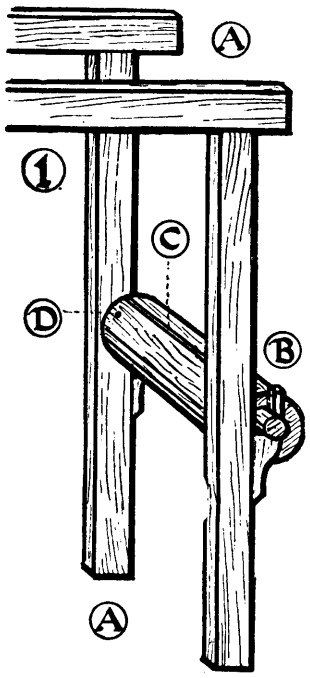


FIG. 33.—Loom Posts with Roller.

Turning on

The actual process of turning on will be readily explained with the assistance of figs. 34 and 35. At fig. 34, no. 1, the warp is shown with the raddle, GG, and the cane stick, HH, in their proper places in the warp. One assistant, we will suppose, is holding the hand-stick, with the bulk of the warp upon it, at some little distance off in the direction of the arrow. The other assistant is holding the raddle, GG, and the cane stick, HH, in the relative position, with regard to the loom-posts, shown in the drawing. The warper must now

stand behind the loom-posts, and, reaching between them, take from the assistant the cane stick, HH, to which the warp is attached by the portee loops. This he must slip into the groove in the cane roll. To fix the cane stick in the groove, another stick must be passed underneath the roller and the warp, into the groove, as shown at no. 2, fig. 34. The

Turning on

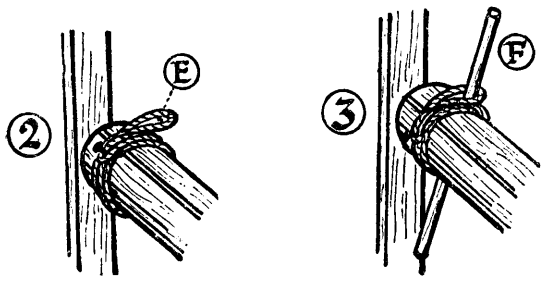


FIG. 33A. FIG. 33B.

Loop and Stick for turning Roller.

raddle must now be brought close to the roller by being slipped along the warp, and the roller itself must be turned once round. This will fix the warp securely in its place, and at the same time spread it evenly upon the roller. When placing the cane stick in the groove care must be taken to leave equal spaces, or whatever proportion of space may be necessary for the working of the loom, at each end of the roller.

The warper and the assistant holding the raddle will now have to change places, but before doing so the roller must be fixed so that it will not turn

Assistance required

back although the tension be kept on it. This may be done at any time, by placing the turning stick, F, in the position shown in fig. 35. This drawing (fig. 35) represents the stage of the operation now arrived at. The warper must take the raddle in hand and see that all the portees are in their proper

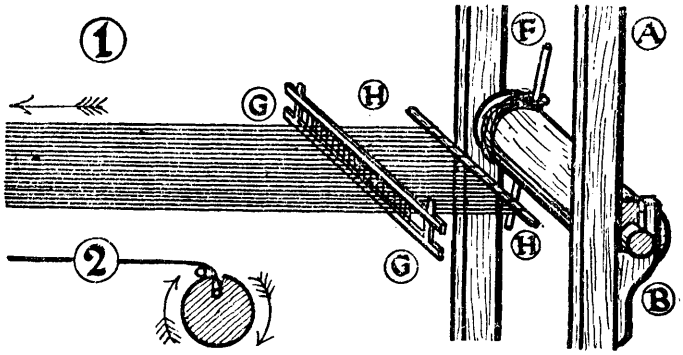


FIG. 34.—Warp ready for fixing in Cane Roller.

places, and that the raddle can be moved easily and without obstruction along the threads. All being in order, the turning on may now proceed. The warper must guide the warp, as it is turned on, by means of the raddle, gently shifting it about so as to lay the threads on the roller as evenly as possible round by round. All the time of turning he must look out for broken or tangled threads, being careful to place any that have to be mended in the portee to which they belong. If all goes well and the warp is turned on easily, it will prove that the warping has been properly done. All this time, from the first turning of the roller,

the assistant holding the hand-stick with the warp upon it must have been pulling with all his force and steadiness against the turning. If, indeed, the warp is of any considerable size, the services of two or three people are necessary in order to give sufficient tension to it. When a few turns have

Assistance required

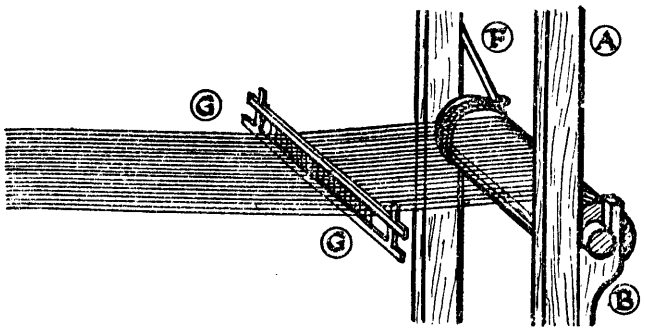


FIG. 35.—Warp ready for turning on.

been given, it may be well to place a sheet of very thick paper or tough card underneath the warp, between it and the roller. This being wound on, will prevent any threads sinking in and giving future trouble, as they would otherwise be apt to do. A long warp may require several of these protecting cards to be wound in with it, but the need for them will depend very much upon the weight and evenness of the tension kept during the turning on. If the warp on the roll begins to feel soft and flabby, it may be known that a card is required. As soon as the important cross is exposed on the hand-stick, the warper must call a halt, leave the

For keeping the Warp Hard on the Roller

Placing Rods in the Cross

raddle, and spread the crossing threads out on the securing cords. This will not be found difficult to do if the weight be kept well on. When the cross is spread out clearly, two smoothly polished, round, wooden rods, pointed at one end, about an inch thick and six inches longer than the width of the warp, must be put into it, in the openings made by the securing cords, and left there together with them. When the rods are safely in place, the turning must proceed and continue as before, until the rods are close up to the raddle. As soon as they are in this position the cap must be taken off the raddle and the raddle itself removed, its work being done. One or two more turns will wind the cross and the rods on to the roller. The hand-stick may then be detached from the warp, and the turning on, or beaming, will be completed, the warp being quite ready to be entered in the loom.

CHAPTER VI

THE BEAMING DRUM

The Essential Part of Beaming Machinery—The Drum and its Fittings—Friction Brakes—Ropes of the Drum—Space necessary for Beaming—Importance of Accuracy of Detail in Weaving Operations—Turning-on Posts—Appliance for Beaming in Confined Space—Winding the Warp on the Drum—Beaming with the Drum.

The Essential Part of Beaming Machinery

THE beaming of such a warp as that described in Chapter IV. necessitates the use of some mechanical appliance in order to give to the threads a great and unintermittent tension during the whole operation. This want is met by the essential part of any turning machinery, the beaming drum.

The Beaming Drum and its Fittings

This drum is a strongly, solidly made, large reel, with an iron axle, on to which the warp to be beamed has to be wound instead of being turned on directly from the hand-stick, as was done in the case of the small warp described in the last chapter. The drum, furnished with all its fittings and fixed in position, is represented by figs. 36, 36A, and 36B. It should be in size at least two feet in diameter and two feet six inches to three feet in length. It must be perfectly smooth and well joined, so that there may be no danger of the finest

The Beaming Drum and its Fittings

silk thread being caught or broken on any part of it. The two stands on which it revolves must be firmly bolted to the floor of the workshop, as the strain they have to bear is very heavy and continuous, and they must be carefully adjusted in order that the

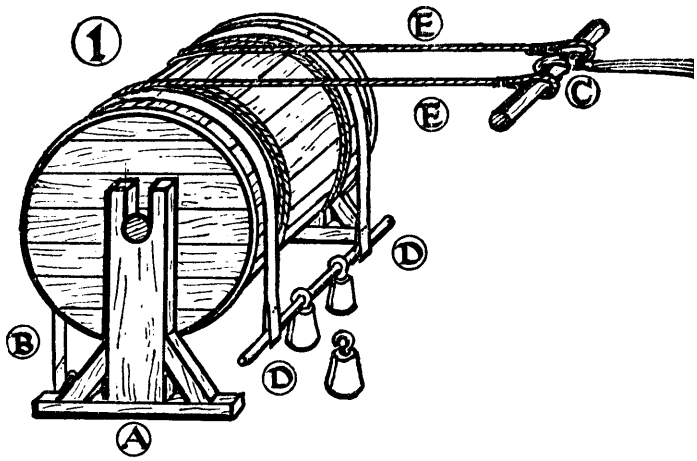


FIG. 36.—The Beaming Drum.

The Friction Brakes

revolutions of the drum may be level and true. The drum itself must be provided with two friction brakes (figs. 36A and 36B, B, B). Each of these brakes consists of a strap of tough leather, about two inches in width, and long enough to reach from the ground at the back of the drum—where they are fixed by strong staples (C, C, fig. 36A)—to the bar DD at the front (fig. 36B). It is by means of these straps that the tension is given to the warp as it is being turned on.

Weights are hung on the bar, and the tension given to the warp can be regulated to a nicety by their means. The Friction Brakes

The drum must also be furnished with two well-made ropes capable of bearing a heavy strain, and long enough to reach from the drum, after going once round it, to the frame on which the roller Ropes of the Drum

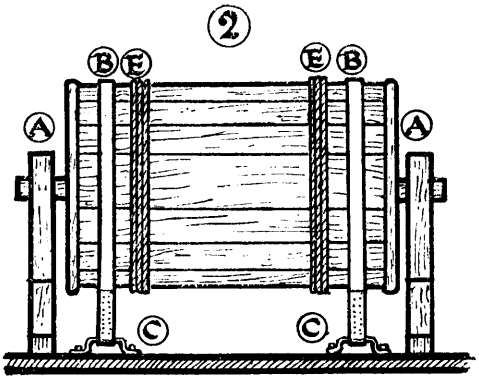


Fig. 36A.—The Drum : Back View.

for turning on is fixed. These ropes must be permanently fastened, at one end, to the drum, as near as possible to the straps of the friction brakes, but not so near as to interfere with them when working. The ropes are wound on to the drum, care being taken to avoid crossing them, as shown at E, E, figs. 36A and 36B. The free ends of the ropes must be looped in order that a thick, round stick, almost as long as the width of space between the straps, may rest in them (F, fig. 36B). To

Ropes of the Drum

this stick one end of the warp to be turned on is attached as shown at fig. 36.

Length of Space necessary for Beaming

The next necessity for good beaming is a long workshop, in which a clear space of thirty or forty feet is available. Where such a space can be had, the drum, fitted up in the manner described, is the

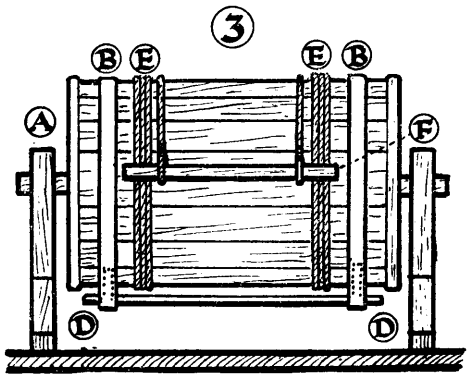


FIG. 36B.—The Drum : Front View.

only apparatus that is required, with the exception of two posts, answering to the back posts of the loom, on which the cane roller is placed for beaming the warp, as described on p. 68 and shown in fig. 33. The posts specially made for turning on must be fitted up exactly opposite to the drum, and as far from it as convenient. They must be adjustable—that is to say, whatever width apart they may have to be in order to accommodate different lengths of rollers, the centre of the space between them must be exactly opposite to the

centre of the drum. ALL THESE MATTERS OF DETAIL ARE OF THE UTMOST IMPORTANCE IN WEAVING. IN THIS CASE, FOR INSTANCE, A LITTLE INACCURACY IN ADJUSTING THE POSTS WILL CAUSE THE DISTANCE OF THE DRUM FROM THE ROLLER TO BE GREATER ON ONE EDGE OF THE WARP THAN THE OTHER. THIS DIFFERENCE WOULD BE MULTIPLIED SEVERAL TIMES IF THE WARP WERE A VERY LONG ONE. IN CONSEQUENCE OF THIS, WHEN IT WAS IN THE LOOM THE WEAVER WOULD DISCOVER THAT ONE SIDE OF HIS WARP WAS LOOSER THAN THE OTHER, AND HE WOULD HAVE TO WASTE A GOOD DEAL OF TIME IN CONTRIVANCES FOR REMEDYING THE DEFECT. Necessity for Accuracy of Detail in Weaving

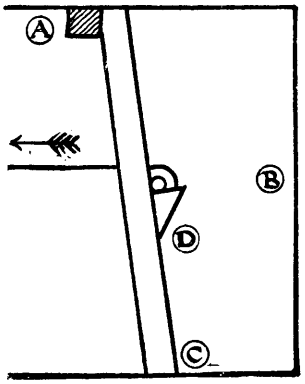


FIG. 37.—Turning-on Post fitted

The posts may be made adjustable in the manner indicated by fig. 37. A strong cross-beam about eight feet long, a section of which is shown at A, must be fixed to the roof of the workshop, as far from the drum as possible and exactly parallel with it. As stated above, the space between the beam and the drum should be at least thirty feet. At the same time the beam must not be less than four feet from the wall indicated in the diagram by the line B, for in this space the assistant stands to turn the roller. A permanent mark should be made on the beam A exactly opposite the centre of the drum, Turning-on Posts

Turning-on Posts

and a line may be painted on the floor also marking the centre of the space from the drum to the beam. This line and mark will make the nice adjustment of the posts, when they are fixed up, quite easy. The two posts need to be very strong, and should be about six inches wide by three inches thick. Their length will, of course, depend on the height of the workshop, as they must reach from the roof to the floor. It will be seen from the diagram that the posts do not stand quite upright, but lean against the beam in the direction of the drum, so that although when not in use they can easily be removed, when the tension is on the warp they are firmly fixed in their places. In order to make the posts stand firm when the weight is not on, their ends are accurately cut to the angles of the beam and roof and of the floor, so that when in position a tap with a mallet at the place marked C, fig. 37, will at once fix them. It will also be seen that the roller simply rests upon brackets fitted to the posts at a convenient height for the turner-on to work at.

Beaming in a Smaller Space

If a space of thirty feet is not available for the beaming it is possible to do it in a much smaller one by means of rollers fitted in a frame. The frame with rollers is fixed to the wall, or placed opposite the turning-on posts, as far away from them as possible. The drum, with its front facing the rollers, stands between them and the posts, as near the latter as convenience will allow. This arrangement of the beaming machinery is shown at fig. 38. The warp in this case unwinds from the drum A, passes under the roller B, over C, and then, turning back, escapes the top of the drum and is turned on at the opposite posts. The simpler arrangement without rollers

is better for several reasons, the principal one being that when the silk goes direct from the drum to the cane roller there is much less friction and strain on it.

Beaming in a Smaller Space

The process of beaming when the drum is used is exactly the same as that described in the last chapter, except for the management of the drum itself, which takes the place of the assistant who holds the hand-stick and pulls, in order to give the

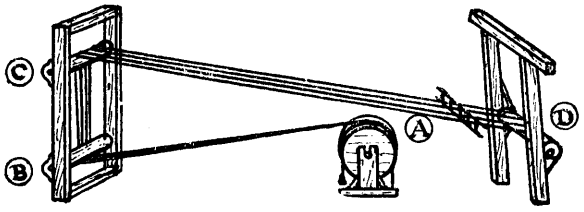


Fig. 38.—Beaming in a Smaller Space.

necessary tension to the threads. It will only be needful, therefore, to give instructions for the management of the drum and refer to the previous explanation for the rest.

In taking the warp off the warping mill on to the hand-stick, when a beaming drum is to be used, the *portee cross* end of the warp must be looped first to the hand-stick, so that when it is all wound on the *porrey cross* (see fig. 14) will be left outside. This is the reverse of the former direction (p. 38), and is necessary because the warp has to be rewound on to the drum. When this has been done the warp will be found in the same position on the drum as regards the crosses, as it was in the former case upon the hand-stick. In order to wind the warp on to the

Winding the Warp on the Drum

drum, the stick C, fig. 36, must be detached from the ropes E, E and placed in the opening made by peg Y, fig. 22, no. 1. The stick must then be reattached to the ropes, and the drum turned so as to wind the warp tightly and evenly upon it. Of course while this is being done the weight must be taken off the bar of the friction brakes; the straps themselves may even have to be removed. As soon as the warp is all wound on the drum, the friction brake must be replaced and a light weight put on the bar. The warper must then take in hand the portee end of the warp and carry it over to the cane roller posts, where the raddle is for the present fixed, in a convenient manner, in the place that the cane roll will eventually occupy. He will then proceed to insert the cane stick in the warp, distribute the portees in the raddle, and fix the cap on. Then the roller will take the place of the raddle and the cane stick be dropped into its groove. One turn given to the roller will fix the cane stick, and the necessary weight being put on the drum, the beaming may proceed.

Beaming with the Drum

When the warp is all off the drum, and the stick, to which it is looped, is in the position shown at fig. 36, the weight must again be taken off the brakes, in order to allow of the spreading and straightening out of the cross and the cords securing it. When this is done and the two rods inserted as directed at p. 72, the weight must be again put on and the beaming can be completed, the tension being kept even by means of the unwinding ropes.

The directions for finishing off the beaming, which are the same in large or small warps, are also given at p. 72.

CHAPTER VII

THE HAND-LOOM FOR AUTOMATIC WEAVING

Opening or shedding the Warp for Wefting—Shedding the Warp without Appliances—Simplicity of Egyptian and Greek Weaving—The Headle-rod—Ancient Horizontal Looms and Automatic Sheds—Indian and Chinese Looms—The Old English Hand-loom—The Loom Frame—The Rollers—The Ratchet and Wheel—Friction Brake for Cane Roller—Comparison of Indian and English Looms—Automatic Method of opening the Shed—The Long Comb or Reed—The Batten—Position of the Harness and Batten—Preparations for entering the Warp in Harness and Reed—Gating the Loom.

Opening or shedding the Warp

THE warp, its special characteristics and the manner of preparing it, have been carefully and minutely explained; this will therefore need no further consideration. The method of opening the warp for the intersection of the weft thread next claims attention, for in this consists the whole art and mystery of weaving. Thus briefly stated, weaving may appear to be a very simple matter, but it will be found, as the subject is developed, that the warp may be intersected by the weft in an infinite variety of ways, and that the contrivances for doing this are numerous, and many of them most elaborate.

Opening or shedding the Warp

So much is this the case that, instead of being altogether a simple art, weaving, in its highest perfection, is perhaps the most complicated of all the arts of life.

In order to explain the method of opening the warp for inserting the weft, it will be necessary to turn back to fig. 13, no. 1. In this drawing, as was intimated at p. 24, is represented the simplest possible form of loom. The method of weaving plain cloth is all that must concern us at present, the weaving of patterns being left for later consideration. The tools required are as simple as the loom itself, being only the spindle, with the weft wound upon it as it was spun (see pp. 14 and 15), and a flat stick to be used for keeping the openings wide and clear for the passing of the weft, and for beating the weft itself together.

To secure the Cross-rods

The loom for the demonstration of weaving being prepared as directed at p. 25, the cross-rods must first be secured in their place at the top of the loom. This may be done by attaching loops of string to the projecting ends of the beading, and twisting it round the two rods as shown in the end view of the rods, fig. 39. The flat rod E must next be placed in the opening made by the lower cross-rod, brought a little way down and turned edgeways, as shown in the section of the loom, fig. 39A. This flat rod is usually called the *shed-stick* because it is used for widening the shed, shed being the technical name for any opening made for the passing of the weft. Through the opening F, fig. 39A, the spindle, G, with the weft upon it, must now be passed, after sufficient thread has been unwound to reach across the warp, and leave the end of it projecting at H. All the warp threads at the

Opening or shedding the Warp without Appliances

back of the shed will now be covered by the weft, whilst those in front are still exposed. The latter must now be covered by the return of the spindle and weft. For this purpose a different opening or shed must be made as shown at I, fig. 39B. This is effected by pressing back the front threads with the top joint of the forefinger of the left hand, and hooking each back string on to it in succession. To do this quickly requires a good deal of practice; it is well, therefore, to begin by raising and passing the weft through only a very few threads at a time. For example, let the warp consist of seventeen threads, nine being in front. Beginning at the first thread on the left-hand side, and pressing it back, the back thread can easily be caught on to the finger, which must next press in the same manner the second front thread and catch up the second back one. Next the third front and the third back, and lastly the fourth front and the fourth back threads must be taken up. It will now be found that four

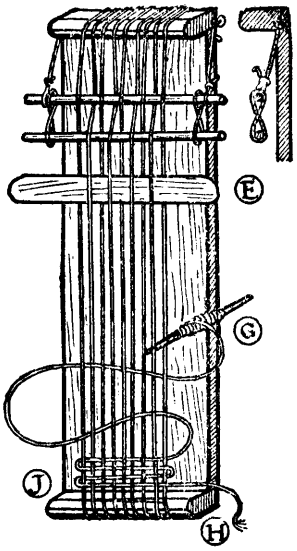


FIG. 39.—Primitive Loom and Shed-sticks.

Opening or shedding the Warp without Appliances

of the back threads nearest the left-hand side of the loom are on the finger, and if the shed-stick be placed flat in its original position, E, fig. 39, they can easily be raised sufficiently high for the weft spindle to be passed through the opening. When this is done and the shed-stick again placed edgeways, the remaining four back threads have to be raised in the same manner, and the weft passed through. After the weft has been drawn straight, the shed-stick being again in a flat position, its edge may be brought down smartly upon the whole weft in order to beat it together. The two shoots of weft will now appear as drawn between H and J, fig. 39, and the shed-stick being returned to its position at F, fig. 39A, the opening for the third shoot will be ready. The fourth opening is made by picking up, in the same way as the second, and so shoot by shoot the weaving may be regularly continued. After a little practice the picking up of the back threads for every second shoot will become quite easy, and may be very quickly done. It will also be found that if the cross-rods are of a good size the shed-stick may be dispensed with. The weft, too, may be wound in convenient balls or skeins, small enough to pass

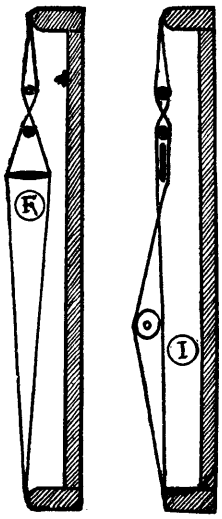


FIG. 39A. FIG. 39B.

through the opening, so that the only tool actually requisite for this simple weaving is a heavy fork or comb to press the weft and beat it together from time to time (see plate II).

Opening or Shedding the Warp without Appliances

The above may be taken as typical of all primitive weaving, both ancient and modern. There is no evidence to show that the "fine linen" of Egypt or the famous textiles of Greece and Rome were woven in a less simple manner. Frames of various sizes for stretching the warp upon were certainly used, and the warps often consisted of a great number of fine threads. Rollers also were added to the loom, enabling the weaver to make long lengths of cloth, but the actual methods of weaving appear to have been as stated.

Egyptian and Greek Weaving Simple in Method

There is, in use amongst some primitive tribes of to-day, a contrivance for bringing forward the back threads of the warp all together or in sections, instead of picking them up separately on the fingers as above described. This is sometimes called a headle-rod. It is a rather obvious improvement, and, where the threads are very fine and numerous, would save a great deal of time. It may have been used in ancient Egypt and Greece, but there is no evidence to prove it. This appliance is a strong rod, a little longer than the warp is wide. It is suspended in front of the loom a little below the cross-rods. Each back thread of the warp is enclosed by a loop which passes between the front threads and is fastened to the rod (fig. 40). When this appliance is fitted to a loom the first opening is made by means of the shed-stick as already described. The second opening is made by the weaver giving the headle-rod a vigorous pull forward, and into the

The Headle-rod

The Headle-rod

opening thus made the flat shed-stick is carefully thrust. When quite through the warp it is turned edgeways, and effectually clears the opening for the passing of the weft.

Horizontal Looms and Automatic Sheds

It is impossible to say how early in the history of weaving two most important steps in its

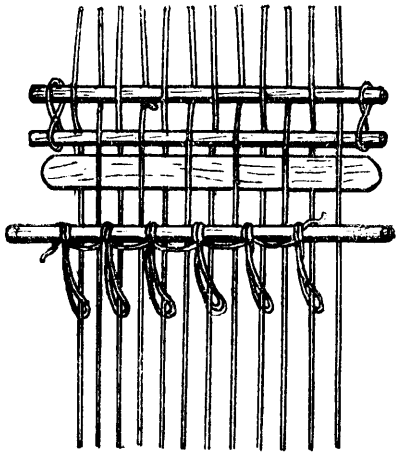


FIG. 40.—Headle Rod.

development were made. These steps were (1) placing the warp horizontally ; (2) arranging an automatic motion by which both the necessary openings or sheds can be made with equal speed and certainty. There is little doubt that it was in China that these improvements were first made. From that country they spread to India and the East generally. There are in existence very ancient

representations of Chinese and Indian horizontal looms with such automatic arrangements. Moreover, the fine silk webs of China and India, so much valued in ancient Greece and Rome, could hardly have been made in the simple manner described above.

Horizontal Looms and Automatic Sheds

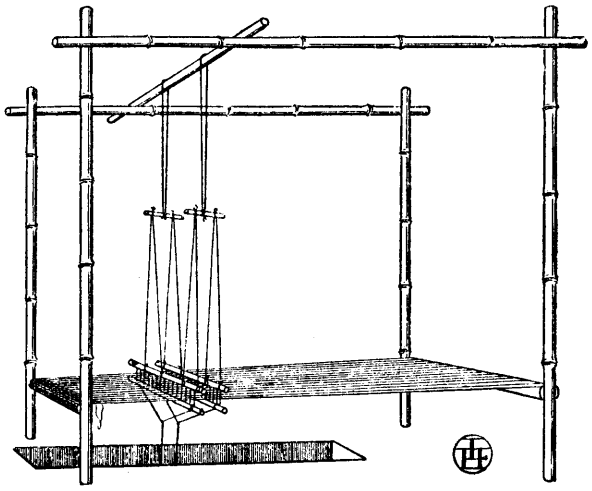


FIG. 41.—Indian Loom.

Fig. 41 is a drawing of an Indian loom made for the weaving of fine muslin. Such looms as this have without doubt been commonly used in India from a time long anterior to the Christian era. The framework is of bamboo, and the warp is stretched between bamboo rollers. There are many details lacking, as we have seen is usual in these ancient drawings, but the automatic motion for opening the

Indian and Chinese Looms

Indian and Chinese Looms

shed, just referred to, is quite clearly shown. Altogether in its general arrangement the Indian loom bears a close resemblance to the hand-loom of old English pattern (fig. 42) and the domestic loom in the old French woodcut of the frontispiece. The stuffs carefully made by hand on such looms as fig. 42 cannot be equalled either in appearance or durability by the productions of the power-loom, notwithstanding all its claims to perfection of mechanism.

Old English Hand-looms

A careful study of this old English loom in all its parts will now be both useful and interesting.

The hand-loom, like the warping mill, was the result of the experience of many generations of craftsmen. Simple as it may appear, it is perfectly adapted for use either in the weaving of the finest silk, or of the coarsest linen, woollen, or cotton materials. The parts already described will be at once recognised—viz., the back or cane roller, the warp with its cross or lease, and the cross-sticks protecting it; but the new features, the loom frame and its other fittings, now claim attention.

The Loom Frame

Strength and rigidity are the chief qualities requisite in the loom frame, in order to enable it to withstand the continual heavy beating down of the weft, on which the making of good cloth so largely depends. The four posts must be made of sound wood, and be about six inches wide by three inches thick and not less than six feet in height. The posts must be joined together in pairs by being mortised into the long side-pieces of wood D, D, which should measure in length not less than eight feet. The cross-pieces, E, E, need not be mortised, but may be simply fixed in their places by screws, in

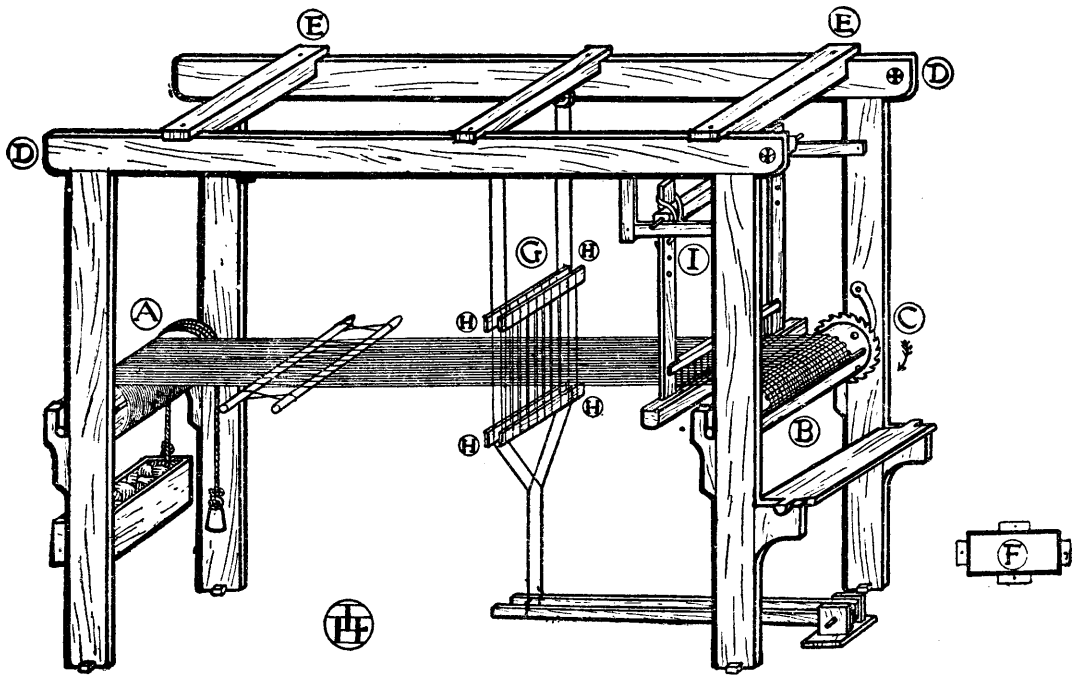


Fig. 42.—Old English Loom.

The Loom Frame

the way shown in the drawing. The length of the cross-pieces will depend on that of the rollers, and the length of these depends on the width of the web to be made. For a twenty-three-inch warp the rollers should be thirty-six inches long. There is no necessity for cross-pieces to join the posts together at the bottom. These would, in fact, be rather in the way of the weaver, who should be able to get conveniently to any part of the warp. In order to fix the frame solidly in its place and prevent the posts from shifting, four little blocks can be nailed to the floor at the foot of each post, as shown in the plan F, fig. 42. In erecting the loom frame care must be taken to fix it exactly square (see Note 1 at end of chapter), so that the front and back rollers are perfectly parallel to one another. Stays also should be fixed between the top-pieces, from the ends marked with a cross, and the nearest solid beam or wall above or behind the weaver, who sits to work facing the front roller. Constructed in this manner, of well-seasoned wood, the loom frame will be found to resist any amount of strain it may have to bear.

The Rollers

The back, or cane roller, A, has already been described (p. 63), and the front or breast roller, B, is exactly like it, having a groove in which two cane-sticks are put, in order to fix the warp.

The Ratchet and Wheel

The breast roller has in addition a ratchet and wheel attachment (C, fig. 42), which allows it to be turned only in the direction indicated by the arrow. The back roller is not so rigidly fixed, but is weighted by a friction brake at each end, the arrangement of which fig. 43, nos. 1 and 2, will readily explain. A is the roller, with the rope

wound three times round it at each end. B is a box suspended between the two ropes, into which any amount of weight, that may be required, can be put. C is a small weight just heavy enough to prevent the rope slipping too freely when the box is heavily weighted and set in the position shown. The warp being placed in the loom, is first sufficiently unwound for its end to reach to the front roller, where it is fixed, in the same manner as in the cane roller, by two rods. It will now be obvious that the warp will be stretched in proportion to the amount of weight put into the box suspended from the back roller.

Method of weighting the Cane Roller

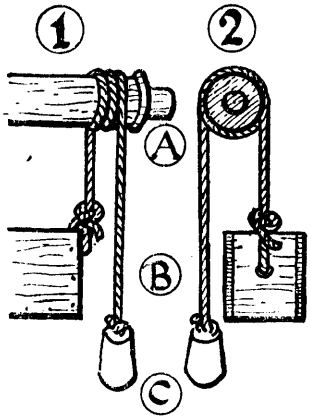


Fig. 43.—Cane Roller and Weighting.

Tapestry looms and some other simple looms for coarse weaving are made with a ratchet and wheel on the back roller, instead of the friction weight. This arrangement would not do for the weaving of fine threads, especially if they be silk, as the tension obtained by two ratchet wheels is rigid, instead of being elastic. When the friction brake is used, no matter how heavy the box may be made, the weight will give slightly at every blow of the beating down. This kindly giving prevents the breaking of the slender threads. The friction brake

Advantages of the Friction Brake on the Cane Roller

Advantages of the Friction Brake on the Cane Roller

also admits of a nice adjustment of the tension to the requirements of the weaving, and has also many minor advantages unnecessary to mention here.

Comparison of the Indian and English Looms

If the Indian loom, fig. 41, be compared with the English one, fig. 42, it will be at once noticed that they are both alike in two most important particulars. Both have the warp arranged in a horizontal position, and the contrivance used for making the opening or shed in the warp is the same in each.

The horizontal position of the warp in the loom was no doubt originally adopted because, in the first place, it enables the weaver to throw the weft swiftly through the opening by means of a shuttle, instead of slowly passing the ball or spindle across the warp ; and, in the second place, because it is easier to arrange for the automatic opening of the alternate sheds. In fact, if the interlacements of the warp and weft required are at all complicated, it would be practically impossible to arrange mechanically for the necessary succession of openings on an upright loom.

Method of opening the Shed

In fig. 41 and at letter G, fig. 42, the simplest possible automatic arrangement for opening the sheds is represented. It consists of four laths of wood, H, H, H, H, fig. 42, joined together in pairs by threads passing from those above the warp to those below it. Each pair of laths thus joined together is called a *headle*, or *heddle*. The threads joining the laths together are not simply single ones, but are made up in the same manner, although on a larger scale, as the loops of the part of the warping mill called the heck, shown at fig. 25, nos. 3 and 4. These compound loops are known as *leashes*, and any number of

them mounted on the two laths is called a *headle.** The front headle of the English loom will be seen to have ten leashes, and the back one nine, thus allowing all the threads of the warp to pass through the eye of a leash. The first, third, fifth and all the odd-numbered warp threads pass through the eyes of the front headle, and the second, fourth, sixth, eighth and all the even-numbered threads occupy the eyes of the back headle. Only nineteen threads are represented in the drawing of the warp, for the sake of clearness, but it might, of course, consist of any number in reason, and the effect would be the same. It will now be seen that if the headles are raised successively, by some means, the alternate threads of the warp will be raised with them, and the necessary sheds opened for weaving.

Method of opening the Shed

There are various devices in use for the purpose of governing the headles in order to make the shed. These will be described later on, but the opening made by means of the arrangement of cords, pulleys, and treadles shown in figs. 41 and 42, as well as in the French loom of the frontispiece, is most simple and effective. By its use the pulling down of one headle causes the other to rise, so that while one half of the warp is rising the other is falling, and the clear opening required is consequently made in half the time it would otherwise take. Fig. 44, in which a longitudinal section of the loom is given, will explain the action of this contrivance. A and B are the rollers of the loom, C, C are the cross-sticks, and D is one of the two pulleys suspended from the centre cross-piece at the top of

* Sometimes the loop itself is called a *heudle* or *hook*, and the collection of them a *leaf* or *lam*.

Method of opening the Shed

the loom frame, just above the ends of the two headles. A cord passes from the front headle over the pulley, and is tied to the top lath of the back headle. The cord is made just long enough to allow the whole warp, when the headles are at rest,

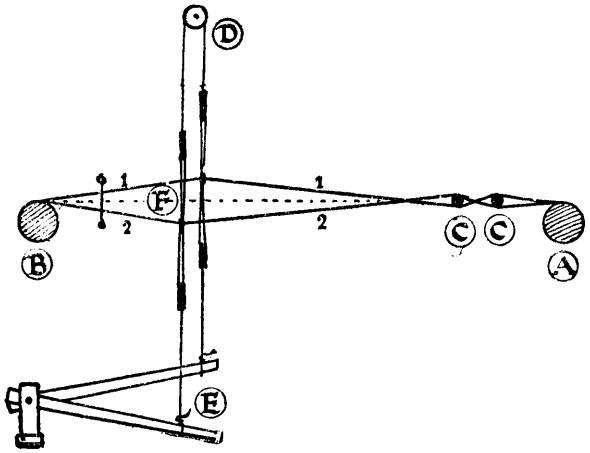


FIG. 44.—Section of Opened Warp.

to lie flat, as shown in fig. 42 and represented by the dotted line in fig. 44. At E are the treadles of the loom, tied separately to each of the lower laths of the headles.

The opening F shown in fig. 44 is obtained by pressing down the right-hand treadle and allowing the left-hand one to rise. The falling treadle draws down the front headle with all the threads of warp carried by it, and at the same time, by means of the pulley D, draws up the back headle

with all its threads, the result being a clear open shed as depicted. In like manner the second shed is made by releasing the right-hand treadle and pressing down the left.

Method of opening the Shed

It is impossible to say at what period the important improvement in the apparatus of the loom was made, which consists in lengthening the short, heavy, independent comb, by which the weft had hitherto been beaten together, and attaching it to the loom itself, enclosed in a heavy swinging frame. It may be that at first the long comb was only fixed in the loom, near the front roller, in order to keep the warp threads from gathering together in places, as they are so apt to do. It is still used, for this purpose only, in looms built for the making of tapestry. When the long comb is fixed in this manner the short comb has to be used as well for beating down the weft. It led, however, to a great advance in the weaving process, when the idea occurred of hanging the long comb loose in the loom, in order that it might be used, not only for keeping the warp threads evenly distributed, but also for beating the weft together.

Origin of the Long Comb

By the adoption of the long swinging comb, needless to say, much time is saved. But more important than this, the blow of the comb is by this means evenly distributed across the whole width of the warp, and is so equalised that even the most delicate threads of silk or cotton, composing the warp, are not unduly strained, although a surprising amount of force may be used, after each shoot of weft, to beat the cloth together.

Advantage of the Long Comb

The name given to the long comb by weavers is the *reed*, because the divisions were originally made

Signification of the Name *Reed*

of fine strips of cane or reed, most carefully prepared and fixed between four half-round laths, in the

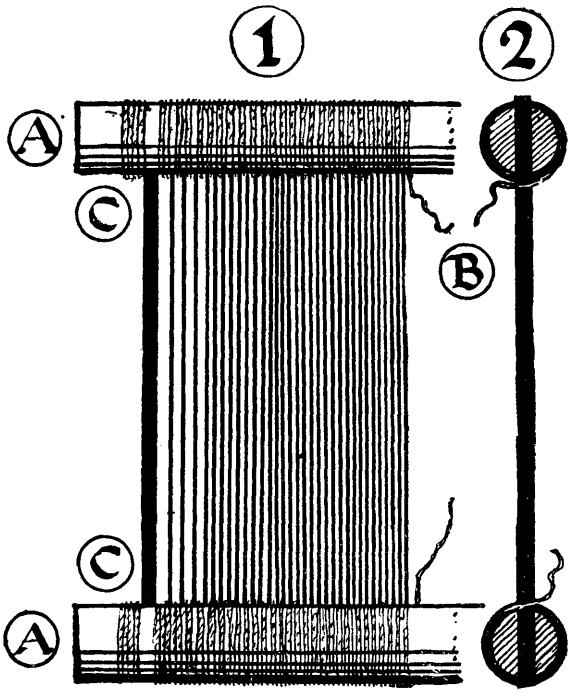


FIG. 45.—Method of Reed-making.

manner shown at fig. 45. A, A, no. 1, are the ends of four half-round laths, shown also in the section no. 2, bound together in pairs by a fine waxed cord, one end of which appears loose at B.

In order to make the reed, the laths had to be fixed in pairs about four inches apart, and, starting at one end, a rather thick strip of cane—shown at C, no. 1, and B, no. 2, fig. 45—was placed between the laths and bound in with the cord as there represented. This thick strip of cane was for the protection of the finer strips which followed after about a quarter of an inch of the binding cord had been wound about the laths. The fine strips were put in, one to each round of cord, the spaces between them being regulated by the thickness of the cord itself. The whole length of reed being thus built up, the end was finished off in the same way as the beginning. The bound laths were finally steeped in melted resin in order to fix everything securely.

Method of making the Reed

The spaces in the completed reed between the strips of cane were called *dents*, and for fine silk-weaving there were often as many as a hundred and twenty to the inch. Often several threads of fine silk were passed, or *entered*, as it is called, in each dent of the reed. These combs still retain the name of *reeds*, although, since the middle of the eighteenth century, metal has taken the place of cane for the strips. The best metal reeds are still made by hand in the same way as the old cane ones, but they are now for the most part made by machinery.

The heavy swinging frame in which the reed is fixed is called the *batten*, and the method of hanging it is clearly shown in the drawing of the old English loom (fig. 42). Fig. 46 represents a batten for use with a hand-shuttle. It is constructed as follows. A is a heavy block of hard wood called the *race-block*, having a groove cut in the top, at the back edge, the same length as the

The Batten

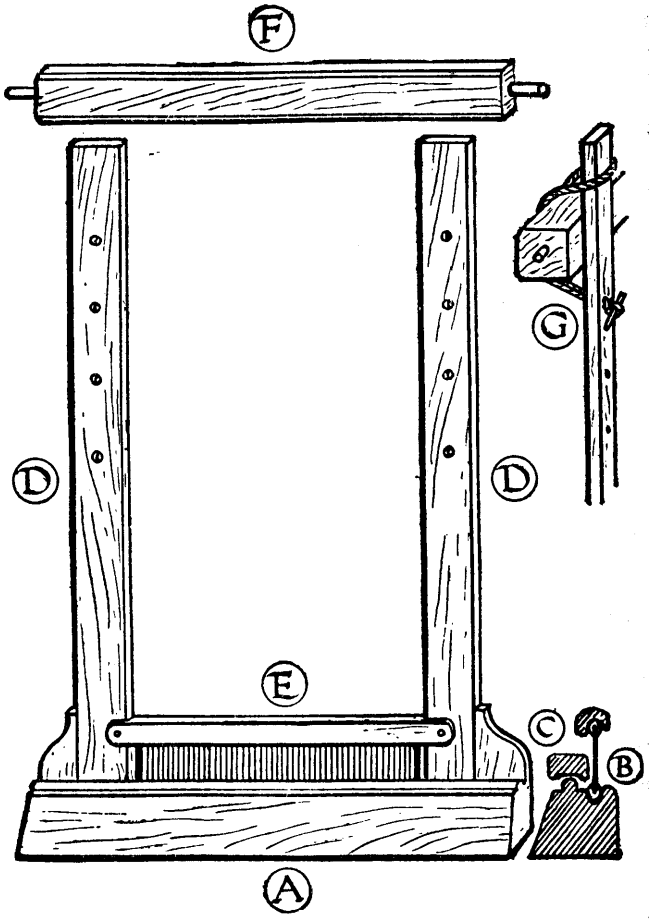


FIG. 46.—Hand-batten.

reed, and of the shape shown in the section at B. It also has a piece of polished beading along the top front edge. This is for the shuttle to run on (letter C in section) as it is thrown through the shed of warp, which is so regulated that the threads held down by the treadle press upon the beading and allow the shuttle to pass over them. D, D are called the swords of the batten, and are mortised into the race-block. E is a grooved cap, also shown in the section; it is movable, and its use is to fix the reed in its place.* F is the rocker by means of which the batten is hung in the loom as shown in fig. 42. When the batten is attached to the rocker by a double cord, as indicated in the side view G, its height can be nicely regulated by means of the peg at the back, which shortens, or lengthens the cord, by twisting, or untwisting it.

The Batten

In order to complete the description of the old English loom, it only remains to point out that the cross-piece, from which the headles are suspended, is movable, and may be fixed at any distance from the front of the loom necessary for the regulation of the shed. The nearer to the reed the headles are hung, the clearer and wider the opening in the warp will be.

Position of the Headles

The position of the batten can be regulated by moving the rocker backward or forward in the brackets on which it rests (fig. 42, I). When the right place for it has been determined it is fixed there by means of small screws being partially driven into the bracket at the front and back of the rocker pins.

Position of the Batten

All the essential parts of the loom for plain weaving are now described, and it is next necessary to explain the method of entering the threads of the warp in the *harness*, as a collection of two or more headles is called, and the reed. Entering has to be

To enter the Warp in the Harness and Reed

* See Addenda, page 340.

To enter the Warp in the Harness and Reed

done with great care and accuracy, as one mistake will throw out the whole succession of remaining threads. It is also very difficult to rectify mistakes when the entering is finished. In some cases the whole of the warp, beyond the faulty place, has to be drawn out and re-entered.

Fixing the Cross-rods for Entering

Fig. 47 shows a warp in the loom prepared for entering. At p. 72 the turner-on is described as finishing his work by winding the cross-rods with the warp on to the cane roller. If not turned on in the loom itself, the roller, with the warp on it, was brought to the loom and placed on the brackets of the back loom-posts. Two strong, side cords, A, C, C, C, were then firmly attached to the front posts of the loom, and, being carried over the ends of the back roller, were rather heavily weighted. The warp was then gently unwound, and the ends of the cross-rods were allowed to rest on the side cords at A. The unwinding was continued until the rods rested at B. The side cords were then twisted once round the ends of the rods, as shown in the drawing, and by this means they were securely fixed at that point, but at the same time could be readily moved backward or forward on the side cord weights being lifted. The warp can now be regulated so that the loops hanging below B will reach to the front of the loom.

Fixing the Headles for Entering

The headles had next to be specially fixed for entering, and for this the short pieces of wood D were provided. These were tied, as indicated in the drawing, to the top of the loom frame and to temporary staples driven into the floor. The ends of the top shafts of the harness rest upon the upper pieces of wood, and the bottom shafts are tightly held down

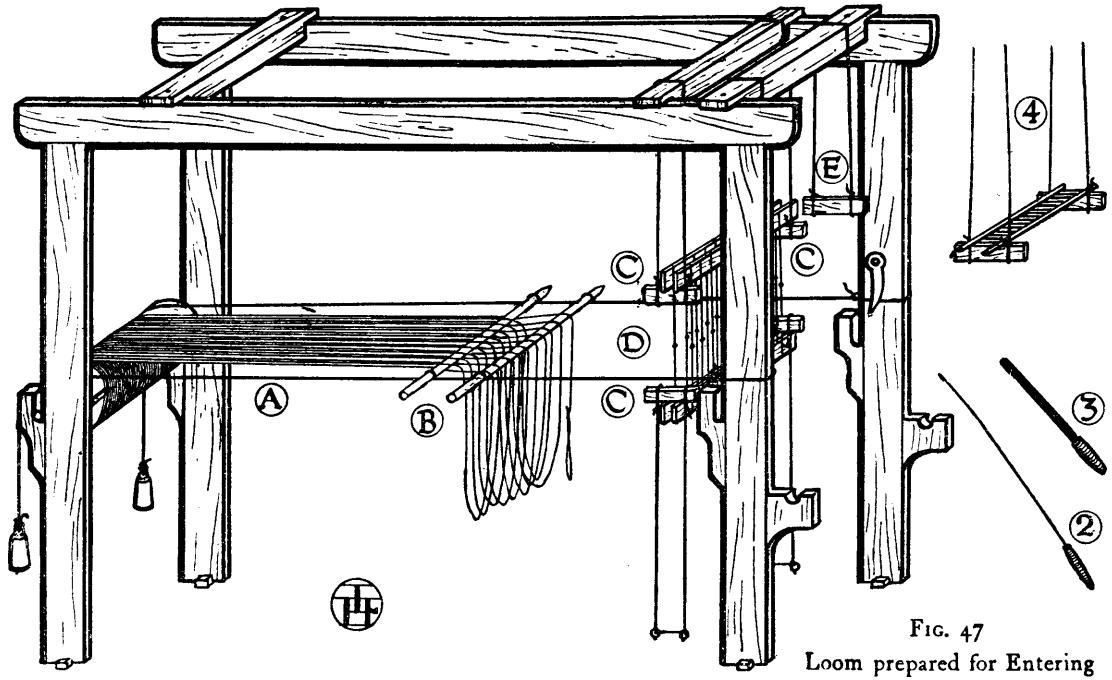


FIG. 47
Loom prepared for Entering

Fixing the Headles for Entering

by the lower pieces, which are attached by slip-loops to the staples in order to regulate them. By this means the leashes of the headles are rendered quite taut and the eyes can be readily selected in due succession by the enterer. To make them still more secure, which is necessary in the case of a rich, full harness of many headles, little blocks of wood may be placed between the ends of the shafts and the latter may be bound together with cords.

Entering Hooks

Nos. 2 and 3 are the hooks necessary for entering. No. 2 must be slender enough to pass easily through the eyes of the leashes, and the flat hook No. 3 must be thin enough to go through the fine dents of the reed.

Note about Entering

It may be noted here that entering only needs to be done when the loom, or at any rate the harness, is new. After a length of cloth has been woven, sufficient of the old warp is left in the loom, with the cross-rods in it, to allow of a new one being tied on to it thread by thread. When the threads are all joined the old piece of warp is drawn forward, and of course the new threads follow the old ones through the headle-eyes.

Method of entering the Harness

These preparations all being made, the entering can proceed. The enterer's assistant sits in the space D, between the warp and the harness. Beginning at one edge, he takes up a small bunch of the looped threads, and first cuts off the looped end; he gives it two or three sharp, firm pulls, which clear the cross between the rods and make it quite easy to select and separate the first thread. When this is done the thread is held ready to be hitched on to the enterer's hook as soon as it is pushed through the first eye in the harness.

The enterer himself sits in the loom in front of the harness, with the slender hook, no. 2, ready for use. He selects the first eye in the front or back headle and pushes the hook through it.* The assistant places the first thread on the hook, which, as it is drawn back, takes the thread with it. The enterer holds the thread in his left hand and repeats the operation with the hook, only selecting the first eye on the next headle, and draws through the second thread, which his assistant has picked out at the cross and placed on the hook. However many headles there may be in the harness, the first hook in each is filled before the first headle is returned to for the beginning of the second course. The keeping of this regular course all through the harness is of the utmost importance. As the entering proceeds, the entered threads are loosely tied together in small bunches, in order to prevent their slipping back again through the eyes.

Method of entering the Harness

Another pair of slings, marked E in the drawing, is placed in front of the harness. To these the reed is tied as shown at No. 4. The assistant now sits in front of the harness, and the enterer stands over him. The enterer thrusts the reed-hook No. 3 down through the first dent of the reed. The assistant holds the first bunch of threads in one hand, after having untied the knot. He traces out the thread coming through the first eye in the harness and places it upon the hook, which is then drawn up and treated in the same manner as when drawn through the harness. The first thread in each headle is taken in succession, and then the second,

Entering the Reed

* In England usually the back headle is first ; on the Continent it is the front.

Gating the Loom

and so on to the end. When the reed is all entered and the bunches of threads safely knotted, the loom will be all ready for the weaver to *gate*, as the adjustment of the parts of the loom for actual weaving is called.

The gating of the loom is always done by the person who is to weave the material upon it, as every weaver has his, or her own ideas as to the best way of adjusting the various parts for the work. It will therefore only be possible on this point to state the principal matters that have to be attended to. In the first place, cords must be attached to the top laths of the headles, preferably the back one, and passed over the pulleys of the centre cross-piece, in order to meet and be joined to short strings coming from the other headle. It is necessary that these, and, in fact, all the cords of a loom, should be so tied as to be easily adjusted to a nicety as regards length; the manner of doing this is, once for all, explained in Note 2 at the end of this chapter. When the headles have been securely connected by the cord, the slings at D, fig. 47, must be removed as well as those on which the reed is resting. The reed itself may, for the moment, be allowed to hang loosely from the harness, suspended by the knotted warp. The space in front of the headles being thus cleared, the batten must next be hung on its rocker in the position and manner shown at fig. 42. The cap of the batten, E, fig. 46, being removed, the reed can be fitted into the groove at the back of the race-block. This groove must be deep enough for the round edge of the reed to be completely buried, so that the silk or other threads of the warp may press on the smooth shuttle-race, and not

fray against the lower edge of the reed as the batten is moved backward and forward. The top edge of the reed is next to be caught in the groove of the reed-cap and the latter screwed by wing-nuts to the swords of the batten. The harness must then be brought to its proper place, by moving forward the cross-piece from which it hangs. The nearer it can be allowed to be to the reed the better, so long as it does not interfere with the swing of the batten. The greater the space between the batten and the harness, the larger the opening has to be made in order to be effective in front of the reed where the weft has to be shot. A large opening has the disadvantage of increasing the strain on the warp threads. The harness and the treadles will now be ready to be connected. A long cord must be tied, at both ends, to the bottom laths of each headle, as in fig. 42, and from the separate treadles, exactly underneath these cords, a double cord must be brought up, and joined to them by the adjustable slip-knot described in Note 2. It now only remains to arrange the friction brake on the cane roller as in figs. 42 and 43, to remove the side-cords and weights, A, C, C, C, fig. 47, to gently clear and separate the warp threads and move the rods as far back as possible, in order to finish the preparation, or *gating*, of the loom for actual weaving. (See end.)

Gating the Loom

NOTE 1, p. 90.—It is very important that the loom-posts should be set up exactly square, in order that the two rollers may be parallel to one another. Before they are permanently fixed they may be tested by a diagonal measurement being taken from the back left-hand post to the front right-hand one. If the distance between the back right-hand post and the front left-hand one

Notes

proves to be the same as that between the two others, the loom will be found perfectly square. The posts should be tested with a plumb-line for uprightness, and the rollers and all horizontal parts with a spirit-level.

NOTE 2.—In order to nicely adjust the length of the various cords for tying up the loom, a very simple slip-knot is used. A reference to figs. 21 and 21A, pp. 40 and 41, will be of use in describing it, as the first loop of the slip-knot is there illustrated. It is usual to *tie up* with double cords, as these always terminate either in a loop or two ends, both of which are necessary for the adjustable slip-knot. The cords to be thus joined are shown at A, fig. 48. The loop for the slip-knot is made at the end of the looped cord in the manner shown at figs. 21 and 21A. Through the loop thus made the two ends of the cord are passed as at B, fig. 48, and tied together in a single knot, after the loop has been drawn close round them, as at C. By pulling the two ends of the single knot the latter is drawn close to the loop, and it will be found, that, whatever weight is hung on the cords at D, the knot will not give way in the least. If, however, the ends of the cord are pulled up, it can be shortened at will, and if the knot is loosened the cord may be adjusted with great accuracy.

NOTE 3.—A large number of cords of exactly the same length are often required in tying up a loom. A simple way of measuring the lengths off, is to drive two nails into a board, or wall at the necessary distance apart, and to wind the cord on to them. If double cords are wanted the skein so made can be cut through at one end only, but if single cords are required both ends will have to be cut.

NOTE 4.—The weaver must know how to make the leashes for the headles of the harness, as well as the smaller ones for the heck of the warping mill (fig. 25, No. 4), as they often break and have to be renewed. For use with coarse warps of linen, woollen, or cotton threads

the leashes act quite as well if made separately and simply slipped, or tied on to the headles. When such

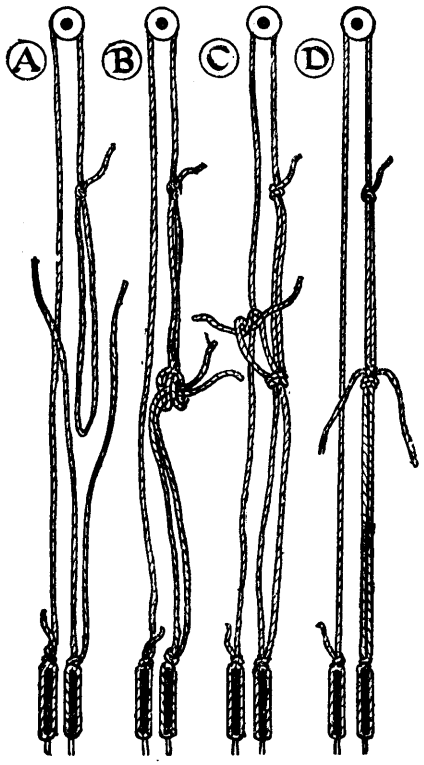


FIG. 48.—Knots.

a warp is entered the action of the loom in working is sufficient to keep the leashes in their proper places on

Notes

the headles. When the leashes are thus separate and movable the harness can be adapted for different counts and widths of warp, so that, when practicable, it is as well to have them so. But in the case of fine silk or cotton warps, of a great number of threads, the leashes must be fixed, and carefully spaced and knitted together on the headles. The appliance for making the separate

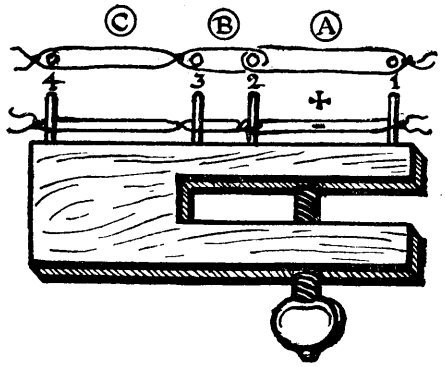


FIG. 49.—Headle or Leash Gauge.

leashes is shown at fig. 49. It is simply a board about fourteen inches long, one inch thick, and six inches deep. On the top edge are four smooth metal, or strong wooden pegs, arranged as in the drawing. The short loop A is made first, on the pegs 2 and 1. The thread is passed through it, and the centre loop, B, is tied round pegs 2 and 3, being double-knotted to prevent its slipping. The leash is finished off by the ends of the thread being tied together round peg 4. The size of the small loop or eye B, is regulated by the position of the pegs 2 and 3. When a large number of leashes are wanted, time may be saved by tying several A loops

before turning the board to tie the double loops B, C. The board may either be held between the knees of the worker or be fixed on a table in such a way as to be easily turned.

Note 5.—The knitted and spaced leashes for fine weaving have to be made on a frame prepared for the purpose (fig. 50). It is constructed as follows: Two

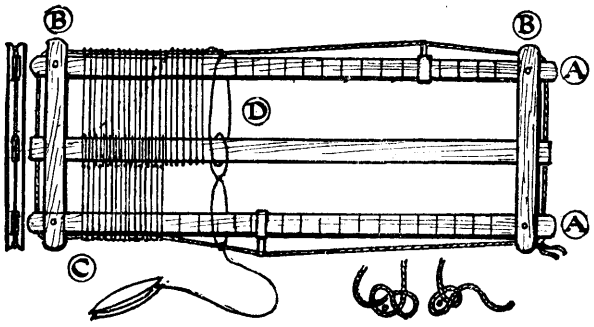


Fig. 50.— Headle Frame.

strong laths, A, A, four inches wide by half an inch thick, and at least three feet long, are neatly mortised into two thick end-pieces, B, B, so as to form an oblong frame not less than fourteen inches wide. The corners are not permanently fixed, but are held together by movable pegs. A wooden lath or brass rod crosses the frame, from end to end, passing through the end-pieces rather nearer to one lath than the other. The diameter of the rod or lath is determined by the size of the eyes the leashes are required to have. Both laths, A, A, are marked out in inches from one end to the other. This is for the spacing of the leashes, so many to the inch. The harness thread, which is made specially strong for the

purpose, is wound upon a small *mesh*, such as is used for the making of string nets.

The leashes are knotted to a strong, thin cord, which is tied and wound several times round one end of each lath and tightly stretched along the outer edge of the frame to the other end, where it is also wound and tied. As in the case of the separate leashes, the small loops of the continuous leashes are made first. The thread must be double-knotted to the cord by means of the mesh at the place where the headle is to begin. The mesh must then be passed round the brass rod, underneath the lath, and the thread again tied to the cord. Another loop is made in the same manner without severing the thread, and so on until the right number are made to the first inch. These being adjusted, the second inch can be made in the same way, and so on till the complete number required has been reached. In the drawing the loops are shown loose in order that their interlacement may be indicated, but they must actually be just tight enough to lie straight on the frame without bending the rod. The thread for the double loops must be tied at the beginning to the opposite lath in the same way as for the single ones. The mesh must then be passed under the frame and brought up through the opposite loop, over the rod, and, usually, double-knotted close by it ; then, being brought over the lath, it must be knotted at the place it started from. The first leash will now be complete, and all the others must be finished in the same way. The eyes of the leashes for silk-weaving are not always double-knotted ; many weavers prefer single knots as being less bulky. Single knots are, however, especially when the harness is new, very apt to slip out of place and give trouble. When finished the centre rod is drawn out of the frame, the pegs removed from the corners, and the collection of leashes thus freed is tied, by the cord to which they are knotted, to the laths of the headle.

CHAPTER VIII

THE ACCESSORY APPLIANCES OF THE LOOM

The Hand-shuttle—Superiority of Hand-shuttle Weaving—The Fly-shuttle—The Batten for the Fly-shuttle—The Raceboard—The Shuttle-boxes—The Pickers—The Picking Stick—The Action of the Fly-shuttle—Advantages of the Fly-shuttle—The Temple—The Skein Reels—The Doubler—The Quill-winder—Other Tools—Method of Weaving with Hand-battens—Method of Weaving with Box-battens.

The Hand-shuttle

THERE can be no doubt that as long as the upright loom only was used, the weft was passed through the opening in the warp in little skeins wound on the hand, or on the long spindles on which it had been spun. But as soon as the horizontal position of the warp was adopted, especially for plain weaving, it is certain that some kind of shuttle for carrying the weft came into use. The advantage given by the invention of the shuttle, was, that it could be thrown swiftly by the weaver through the opening, from edge to edge of the cloth. The ease and speed of the work would thus be considerably increased.

The hand-shuttle now used for silk-weaving is a

The Hand-shuttle

very different tool from the shuttle of the ancients, if we may judge from the few specimens preserved in the British and other museums. The general shape of it is, however, very similar. The chief qualities required in the shuttle are slenderness combined with a capacity for carrying a great length of thread, weight, in order to steady it in its rapid movement, and perfect smoothness of finish, so that it may run from side to side over the most delicate threads without catching up or fraying them.

Qualities required in the Hand-shuttle

Description of the Hand-shuttle

The best hand-shuttles are made of good, hard, boxwood. They are about eight inches long and one inch wide by three-quarters of an inch deep. The general shape and section are shown in fig. 51. The front edge, lower line, no. 1, is straight, and the back edge, which, when the shuttle is thrown, is towards the reed, is curved near the ends. At the ends, which are sharp and smooth, slips of metal are inserted in order to protect the points from damage should the shuttle fly out and fall. The curved shape of the ends is beautifully adapted for delicate throwing and catching. The top of the shuttle is flat, with rounded edges, but the bottom has the edges not only rounded, but slightly raised, in order to present less surface for friction with the threads over which it slides. The shape of the bottom is shown by the section at no. 2. In the centre of the top of the shuttle an oblong hollow is carved, as deep as it is wide. This is for the reception of the *quill*, as it is called, on which the weft thread is wound. At each end of the hollow a small, flat hole is made, and into one of these a minute, spiral spring is fixed. By means of this spring a piece of thin, hard steel wire, bent

in the form shown at no. 3, is kept in position, after it has been inserted by pressing one end against the spring and allowing the other end to be pushed by it into the opposite hole. The bent wire is for the purpose of holding the quill in the hollow of the shuttle, and it is bent to the shape shown in the drawing in order that it may act as a gentle brake to prevent the quill being unwound too freely. By

Description of the Hand-shuttle

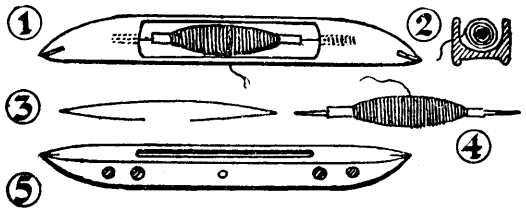


FIG. 51.—Hand-shuttle.

means of closing up or extending the ends of the bent wire the tension of the thread on the quill can be regulated to a nicety. At no. 4, the quill, with weft wound on it, is shown on the wire; it may also be seen in its place in the hollow of the shuttle in no. 1. The quills are now mostly made of paper, but occasionally a weaver will prefer a quill made of a small piece of hollow reed. Originally, no doubt, feather quills were used, as the name denotes. As the shuttle is thrown from side to side, the weft is unwound through the small hole shown in the centre of no. 5, into which a porcelain or glass eye is fixed. The quill must be short enough to move longitudinally as the weft is unwound, or the latter will be apt to break, how-

The Hand Shuttle in use

ever skilfully it may have been put on to the quill.

Fig. 52 represents the hand-shuttle in use. It is lightly held in the right hand of the weaver, partly within the open shed, and resting on the race-board, ready to be thrown by a slight, quick wrist movement. The throw causes it to glide along the beading, over the lower warp threads, to the opposite edge, where it is caught by the fingers of the left hand and guided into the palm. As soon as it is out of the shed the hand is withdrawn from the batten. This allows the reed, fixed in the batten, which has been held off by the thumb of the left hand, to fall against the weft and press it home. In the meantime the right-hand thumb is prepared, as soon as the blow has been given, to push the batten away for the next throw of the shuttle from left to right. In gating the loom the batten is so hung, that when at rest, the reed is just at the place where the weft is to lie. THE QUALITY OF THE WORK DEPENDS VERY MUCH UPON THE WAY IN WHICH THE SHUTTLE IS CAUGHT AND THE THREAD DRAWN THROUGH THE SHED. IN FACT, IT IS THE DELICATE MANNER IN WHICH THIS CAN BE DONE WHICH MAKES GOOD, HAND-SHUTTLE WEAVING SUPERIOR TO ALL OTHER KINDS WHATEVER.

The Fly-shuttle

The simple invention of the fly-shuttle, in the eighteenth century, was an extremely important event in the history and development of weaving. Its effect will be referred to later on, but it will be best to describe its construction in the present chapter, in which the weaver's tools are especially being dealt with.

The fly-shuttle differs from the hand-shuttle

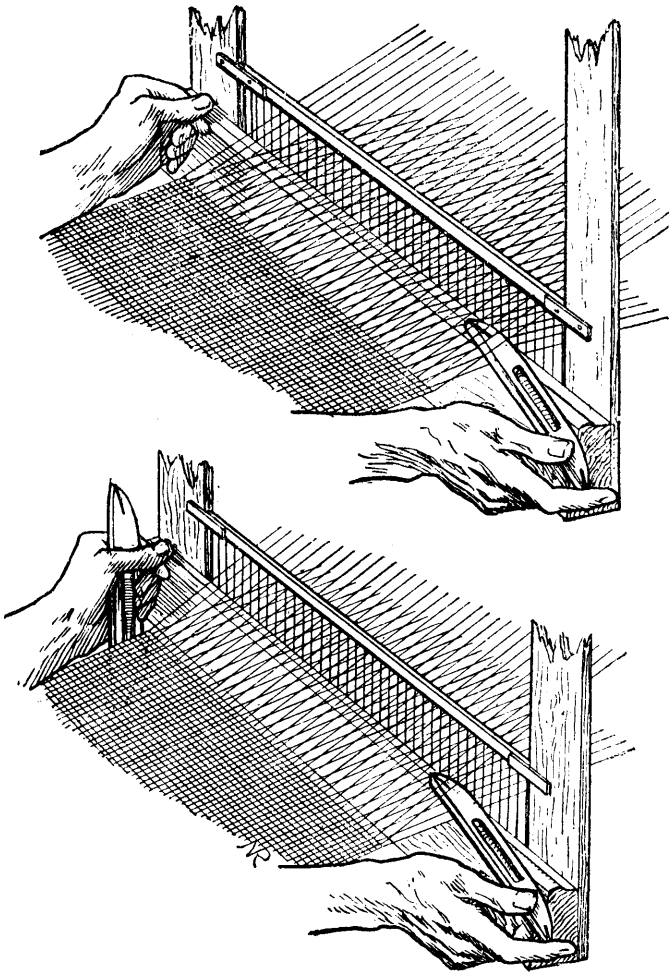


FIG. 52.—Method of handling One, or Two, Shuttles.
If more than two shuttles are used they are
laid in order on the web.

The Fly-shuttle

both in form and in the manner in which it is thrown and caught. The shuttle itself is represented in fig. 53. The difference in its form will be at once perceived. The fly-shuttle has both sides curved exactly alike, and the metal points are set exactly in the centre of the ends; they are also heavier than those of the hand-shuttle. The shuttle itself is longer, and deeper and broader in proportion

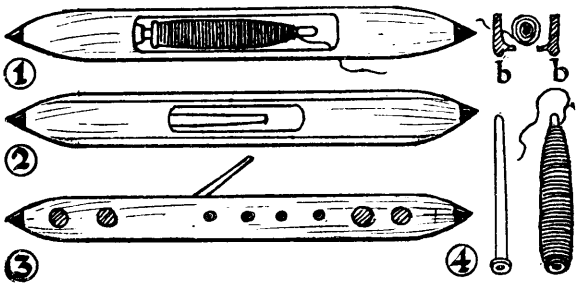


FIG. 53.—Fly-shuttle.

to its length. The weight of a fly-shuttle for silk-weaving is from three to four ounces, but for heavy work and power-loom weaving it is made much heavier. The oblong hollow for the reception of the quill, or spool, is in the same position as in the hand-shuttle, but differs in that it is cut right through. The opening at the bottom, however, is not so large as at the top. It is shown in the section between the runners b, b, and also in no. 2. In the hollow at no. 1, instead of the bent wire on which the quill is fixed, a thin metal spike is securely fastened. This spike is hinged at the end near where it joins the shuttle, so that it can be

turned up into the position shown in the side view, no. 3. For use, in this shuttle, the weft

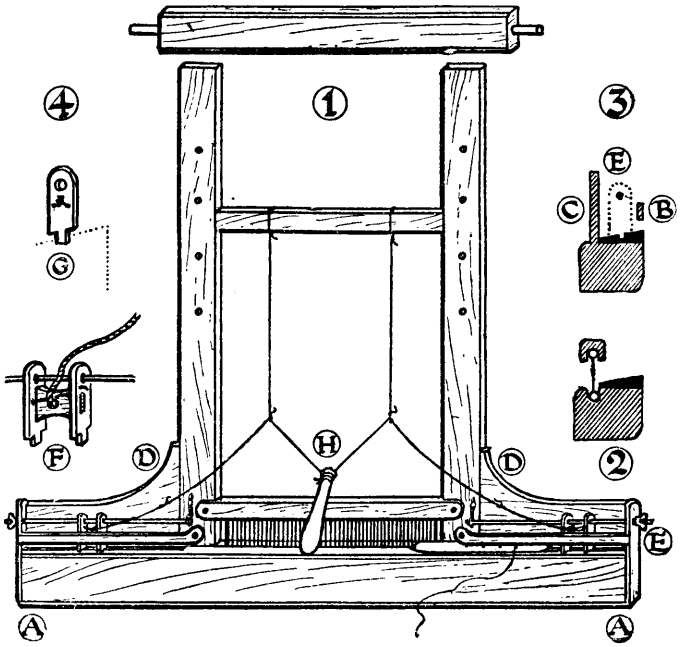


Fig. 54.—Fly-shuttle Batten.

is wound on to small hollow boxwood *plugs* (no. 4). When filled, these are pressed on to the spike, which is then turned down into the hollow. The weft, which is put on the plug in

The Fly-shuttle

such a manner that it unwinds uninterruptedly from the end, is threaded through the endmost hole, no. 3, and in and out of the other holes, according to the degree of tension desired by the weaver. In order to increase the weight of the boxwood, both the fly- and hand-shuttles often have holes drilled into them, which are filled with plugs of lead. The ingenuity of the fly-shuttle invention does not, however, lie in the shuttle itself, but in the contrivances for throwing and catching it. These consist of the shuttle-box, the picker or propeller, and the picking stick.

The Fly-shuttle Race

The *shuttle-box* is constructed on the race-block, extended, for the purpose, to about fourteen inches beyond the swords, on both sides of the batten (fig. 54). The shuttle race in a box-batten, instead of being merely a small rounded beading as in the hand-batten, is a perfectly even strip of hard wood, not less than two and a half inches wide, and long enough to reach from A to A, fig. 54. It is slightly bevelled, and when glued firmly to the race-block the surface gently slopes toward the reed. It is bevelled at such an angle that when the batten is pushed back, the race cannot slope outwards and cause the shuttle to fly off, as it passes along. The shuttle race has to be most truly and evenly made, as the least irregularity on its surface is fatal to the action of the shuttle. No. 2 is a section of the race-block, the race itself being indicated by solid black.

The Shuttle-box

The shuttle-box is shown in section at no. 3. It will be seen that it has a high back and a low front, C and B. Also that a groove is cut in the race. This groove extends from the end of the box to the edge of the sword D, no. 1.

Immediately over the groove, and a trifle longer than the groove itself, a thin metal rod, having a small flat head, is fixed. It is passed through a screw staple which projects from the sword to a hole in the end of the shuttle-box, where it is fastened by a screw and wing-nut, E. The Shuttle-box

The *picker* is represented at no. 4. It is usually made of buffalo-hide, which is very tough and hard, qualities most necessary for the purpose. Two pieces of hide cut to the shape of G, no. 4, are joined together by a piece of hard wood, strengthened with twisted wire, as at F. The tongues at the bottom of the pickers fit easily into the grooves in the bottom of the shuttle-boxes. The iron rod E, no. 1, passes through the hole at the top of the picker indicated by the dotted line (no. 3). No. 1 shows both boxes fitted up, each being furnished with a picker. The pickers have to move freely and firmly from end to end of the shuttle-box to the fullest extent allowed by the iron rod. The Pickers

The *picking stick* is represented at H, no. 1. It is simply a convenient handle attached to the centre of a strong cord, which is long enough to join the two pickers together loosely as in the drawing. It will now be readily understood that The Picking Stick

IF THE PICKING STICK BE PULLED WITH A SLIGHT JERK TO THE LEFT, THE SHUTTLE IN THE RIGHT-HAND BOX WILL BE DRIVEN OUT BY THE PICKER, ACROSS THE RACE, INTO THE OPPOSITE BOX. IT WILL THERE BE CAUGHT BY THE OTHER PICKER, AND ANOTHER JERK FROM LEFT TO RIGHT WILL BRING IT BACK AGAIN. This, roughly speaking, is the method of using the fly-shuttle. Action of the Fly-shuttle

Advantages of the Fly-shuttle

The advantages of the use of the fly-shuttle are, mainly, two: (1) The weaving can be done with increased speed. One hand only is required to work the picking stick, the other being left free to manipulate the batten, the beat of which may consequently be made much more rapid. (2) Webs of great width, which would be impossible to weave with a hand-shuttle, can, by means of the fly-shuttle, be as quickly woven as narrow ones. It is very rare to find any woven stuff, more than thirty inches wide, made before the invention of the fly-shuttle. If ever such wide work were attempted, two weavers were employed, one to throw, and the other to catch the shuttle.

It should also be noted, that, the invention of the fly-shuttle rendered that of the power-loom possible. the throwing of the shuttle being the chief difficulty which the inventors, who attempted to apply steam-power to the loom, had to overcome.

The Temple

The temple is an appliance that should not often be required in hand-loom weaving. If the warp and weft are properly proportioned one to another, the cloth, as it is woven, will not "draw in" narrower than the entering of the warp in the reed, to any appreciable extent. When, however, it is found that this "drawing in" takes place, it may be readily corrected by the use of the temple.

The temple for hand-loom weaving is quite simple in construction. Two pieces of hard wood are cut to the shape shown in fig. 55, no. 1. At the broad end of each of these a row of fine points is set. These, when joined together, are for the purpose of holding out the edges, of the material being woven, to the required width. The means

of adjusting the length of the temple are shown at A and B, nos. 1 and 2. A is a loose metal band fitting closely to the two parts of the implement. B is a long pin, which may be put through any of the holes in the two members, in order to join them together. The pin is first inserted, and the temple placed on the cloth a few inches from the reed, with the end points catching the edges of the

The Temple

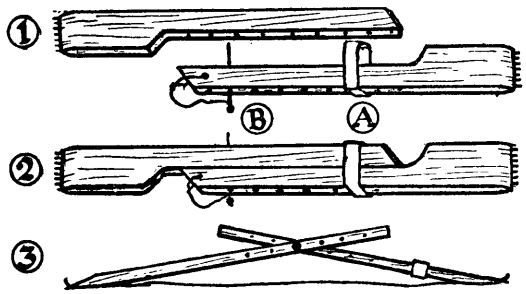


Fig. 55.—Temple.

material. This position is shown at no. 3. When placed thus, if the temple be pressed down it will slightly force out the edges of the web. The metal band A will keep it flat if slipped on as at no. 2.

When the weft is supplied to the weaver in skeins, a pair of reels, mounted on a stand in such a manner that the distance between them can be regulated, will be required (fig. 56). The upright of the stand has a slot cut in it for the greater part of its length. The reels revolve on elongated axles, and may be fixed in the slot, at any height, by means of a screw and collar. This is for the purpose of adjusting them to different-sized skeins. The weft is usually wound

The Skein Reels

The Skein Reels

first on to bobbins, and from the bobbins on to the quills or plugs ready for filling the shuttle.

The Doubler

Several threads of weft often have to be slightly twisted together in order to make up the required thickness for each shoot. It is seldom, indeed, that a weft is made up of less than two ends. The little contrivance generally used for this *doubling*, as it is called, is shown in fig. 57. It has a solid square stand, A, and an upright, B, from the top of which a short arm extends, having a smooth hook, C, at the end of it. About a foot above the stand there is a shelf, D, in the centre of which a thin tube of glass, or metal, is fitted into a hole. The tube is small enough to go through the hole in a bobbin when one is stood over it in the centre of the shelf. For example, let it be supposed that four threads of weft have to be wound together on a quill. Three bobbins must be placed on end, near together,

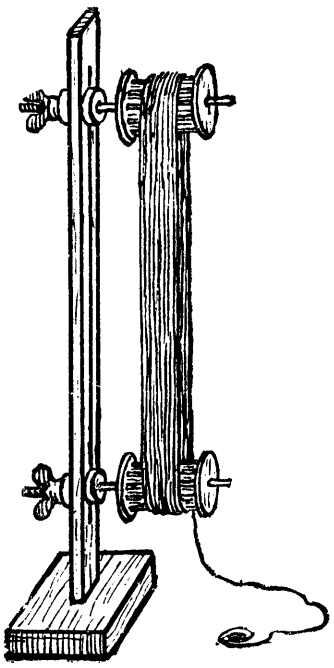


Fig. 56.—Skein-winder.

on the stand, in such a position that the silk upon them all unwinds in the same direction. The three ends of thread from these bobbins have to be carried up through the tube in the shelf D, on which the full bobbin, E, has previously been placed, as shown in the drawing. The ends of the threads from the four bobbins are then taken over the hook C, and as the silk is drawn off the bobbins, that from E gently winds round the other three threads and loosely unites them. No. 2 shows the shape of the rimless bobbins used for weft.

The Doubler

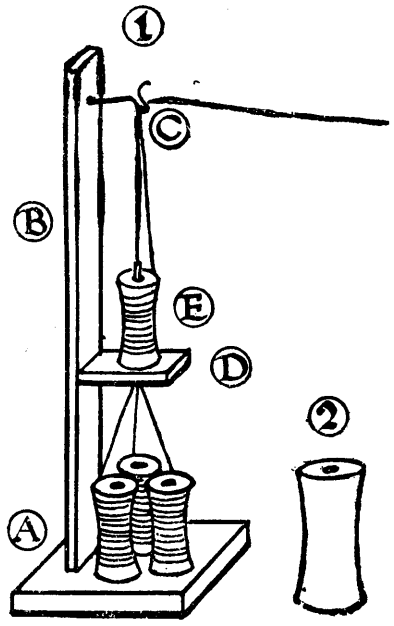


Fig. 57.—Doubling Stand.

The *quill-winder* is a very important adjunct to the loom, as good winding is very necessary for successful weaving. This is especially the case when several threads are wound together on the quills. A drawing of the most useful kind of winder is given in fig. 58.

The Quill-winder

A small, low table, about two feet long, has two,

The Quill-winder

firm uprights fixed near the right-hand end. Between these a small, heavy wheel, having a broad, shallow groove on its edge, is truly poised on an axle, which terminates in a small handle. By means of this handle, the wheel can easily be made to revolve with

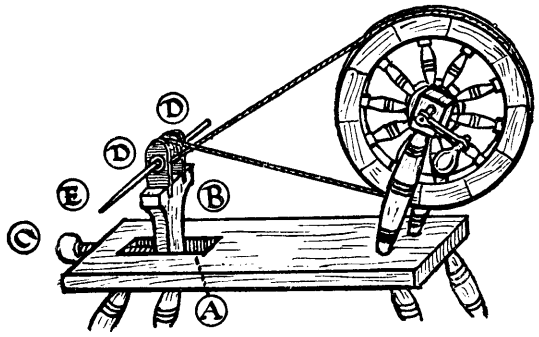


FIG. 58.—Quill- or Plug-winder.

great rapidity. At the opposite end of the table a slot, A, is cut, and into this a shaped block is made to fit. The large screw C, which, after passing through the edge of the stand into the slot, runs into the block, not only secures it firmly in position, but is used to regulate the distance between the block and the wheel. D, D is a pair of thick leather bearings, in which a metal spindle, having a pulley in its centre, is carefully fitted. The pulley is connected by a cord to the large wheel, and the latter being turned causes the spindle to revolve with great rapidity. The elongated end of the spindle E is tapered, so that the hollow plugs or quills can be fixed on it, and on these the weft is wound very carefully as the spindle

revolves, and with perfect evenness (see Note 1 at end of chapter, p. 127).

The Quill-winder

Fig. 59 represents the weaver's shears, the picker and nipper, and the rubber The shears and nipper are in constant requisition, but need no explanation. The rubber is made of sheet steel, with a wooden handle, and is used for rubbing the surface of the woven material after it has been cleared of knots and ends. Its use is particularly needed in plain silk-weaving, the evenness and beauty of which it much enhances.

The Shears, Nipper and Rubber

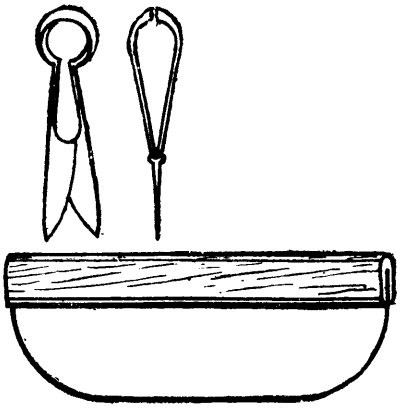


FIG. 59.—Shears, Picker and Nipper, and Rubber.

The hand-loom for plain weaving and all its appliances, as well as the necessary preparations for the work itself, having been described, the actual process of making cloth, both by hand-shuttle and fly-shuttle, will only require a very brief explanation. For this purpose reference must again be made to fig. 42, which fairly represents a gated loom, except in respect to the harness, which is placed too far from the batten. This was purposely done in order to show the headles quite clearly.

Method of Weaving

The weaver takes his seat in the loom, his feet

Method of Weaving

lightly resting on the treadles. He begins by pressing with his left foot the treadle on which it rests. This immediately raises the back headle and depresses the front one. The result of this action is the first open shed. On pushing back the batten a few inches, by pressing the thumb of his left hand against it, a part of the shed appears in front of the reed, and if the loom be properly gated, the opening will be found large enough for the insertion of the shuttle. The method of throwing the hand-shuttle has already been fully described at p. 114, and should here be referred to, together with fig. 52, which shows the hand-shuttle in use. It must be added, however, that as soon as the shed is free from the shuttle after every shoot, and the batten is released in order to beat the weft into place, the opposite treadle must simultaneously be used and the shed changed. This prevents the newly laid weft from springing out of position, and makes all ready for the following shoot. It must also be emphasized, that, when catching the shuttle after the second and following shoots, the weaver gives a slight pull to it, which causes the weft to lie straight in the warp, and brings it exactly to the edge, where it turns in, at the opposite side. Unless this is properly done the *selvage* will be disfigured either by a pucker or a loose loop.

As the weaving progresses the breast roller has to be turned from time to time, in order to roll the newly made cloth upon it. This is done by means of a short, strong stick which fits into the holes in the roller, one of which is shown near C, fig. 42. (See *take-up motion*, note 2, at end of chapter).

With regard to the friction brake on the cane

roller, both the heavy and light weights must be kept suspended. Neither must be allowed to approach too near either to the roller or the floor, or their effect will be marred. Method of Weaving

When the box-batten and fly-shuttle are used, the left hand of the weaver is kept on the cap of the reed (fig. 54), near to its centre, and the right hand holds the picking stick. The way the box-batten is balanced in the loom is rather different from that of the hand-batten. Instead of the weaver merely allowing the batten to fall against the weft to beat it together, in this case, he pulls the batten towards him with his left hand, with whatever force is required for the blow. The box-batten, therefore, is not hung so near to the front of the loom as the hand-batten. The quality of the work, when the fly-shuttle is used, depends, of course, mostly upon the way in which the picking stick is manipulated. The shuttle has not only to be driven by a jerk of the hand, but to be caught on the picker at the other edge in such a way as to cause it gently to slide into the shuttle-box without any rebound. The knack of doing this, as it should be done, by a simple drop of the hand, is only to be acquired after a great deal of practice. The evenness of the selvages of the web, which is the final test of good weaving, depends almost entirely upon the manner in which the shuttle is caught in the box. Weaving with Box-battens and Fly-Shuttle

Note 1.—The winding of the plugs or quills for the shuttle is most important. If it be badly done it is impossible to do good weaving. This is particularly the case with regard to winding for the fly-shuttle. Loose, uneven shoots, knots, loops, and all sorts of disfigurements in the web, are the result of careless winding; to say nothing Notes

Notes

of breaking threads and the flying out of the shuttle from the loom. Fig. 59A will show the proper method of winding the weft. No. 1 is the correct shape of a wound quill. No. 2 shows the way it should be started. The thread must first be wound from A to B, and each layer should gradually diminish in length until the shape of No. 1 is attained, and is finished off in the centre.

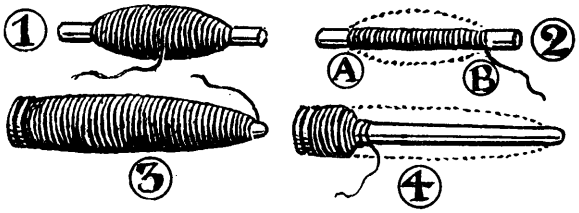


FIG. 59A.—Quills and Plugs.

The plug for the fly-shuttle (no. 3) must be so wound, that it will run off clearly from the point. It must be filled up at the thick end, to its full size, and the shape of no. 4 must be retained until it is finished off at the thin end. A well-wound plug will run off quite freely from the fixed plug, in a single thread, from beginning to end. A badly wound, soft quill or plug will come off in lumps, get entangled, and give much trouble to the weaver.

NOTE 2.—What is called a *take-up motion* is sometimes fitted to a hand-loom. This is an arrangement of cog-wheels, or worm and wheel, which causes the cloth to wind on to the breast roller automatically as it is woven. That this is not necessary is proved by the fact that weavers usually wind the motion by hand, instead of connecting it to their treadles or Jacquard machine, as is intended.

Plate VII.—Tapestry Ornaments. Fragment of a Robe of Amenhetep II., found in the Tomb of Thothmes IV. Amenhetep, whose Ka name is woven in the design, reigned in Egypt, B.C. 1500.

See page 133. FRONTISPIECE TO PART II. *Cairo Museum*.

PART II

SIMPLE PATTERN-WEAVING

PART II

SIMPLE PATTERN-WEAVING

CHAPTER IX

TAPESTRY-WEAVING

A Definition of Pattern-weaving—Ancient Textile Decoration—The Origin of Tapestry-weaving—Tapestry a Variety of Plain Weaving—The Effect of tight and loose Wefting—Tapestry-weaving necessarily an Artistic Handicraft—Tapestry akin to Embroidery.

Definition of Pattern-weaving

THE art of pattern-weaving consists in the mechanical repetition of a simple or a complex ornamental design, wrought in as the fabric is being woven, and occurring at regular intervals in more or less obvious geometrical shapes and spaces. With this kind of pattern-weaving there is no evidence to prove that the ancients, with the exception, perhaps, of the Chinese, had any acquaintance. The webs of Egypt were famous throughout the ancient world, and the Egyptians exchanged the productions of their looms for the manufactures and other merchandise of neighbouring, and even far-distant, nations; but amongst all the examples of Egyptian webs, so many of which

Pattern-weaving Unknown to the Ancients

Pattern-weaving Unknown to the Ancients

have been preserved to the present time, there have been found no specimens of mechanical pattern-weaving. It is true that a few trifling attempts seem to have been made to vary the texture and appearance of these ancient weavings, by means of the use, both in warp and weft, of different-sized and different-coloured threads, but even these are extremely rare, and in some cases may even be accidental.

The Kind of Textile Decoration practised by the Ancients

Although the mechanical weaving of design does not seem to have been practised by the ancient Egyptians, it must not be supposed that the plain, fine webs made by them remained undecorated, for, on the contrary, many of them were highly ornamented. Such ornamentation, however, was not produced in the loom automatically or in the actual texture of the fabric. It was added to the material either when in progress or after it was finished, and was done by means of painting, dyeing, stencilling, stamping, printing, or embroidery, with or without a needle. The designs thus applied to these ancient textiles consisted, for the most part, of bands of ornament and detached spots powdered over the ground.

Origin of Tapestry-weaving

Towards the middle of the dynastic period in Egypt (B.C. 2000) the fine linen mummy-cloths, which had hitherto been quite plain, are found to have stripes of different-coloured weft, occasionally shot across them. They also often have short spaces of warp left unwoven, forming bands across the material. It may well be assumed that the idea of darning in a pattern on these bare spaces of warp, in imitation of the applied borders of ordinary needle-work, would occur to some enterprising embroiderer, and, being carried out, would be the beginning of a

new form of textile decoration. This in turn might lead to the cutting away of the weft in spots and spaces, as in drawn-thread work, and to these being filled in with darning in a similar manner. At any rate, whatever may have been its origin, there is now evidence that such work was done in great perfection as early as B.C. 1500. It was practised as a traditional method for the ornamentation of woven materials in Egypt until the Ptolemaic period (B.C. 305), was continued through the Roman period and during the early centuries of the Christian era. The British Museum and the Victoria and Albert Museum at South Kensington are particularly rich in specimens of the Egypto-Roman work, but at present there are only three samples of ancient Egyptian weaving of this kind known to exist. These are in the museum at Cairo. They were found in 1893, in the tomb of Thothmes IV., who reigned in Egypt B.C. 1450. The smallest and oldest piece of the three has, worked into it, the cartouch of Amenhetep II., who reigned fifty years earlier than Thothmes IV. They are fine, delicate pieces of workmanship, and must be typical of the best textiles of that period (plate VII).*

Origin of Tapestry-weaving

With regard not only to Egyptian, but to almost all ancient, ornamental textiles of earlier date than A.D. 600, it may safely be said, that, however elaborate they may seem to be, they exhibit only two sorts of simple, plain weaving, and that these two sorts of weaving only differ in the manner in which the weft is laid in the warp.

Ancient Ornamental Textiles consist of only Two Sorts of Plain Weaving

* For a full and interesting description of these precious fragments see Mr. W. G. Thomson's "History of Tapestry."

Ancient Ornamental Textiles consist of only Two Sorts of Plain Weaving

In the plain ground of these ancient webs, the weft is passed across in the shed with sufficient tension to pull it straight, as has been fully explained in Part I., on plain weaving. The effect of this is, that the warp and weft show in almost equal proportion in the finished material. For the ornamental parts, however, the weft is placed quite slackly in the shed, with the result, that, when it is pressed down, the warp is completely covered up and hidden by it. For example, if a white warp be shot with white weft in the ordinary way, white cloth will, of course, be made. But if the weft be changed to black for, say, twelve shoots, a grey stripe or band, across the material, will be made by the mixture of the black weft with the white warp, each showing equally. If, instead of the black weft being shot in the usual way, it be put in quite loosely, the first shoot, when pressed down, will cover the first, third, and all the odd-numbered threads in the front, and the second and all the even-numbered ones at the back. The next shoot will cover the even-numbered threads in the front and the odd-numbered ones at the back, so that, the two shoots together will make a continuous line of black weft right across the cloth. If the loose wefting be continued for twenty-four shoots, the result will be a band of solid black, of about the same measurement as the grey band obtained by the ordinary manner of weaving.

Example of Tight and Loose Wefting

In fig. 60, a piece of cloth worked, in the above manner, in two sorts of tabby weaving is shown. At A, A, A, A the white warp and weft are interlaced in the usual manner. At B, the white warp is shot in the same way, but with a black weft, thus

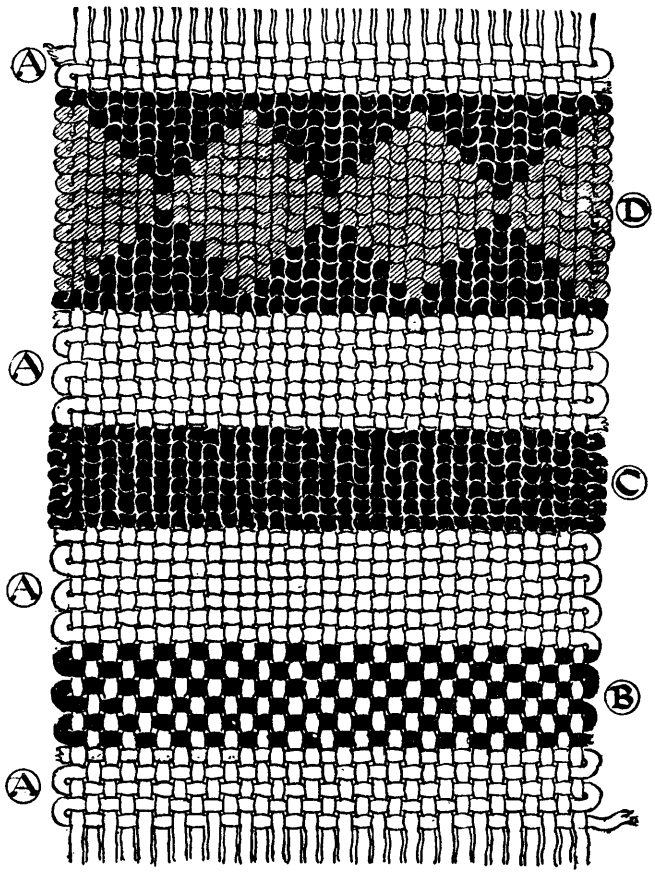


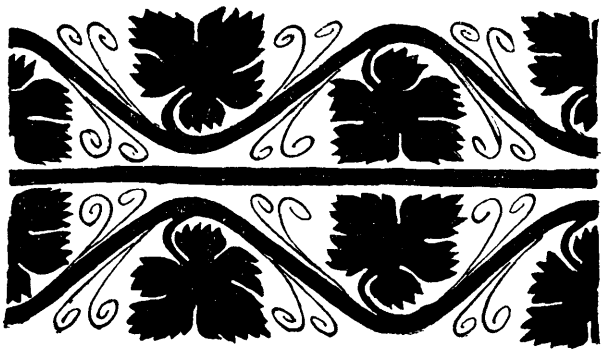
FIG. 60.—Bands of Tabby and Tapestry-Weaving.

Example of Tight and Loose Wefting

forming a grey band. At C the white warp is shot loosely with black weft, so that the warp is entirely hidden. At D the loose weft, instead of being carried right across, is worked up in pyramidal shapes, from their bases on nine threads to their point on one thread. Into the spaces between these pyramids, diamond shapes, in some other colour are fitted, still with loose weft. They begin on a single thread, and, after filling the space, are diminished again to a point. The triangular shapes now remaining, are filled in with black, until a line is reached at which the ordinary white ta by weaving again begins.

This is precisely the method in which all the beautiful textiles of ancient production, that remain to us, were woven. Figs. 61 and 61A are examples copied from the borders of a Coptic textile in the Victoria and Albert Museum. The exquisite designs of these tapestry-woven ornaments in plain linen webs, have often been commented on, but the technique of the work has seldom, if ever, been described. The spaces for the patterns were either left unwoven, or the weft was cut away, in the desired shapes, after the length of fabric was taken out of the loom, as in drawn-thread work. On the warp threads thus laid bare, the pattern, in two or more colours, was darned by means of a needle, or worked in with the fingers, the loose weft being passed backward and forward between alternate threads in the manner above described.

There are no examples remaining from classic times of tapestry hangings of any considerable size, but it may be assumed that the famous picture tapestries, so often referred to in Greek and Roman



Example of Tight and Loose Wefting

FIG. 61.—Coptic Border.

history and poetry, were made in the same manner as the textile ornaments of these Egypto-Roman and Coptic webs—that is, they were a mosaic of many coloured pieces of simple weaving with a loose weft, the plain ground between the ornaments probably being entirely dispensed with. Whatever may have been the technique of these ancient works, there is no doubt that this was the simple method used in weaving the wonderful Mediæval, Renaissance, and later tapestries with which our museums and private collections abound. It is an interesting fact, that, the loose weft cannot be put in by machinery, or

FIG. 61A.—Coptic Border.

Tapestry-weaving necessarily a Purely Artistic Handicraft

thrown swiftly across the web in a shuttle. As this must always be done with judgment, tapestry-weaving is likely to remain a purely artistic handicraft as it has ever been.

Tapestry akin to Embroidery

Tapestry-weaving is really, as has been pointed out, akin to embroidery, and only differs from it, in that it is freely darned or woven in the simplest manner on a bare warp, instead of being wrought upon an already woven material. It was therefore quite appropriate, that it should have been treated of in the volume of the present series devoted to needlework. To that book any reader desirous of following out the subject in detail must be referred.* It was necessary, however, to give some little attention to the matter here, in order that the automatic weaving of repeated pattern might be clearly distinguished from tapestry-weaving.

* "Embroidery and Tapestry-weaving," by Mr. A. H. Christie. Artistic Crafts Series of Handbooks (John Hogg, publisher).

CHAPTER X

THE SIMPLEST WARP AND WEFT EFFECTS OF PATTERN

Further Definition of Pattern-weaving—Patterns possible on the Loom with only Two Headles—The Striped Webs of India—Ancient Use of Striped Cotton Hangings—Patterns resulting from striping the Warp—East African Woven Design—Various Simple Warp Patterns—Simple Weft Effects—Tartan Patterns—Inlaying or Brocading—Primitive Indian Brocading—Usual Method of Brocading—Binders or Ties—Brocading on Weaving Board—Extra Headle for Brocading—Long and Short Eyes of Headles—Cashmere Shawl Weaving—Origin of Brocading.

Further Definition of Pattern-weaving

WE have seen how entirely dependent, in tapestry-weaving, is the working out of any ornamental design, on the artistic skill and taste of the weaver. We have seen also, that as the technique of tapestry is so simple, scarcely any tools or mechanical appliances are necessary in order to weave it. Ordinary pattern-weaving, on the contrary, whether simple or complex, is done by means of certain devices and appliances which have been invented from time to time in the course of ages. By their use the loom is *set up* or *tied up* under the direction of the designer, in such a way, that, when the weaver begins his

Further Definition of Pattern-weaving

shuttling, the design will be woven and repeated automatically, in the loom, as the work proceeds. This being so, the weaver's whole attention can be given to the keeping his loom and all its fittings in order, and his threads of fine silk, or other material, mended and even, both in warp and weft. In a fine silk loom, of thirty or forty thousand threads in the width, this is quite sufficient occupation for one man or woman.

Needless to say, the mechanism by means of which the pattern is worked out, which is often a marvel of ingenuity, was not all invented at one time. In fact, every weaver is continually devising little helps and dodges for his own use. But the most important contrivances were invented very early in the history of the loom, and succeeding generations of craftsmen have only extended and developed them. It must never be forgotten, however, that EACH STEP TOWARDS THE MECHANICAL PERFECTION OF THE LOOM, IN COMMON WITH ALL MACHINERY, IN ITS DEGREE, LESSENS THE FREEDOM OF THE WEAVER, AND HIS CONTROL OF THE DESIGN IN WORKING.

Patterns possible on the Loom with Two Headles only

We must now return to consider the old English loom, fitted up as represented in fig. 42, and inquire as to the possibility of designing patterns which can be woven automatically upon it—patterns, that is, which will work out, as the weaver proceeds, shoot by shoot, as if he were making plain cloth. It is obvious that such designs must be very simple in character, and must depend entirely on some arrangement, or diversity of the threads, in warping. It is interesting to find that a great variety of patterns can be designed to work out in this simple way.

The Indian weavers of fine cotton fabrics have always been famous for warp pattern effects. They were perhaps the first to make use of broad and narrow stripes of contrasting colours in their webs. This is of course the simplest of all pattern effects to be obtained. Many of these Indian fabrics, by reason of their finely contrasted colours and the pleasant proportion of their stripes, are very beautiful in effect, and can be used with great advantage in personal and architectural decoration.

The Striped Webs of India

The garden court of the palace of Shushan, where the little drama of Esther and Ahasuerus began, was hung, no doubt, with material decorated with coloured stripes. The hangings are described as of "white, green, and blue, fastened with cords of fine linen and purple, by silver rings, to pillars of marble" (Book of Esther, ch. i. v. 6). This account of an ancient decorative scheme, furnishes us with another evidence of the frequently remarked unchangeableness of the East, for just such striped and coloured webs, are being made by the Indian weaver of to-day on his simple hand-loom, a counterpart of the ancient loom, on which, the hangings for the Persian palace court were woven so long ago.

Ancient Use of Striped Cotton Hangings

By means of striping the warp, in quite a different manner from the above, a large range of small patterns can be made which are very interesting. As these are constructed on the same principle as that on which suitings and homespun cloths are designed, it will be well to devote some little space to their particular consideration.

Patterns resulting from striping the Warp

A delicate and pretty example of this simple kind of pattern-weaving may be seen in a case of

East African Woven Design

"personal ornaments" made by the natives of East Africa, exhibited in the ethnographical galleries of the British Museum (see plate I). The pattern is in very dark blue (almost black) and bright red, on a white ground. This design, in common with those just referred to, is made by taking advantage of the fact that in plain, or "tabby," weaving, one shoot of weft has all the odd-numbered warp threads above it and the even ones below, while in the next shoot the order is reversed, the even threads being above and the odd ones below.

Copy of East African Woven Design

The collotype illustration plate VIII is taken from a woven copy of the edge of the East African web just mentioned. It is shown in process of making. The loom is simply a small board with a warp stretched on it. The sheds are opened by a shed-stick and leashes as described at p. 85. The actual width of the web is an inch and a quarter, in which space there are sixty threads, eighteen being black and forty-two white.

It certainly appears curious that if white and black threads are warped alternately rather close together, so as to well cover up the weft, the effect of black and white lines running, as might be expected, in the direction of the warp, will not result when the web is woven. Instead of running longitudinally, the black and white lines will be across the web, as in no. 1, fig. 62. In this diagram the black vertical lines represent the odd threads of a warp, and the white lines the even ones. If a shed be made by raising the odd threads and depressing the even ones, it is manifest that only the black portion of the warp will show on the front of the material. The next shed being

made, the position of the threads will all be reversed, and the white portion of the warp now being above the weft, no black will be visible at all. If, as is necessary for this kind of pattern, the warp be full enough to well cover up the weft, the latter will interfere very little with the colour of the latitudinal stripes.

Copy of East African Woven Design

No. 2 shows the warping of an even and odd, and an odd and even black thread, warped alternately at regular intervals in the whole width, the result of this warping being, when the stuff is woven, two vertical zigzag lines with opposing curves.

By warping the black and white threads in the order shown at no. 3 the latitudinal lines given by the warping of no. 1 are cut up into alternate squares, and form a common checker pattern.

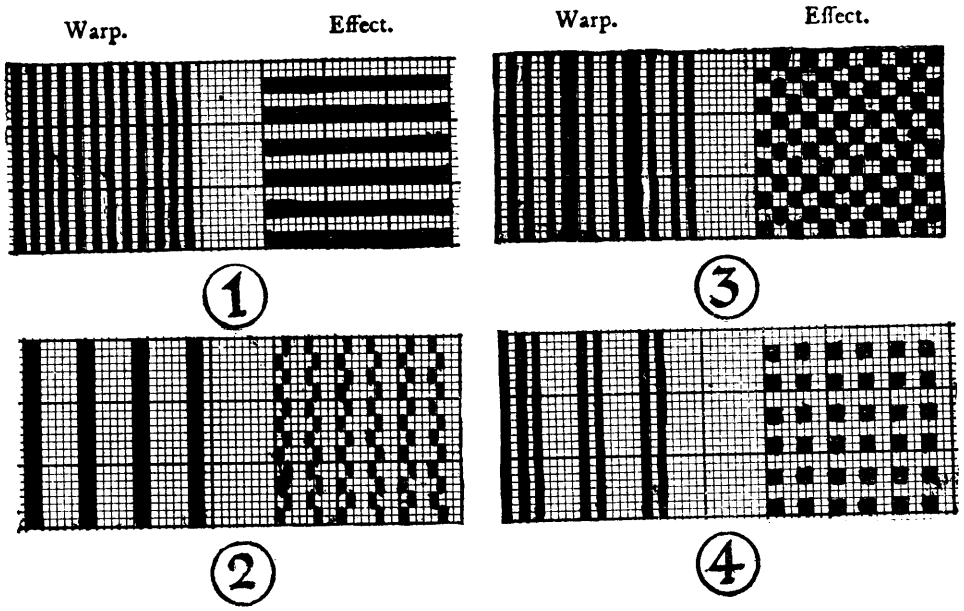
The warping of no. 4, weaves into detached squares, and no. 5 forms quite an elaborate pattern, with border.

The warping represented by no. 6 is that of the border of the East African web, a copy of which is shown in plate VIII.

These diagrams give only a few of the designs which can be made for this simple form of pattern-weaving. The number possible is infinite, especially if threads of various colours are used in addition to the black and white ones.

By striping the *weft* an additional number of simple patterns can be made. But weft effects cannot be rendered automatic except by the aid of much more complicated machinery than the loom, as at present described, is furnished with. For weft effects, the weaver would have to count his shoots, or measure off spaces, in order to keep any

Simple Weft Effects


Warp.
Effect.
Warp.
Effect.
1
3
2
4

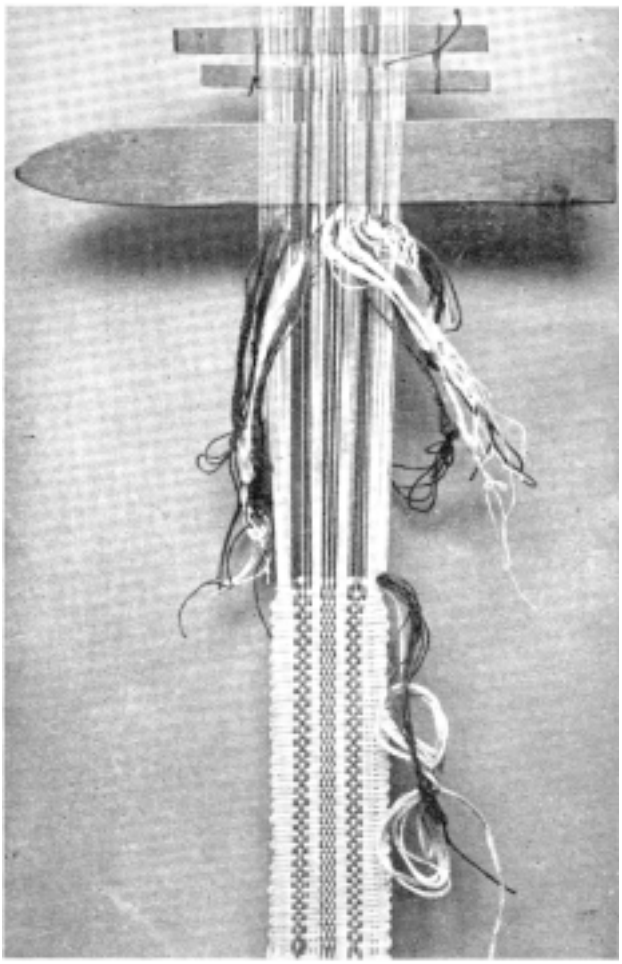


Plate VIII.—Copy (in progress) of a Portion of the East African Web illustrated by Plate I.

See page 143.

By the Author.

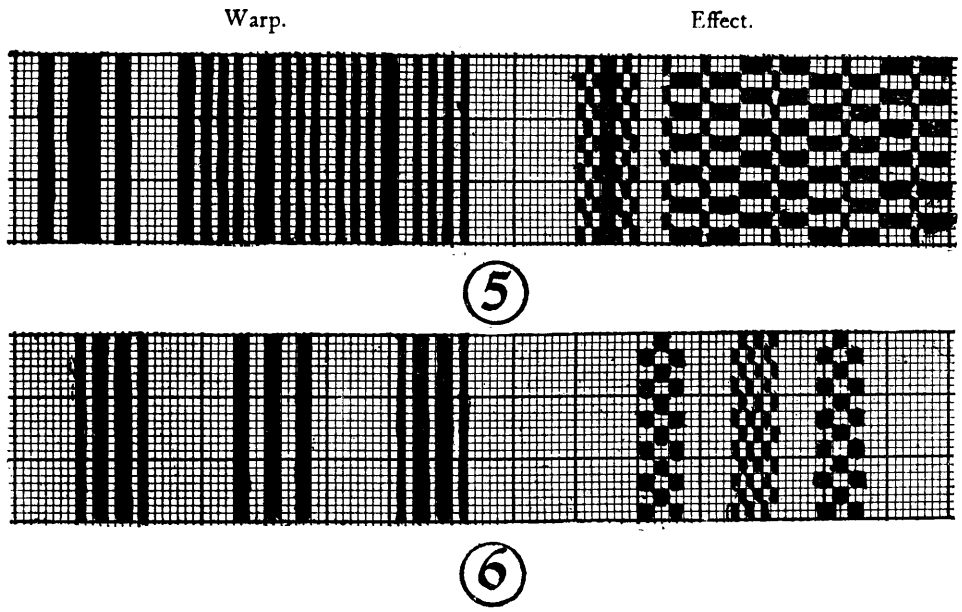


Fig. 62.—Warping Patterns.

Simple Weft effects

uniformity or proportion in the stripes. As already noticed, by striping the weft, the Egyptians first began to ornament their plain weaving. It is quite probable that the stripes of red, blue, white, and purple, in the hangings made for the Hebrew tabernacle, were weft effects. If these were so the striping would be horizontal, and would form a fine background for the gold figures of cherubim, which, we are told, were wrought cunningly on them with the needle.

The Principle of Tartan Patterns

By means of striping both the warp and weft in various colours, the well-known *tartan* effects are produced. The tartan is a very ancient kind of ornamental weaving, and is capable of an infinite number of combinations. This is proved by the variety and individuality of the Scottish *plaids*. It has been supposed that the "variegated webs made by Sidonian women" mentioned by Homer, were a kind of tartan mixture of colour.

Example of Tartan Striping

Fig. 63 shows the manner in which tartan striping is arranged. In this case both warp and weft are variegated by stripes of blue, red, yellow, and white.

At the crossing of the stripes the additional mixed colours made are, deep red, deep blue, orange, green, and purple. When fine, rich colours and good yarns are made use of, very gorgeous effects can be obtained in this simple manner.

Other Methods of ornamenting Simple Webs

There are many other easy methods for ornamenting plain woven webs, such as the use of different-sized threads, both in warp and weft, the use of different materials, such as glossy silk or cotton in contrast with linen or woollen yarns, the use of threads of different twist texture, &c., &c.;

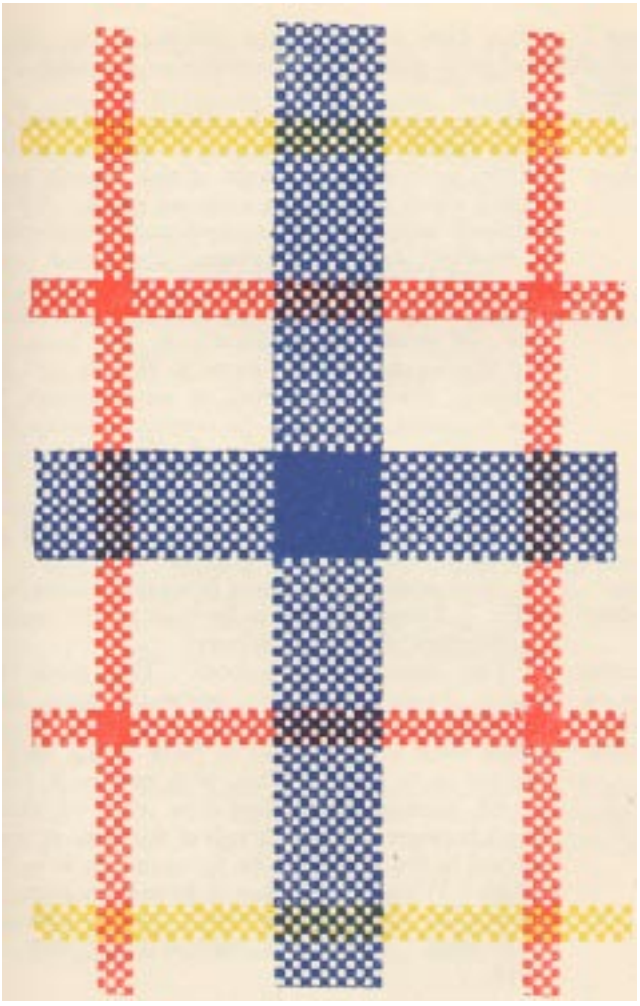


Fig. 63.—Tartan-weaving.

Other Methods of ornamenting Simple Webs

so that even with quite the simplest looms, plenty of scope is given for the exercise of ingenuity and design.

Inlay or Brocading

An ancient and favourite method of decorating woven fabrics was by inserting, in addition to the ordinary weft, secondary wefts of rich threads, such as gold, silver, silk, or rich coloured wools. These additional wefts were so arranged as to form spots, or detached ornamental shapes, distributed over the ground. This decoration is called *inlay* or *brocading*. At the beginning brocaded ornaments were not worked automatically in the loom, as they afterwards gradually came to be. It will be necessary, therefore, as well as advantageous, to trace, as nearly as possible, the manner in which the brocading process was developed. Especially as it led to some of the most important inventions in the history of weaving, and, moreover, many suggestions useful to the artistic craftsman may be gathered by the way.

Indian Brocading

A most primitive manner of brocading is described by Dr. J. Forbes Watson in his book on the textile manufactures of India, as follows :

Dr. Forbes Watson on Indian Brocading

"Two weavers sit at a loom. They place the pattern, drawn upon paper, below the warp, and range along the track of the weft a number of cut threads equal to the flowers or parts of the design intended to be made. Then with two small, fine-pointed, bamboo sticks they draw each of these threads between as many threads of the warp as may be equal to the width of the figure which is to be formed. When all the threads have been brought between the warp they are drawn close by a stroke of the reed. The shuttle, with ordinary weft, is

then passed by one of the weavers through the shed or opening in the warp, and the weft having been driven home, it is returned by the other weaver. The weavers resume their work with the bamboo sticks, and repeat the operation of the reed and shuttle in the manner above described, observing each time to pass the cut threads between a greater or less number of the threads of the warp, in proportion to the size of the design to be formed."

Dr. Forbes Watson on Indian Brocading

Although brocading is sometimes done in the way described above—viz., by using short pieces of coloured threads cut to the required sizes—it is much more usual to find a continuous thread, carried in a small shuttle, made use of for the purpose, each colour, and each separate piece of design having its own shuttle and being worked backward and forward to the shape of the ornament.

More Usual Method

The working of brocaded ornament into a plain warp between the ordinary shoot, does very well so long as the warp is fine and very scanty, as is the case with that used for the gauze-like Indian muslins. These are open enough to allow the sparkling gold and bright-coloured silk to shine out from between their threads, but in denser warps the ornamentation would be buried and almost invisible if merely placed between the ordinary shoots of weft.

Above Method only Suitable for Scanty Warps

In order to make these inlaid ornaments have their proper effect in a close warp, the brocading weft must be made to pass under only one in every three or more warp threads, instead of being tied down closely like the ordinary weft. By this means the rich gold or coloured weft not only shows for all it is worth, but, being tied down by

Ties or Binders for Brocading

Brocading or Weaving Board

only one in every three or more threads, stands clearly and boldly up on the surface of the cloth.

This effect can be tried on the weaving board, fig. 39, and a practical experiment will best demonstrate the theory of ties and binders. The mechanical contrivances for binding the brocaded ornament in the loom can then be readily explained.

For this experiment the board must be set up with thirty-one strings, and plain weaving with self-coloured weft begun on it as in fig. 64, AA. At B brocading commences. It will be seen that the brocaded form in the illustration is drawn in two shades, half-tone and black. These shades may represent any two colours that may be selected. Beginning with the lighter colour, and counting from the right hand, the weft must be brought from the back between the seventh and eighth strings of the warp, passed underneath the tenth, and over the eleventh and twelfth strings. The brocading weft must now pass at the back of seven strings and reappear in the front between strings nineteen and twenty. The coloured thread must then be carried over two strings, under one, over two more, and between strings twenty-four and twenty-five, pass to the back, and be left hanging there, while the ordinary weft is thrown twice across the warp, after the usual sheds have been opened for it. As soon as the shoot has been pressed down the brocading may proceed, beginning this time from the left. The coloured weft must now be brought forward between the twenty-fourth and twenty-fifth strings and taken back, over and under the same strings as in the first line, until it reaches the point of starting. Here it must be again taken to the back, and the two shoots

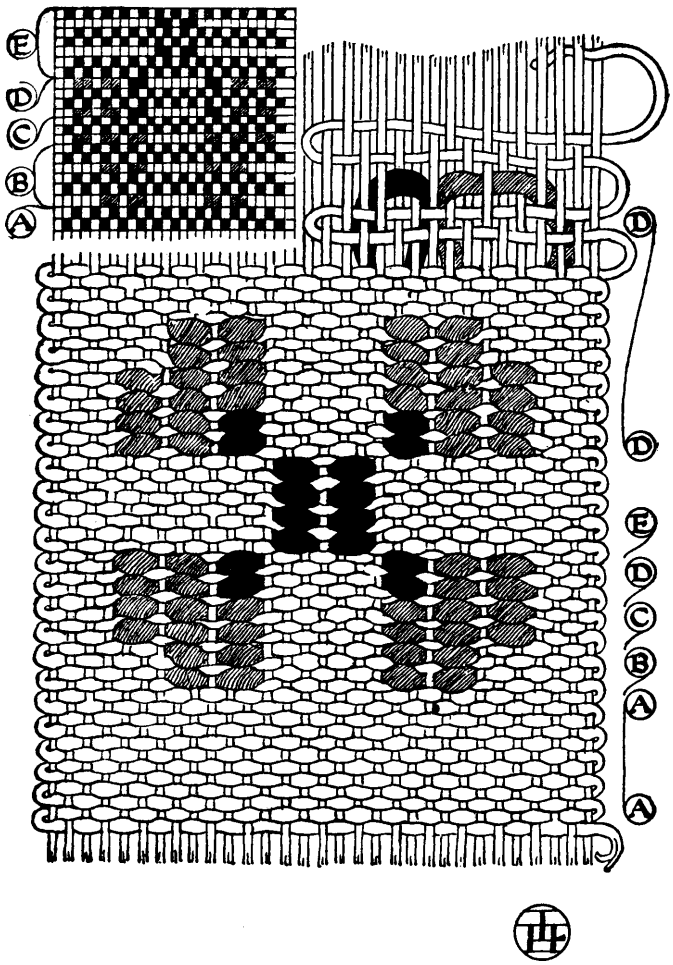


FIG. 64.—Brocading on Board.

Brocading on Weaving Board

of ordinary weft repeated. This will complete the space marked B in the drawing. It will be seen that the brocading in space C must approach three strings nearer to the right and left edges of the web than that of B. In all other respects the space C must be worked in exactly the same manner as B. In space D, however, two brocading colours are indicated. The new colour, represented by black, should be put in first. It will be seen that the black only covers four strings, two on each side of the centre, with a space of seven strings between them. As soon as the dark weft is in its place the lighter colour may be filled to right and left of it, and this being repeated twice, the space D will be filled. At E only the dark colour occurs, and that in the centre of the web, where it covers two spaces of two strings each, with one string between to bind them. From this point the brocaded figure can readily be completed without further instructions. In order more clearly to illustrate the process, at the top right-hand corner of the drawing, the portion D of the brocading is represented in progress, but without the web having been beaten together. At the top left-hand side of the illustration a part of the ground and figure is shown as it would be expressed or designed on weaver's ruled paper.

To return to the old English loom fitted up as in fig. 42. Brocading up to this point and in the above ways may be done upon it without extra appliances. The process, however, of picking up the threads for the binders and counting the spaces in the undivided warp would be a very tedious one. It will therefore be readily understood that it would be a great advantage if the binding threads necessary for the

brocading could be separated in the warp automatically when they were required, without interfering with the making of the plain groundwork of the cloth.

Brocading on Weaving Board

The facility of selecting certain threads can be secured if another headle be added to those already in the loom. This additional headle must be so arranged, that, after two or more shoots of plain ground have been made, the proper shed for the brocading may be opened. This shed may be so made as to act across the whole of the warp, or in particular spaces, such as borders of a certain width, at the centre of the web, or at any regular intervals that may be desired. This contrivance not only facilitates the binding of the brocaded figure, but by dividing the threads into small groups makes it much easier to *count in* the shapes of the ornaments, previously designed on ruled paper. The method of drawing figures for inlaying or brocading is shown by fig. 65.*

Use of an Extra Headle for Brocading

The extra headle required for brocading has to be fixed in front of the two already in the loom, and through the eyes of its leashes the warp threads must be entered, after they have passed through those of the ground headles, and before their entry in the reed. The new headle will only require one leash to every three of the warp threads for the production of the brocading suggested by fig. 65, and of

* In designing ornaments for brocading, on squared paper, it must be remembered that each square of the paper represents the group of threads between the binders, and also that the size the figure will be, when woven, depends on the number of ties to the inch laterally and the thickness of the weft longitudinally.

Use of an Extra Headle for Brocading

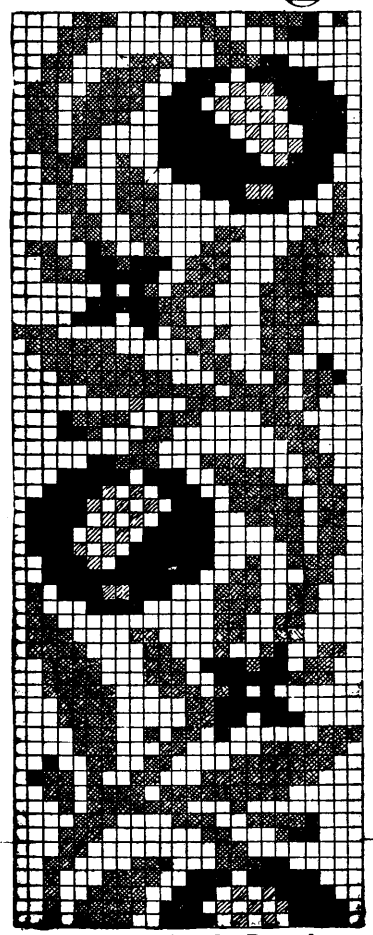


Fig. 65.—Design for Brocade, on Ruled Paper.

these, two must be entered together in one eye and one drawn, without entering, between the leashes. The effect of this arrangement will be that, when the new headle is raised, either by an extra treadle or a hand-cord and pulley, two threads will be raised and one left down, right across the loom, or wherever, in the width, spaces to be brocaded are arranged for. Thus the necessary shed for the brocading weft is made. When one line of the brocading has been done and the following shoots of plain tabby ground have been made

the strips of coloured weft will be found slightly but firmly tied down on the under surface of the cloth, which is really the face of it. In a horizontal loom webs are generally worked face downwards, and, indeed, must be if brocaded.

Use of an Extra Headle for Brocading

There must be an important difference between the leashes of the ground headles and those of the brocading headle. It will be at once perceived that if the leashes of the latter had *small eyes* similar to those of the former, the back headles could not work freely, as two out of three of the threads would be fixed by the new row of eyes standing in front of them. This difficulty is obviated by making long eyes in the leashes of the front headle, so that when it is at rest there is room for the ground headles to work without hindrance. It will be found that this arrangement does not interfere at all with the lifting power of the front headle.

Difference in Eyes of Leashes

By means of fig. 66 this important difference in the leashes of the two sorts of headles may be readily understood. Nos. 1 and 2 show in section the ground and the brocading headles. In no. 1 the headles of the ground harness are depicted one raised and the other depressed, whilst the brocading headle is at rest. In this position the front headle does not affect the warp at all, the long eye allowing the threads to rise and fall, as necessary for tabby weaving. In no. 2, however, the front headle being raised, takes up with it all the threads entered in it, and allows all those passing between its leashes, which are the binders, to remain at the level of the warp as long as the ground harness is at rest.

Two Sorts of Leashes

This simple difference between the leashes of the headles, some having long and some short eyes,

Importance of the Use of Long and Short Eyes in Figure-weaving

plays a very important part in the development of pattern-weaving. The invention of damask-weaving in particular is based entirely on it.

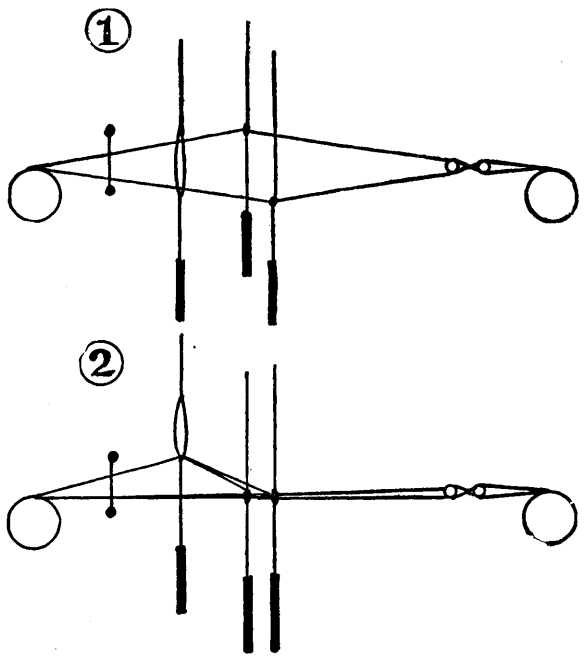


FIG. 66.—Section of Two Sorts of Leashes.

Cashmere Shawl Weaving

The exquisite work which may be done on a loom with mechanical fittings such as have now been described, is shown by the wonderful shawls for

which Cashmere has been famous for many centuries (see fig. 67).

Cashmere Shawl Weaving

The process of weaving the Cashmere shawls has been instructively described by a traveller in India : *

"The loom differs not in principle from that of Europe, but is inferior in workmanship, and the factories contain from three to three hundred of them, crowded together into very small spaces. About three weavers work at each loom. When the warp is fixed in the loom the pattern-drawer makes a design in black and white. He shows it to the colourist and the scribe, and they confer together. The colourist, having well considered it, points out the proportion of the colours, and, beginning at the foot of the pattern, he calls out the colour and number of threads to which each is to extend, that by which it is to be followed, and so on in succession until the whole pattern has been described. From his dictation the scribe writes down the particulars in a kind of shorthand, and delivers a copy of the document to the weavers.

"The workmen then prepare the needles by winding on each, coloured yarn of about four grains weight. These needles without eyes are made of smooth wood, and have both their sharp ends slightly charred to prevent their becoming rough through use. Under the superintendence of the colour-master, the weavers next knot the yarn of the needles in their proper places to the warp.

"The face or right side of the cloth is placed next to the ground, the work being carried on at the back, where the needles all hang in a row, making from four to fifteen hundred, according to the lightness or heaviness of the ornament. As soon as the designer is satisfied that the work in one line is completed the reed is brought

* Moorcroft's "Travels in Cashmere," 1841.

Cashmere Shawl Weaving

down upon it, with a vigour and repetition apparently very disproportionate to the delicacy of the material."

It is a grievous fact that this beautiful handicraft of shawl-weaving has almost died out in India, owing to the competition of the cheap, meretricious,

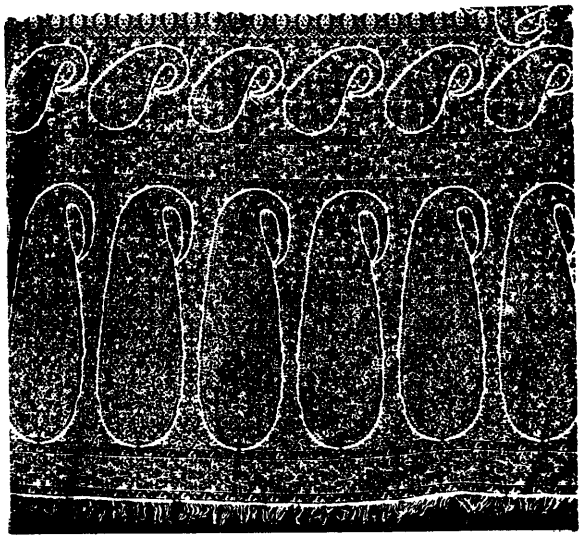


Fig. 67.—Border of an Indian Shawl.

European, machine made imitations of the Cashmere weaving and design, with which the markets of both the East and West were flooded in the last century.

Origin of Brocading

Before leaving the subject of brocading, for the present, it may be interesting to remark that, no

doubt, like tapestry decoration, it was suggested at first by the work of the embroiderer, to which it bears even a closer resemblance than does tapestry itself. Brocading has been called "embroidering with the shuttle." There is a beautiful passage in the *Iphigenia among the Tauri* of Euripides in which the phrase is used :

Origin of Brocading

"But now beside the ruthless sea I make my cheerless home, an alien, torn from home and friends, with none to call me wife or mother; never singing Hera's praise, my Queen in Argos, nor mid the merry whirr of looms broidering with my shuttle a picture of Athenia Pallas or the Titans."

CHAPTER XI

SINGLE-HARNESS PATTERNS

Ruled Paper and its Uses—Sketches of Entering and Tie-up—Designs possible on a Loom with few Headles—The Position of Cloth in Weaving—Tying up the Loom—Plan of a Tie-up—Simple Twills—The Broken Twill, its Importance—Origin and Peculiarity of Satin-weaving—The Four-headle Twill—Method of drawing Designs for Simple Looms—Simple Pattern with Tabby Ground throughout, its Advantages.

Single harness Patterns

AN important range of small patterns can be woven by the use of a single harness * composed of several headles, and the range may be very much extended by entering the warp in varying order instead of in regular succession.

Before giving a few examples of these patterns, it will be necessary to devote a little space to the explanation of three things. (1) The setting out and use of designer's *ruled paper*; (2) the method of expressing on paper the order in which the warp is *entered* in the headles; and (3) the *tie-up* of the loom, as the connection between the treadles and headles is called, which renders pattern-weaving automatic.

* Leashes with short eyes have some advantages over those with long ones. A single harness, therefore, should be made with leashes having short eyes.