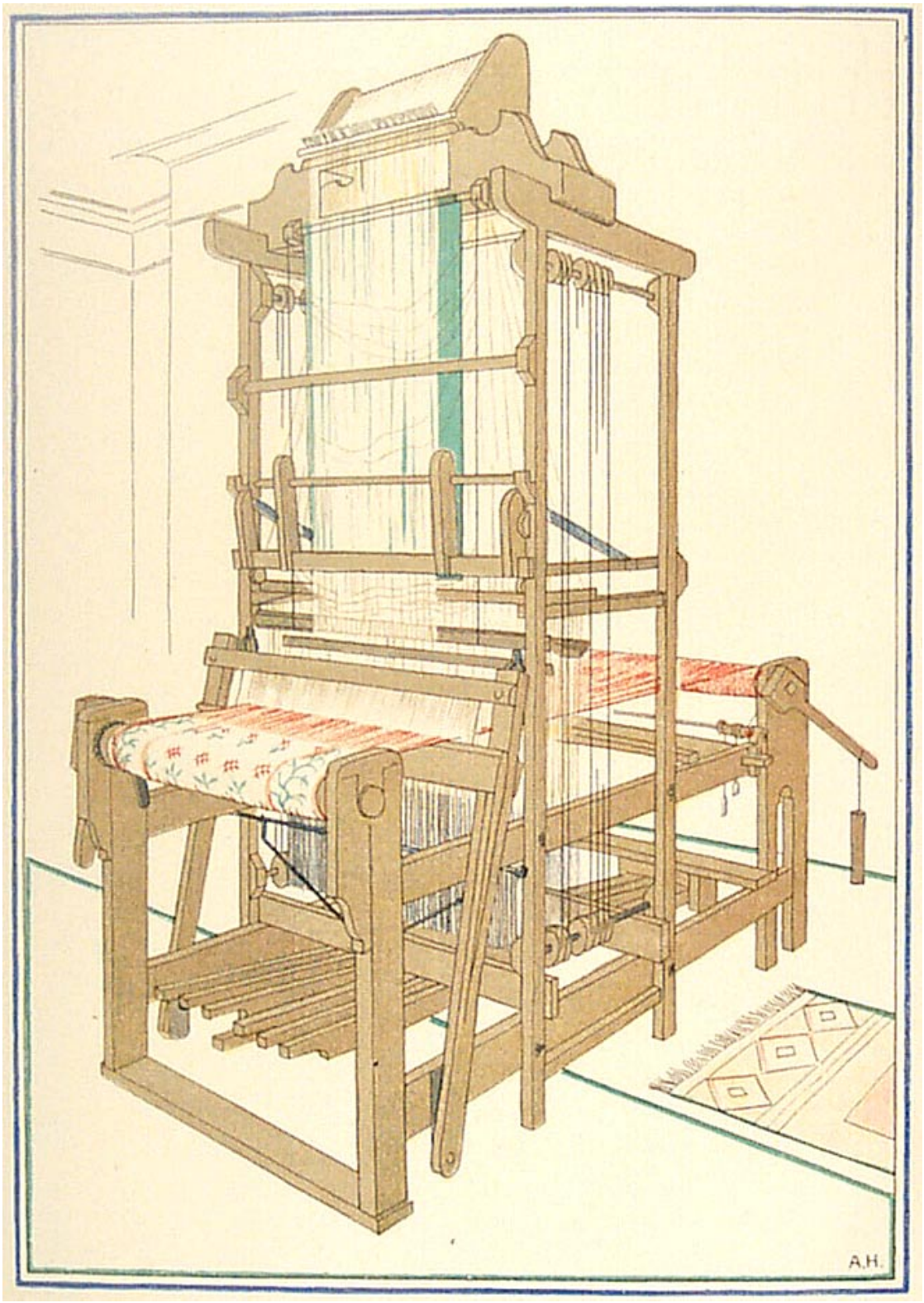
THE NEW DRAW-LOOM

FRONTISPIECE.



Full sized New Draw-loom for weaving Silk Tissues with borders.

THE NEW DRAW-LOOM

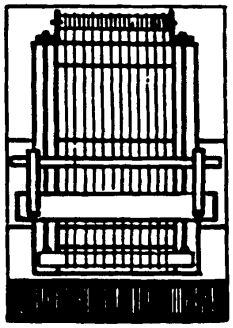
ITS CONSTRUCTION AND OPERATION DESCRIBED FOR THE USE OF HANDICRAFT PATTERN WEAVERS

BY

LUTHER HOOPER

AUTHOR OF "HAND-LOOM WEAVING, PLAIN AND ORNAMENTAL," "SILK," "WEAVING FOR BEGINNERS," "WEAVING WITH SMALL APPLIANCES," "THE LOOM AND SPINDLE," ETC.

DIAGRAMS, DESIGNS, AND WORKING DRAWINGS BY THE AUTHOR
A FRONTISPIECE AND PEN DRAWINGS BY ALICE HINDSON, AND
ILLUSTRATIONS OF WOVEN WEBS IN COLOUR AND MONOCHROME



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Preface

WHEN I made my first little board-looms some years ago with a view to teaching pattern weaving in the simple, primitive, natural method which we call tapestry weaving, and began the first volume of the series of hand-books, *Weaving With Small Appliances*, I had no intention of following up the idea so far as I have since been led to do. The design and construction of more and more advanced pattern-weaving looms of a size and nature suitable for domestic and studio use has proved a most fascinating study, and has resulted in the production of a succession of pattern-weaving hand-looms of more or less complicated mechanism, easy of manipulation, quiet in working, and of great artistic possibilities.

In the third volume of the "Small Appliance" series, plain weaving and simple pattern weaving were treated of, and the looms and appliances necessary for their practice were described under the head of "Table-loom Weaving": the looms were so called because, having no treadles, they could be worked entirely by hand and were small and portable enough to be placed on an ordinary strong table.

The description of the table-loom and instructions for weaving with it were carried up to the point where the use of two sets of ordinary headles working together are required in the loom; the webs when produced being woven by what is technically known as *Compound Pattern Weaving*. This process was briefly described in the last chapter

of the book, and, at its conclusion, I expressed a hope that I might carry forward the further development of the table-loom in this direction and describe its necessary mechanism in a future work. The results of much careful, pleasant study, as well as interesting design and mechanical contrivance, in which several of my pupils have taken part, are described in the present book, which is the fulfilment of that hope.

Then, again, to go further back; in the year 1911 at the conclusion of my book, *Hand-loom Weaving, Plain and Ornamental*, I wrote as follows—

It may be surprising and, perhaps, disappointing, to some readers to find that my descriptions of methods of pattern weaving and of weaving appliances come to an end just before the introduction of the Jacquard machine, early in the last century.

Certain objections to that machine I here stated and continued—

The speed of weaving plain as well as ornamental textures by means of this machine has, of course, vastly increased, and has enabled the work to be done on steam power looms; but, although this is in many respects a commercial advantage, the artistic quality of machine weaving is far below that of earlier times, and moreover, the ruthless, rigidly perfect mechanism of the machine has had a disastrous effect not only on the materials woven but on the weaver as a craftsman, which is no unimportant matter.

There can be no question that the best weaving was done before the innovations of the engineer and mechanician were made. It would therefore seem that the right road to improvement in artistic pattern weaving is, as in all the crafts, only to be

found by those who are willing to return to the traditional methods and simpler ideals of the earlier masters of craftsmanship.

I have made the above quotations from my earliest and, perhaps, most important book, with a view to showing that the present book on the new draw-loom and its modern uses may be considered as a sequel not only to *Table-loom Weaving* but to *Hand-loom Weaving, Plain and Ornamental.*

My new draw-loom, in all its varieties, is so arranged that the weaver himself, having tied up his design on a set of cords arranged in front of him as he sits in the loom, can, without a draw-boy or a machine of any kind, draw such cords as may be necessary to form the design, shed by shed, line by line, and repeat by repeat in due succession without moving from his position.

Of course, I do not claim that my new draw-looms can be rivals of the Jacquard machine for commercial mass production of ordinary textiles in factories, whether the materials be woven on foot power or steam power looms, but I am confident that for domestic or studio use they will be found more practical and adaptable than any other kind of weaving appliance hitherto designed.

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PART I
INTRODUCTORY

THE NEW DRAW-LOOM

Chapter I

TRADITIONAL LOOMS TO WHICH THE NEW DRAW-LOOM IS CLOSELY RELATED

The new draw-loom embodies ancient principles

THE new draw-loom for pattern weaving, in all its parts and mechanism, embodies the principles on which the pattern looms of Ancient China, and those of the Nearer East as far as Byzantium were constructed. The same traditional principles characterized the more heavy, cumbrous, but extremely effective looms of Arabia, Turkey, and Southern Europe in the Middle Ages. The looms of Italy, France, and Central Europe, on which the most sumptuous textile fabrics of the Renaissance were woven, works of art and skilful craftsmanship which have never been surpassed or even equalled in more modern times, all followed in the same tradition, as did also the ingenious and beautifully constructed draw-looms used by the Spitalfields and other British weavers, whose work in silk became so famous during the seventeenth, eighteenth, and the first quarter of the nineteenth centuries.

Gradual development of weaver's craft and appliances

Thus far, the evolution of the craft of weaving as well as that of the loom maker, had taken an unbroken course of development; the looms being constructed almost entirely of wood and their mountings, or *harnesses* as they were called, of more or less elaborate design suitable for

The harnesses of ancient looms

weaving different kinds of textures and patterns, were composed of flaxen cords and twines of extraordinary strength and of various degrees of fineness. These harnesses were connected by loops or eyes with warps of handspun silk, linen, or other fine threads. The whole of the sensitive mechanism of the pattern weaving draw-looms was actuated, as they had been from the most ancient times, simply by the hands and feet of the intelligent, well-trained weaver and his assistant the *draw-boy*, as the weaver's mate or helper was called.

Simplicity of essential principles

Up to this point of development the draw-loom, although it had become to a certain extent an elaborate machine, had remained, in its essential principles, as simple, adaptable, and manageable as it had ever been, insomuch that the intelligent weaver, even if he could not actually design and construct it himself, could repair and alter it to his individual desire and keep it in working order, without the assistance of a mechanic or engineer. In fact, the loom, under the master weaver's management, was simply a more or less complicated tool by means of which he carried on his interesting artistic occupation.

The industrial revolution : its character

The period between the years 1750 and 1825 was made memorable in Great Britain by the rise and development of an extraordinary revolution in industry. It was a time of feverish activity and change in all branches of manufacture, trade, economics, and science and art applied to production. In promoting this revolution, inventors, manufacturers, capitalists, mechanicians, and economists, as well as artists and scientists, devoted their most strenuous

energies to devising and perfecting machinery and appliances for speeding up and cheapening the production of all kinds of manufactured goods, as well as to marketing them to the greatest advantage. Most prominent amongst the trades specially affected by this industrial revolution were the various branches of the textile industry. An immense amount of inventive skill, business talent, and capital were devoted to the successful production of more or less automatic spinning and weaving machines actuated by steam power, which were gradually superseding the hand-loom and degrading the weaver as a skilled craftsman.

Effect of the revolution on the textile industry

It would be altogether outside the scope and purpose of this book to describe or discuss the effect of the changes which took place not only in the implements and appliances of the weaver's trade and the trades subsidiary to it, or to lament or describe the disastrous results of the invention and introduction of the automatic steam power loom on the vast body of hand-loom weavers employed in all branches of the trade, especially as the situation was complicated by the general change over from the *domestic* to the *factory* system of manufacture, which was taking place at the same time and was, indeed, part of the revolution itself.

The change from domestic to factory system of manufacture

The above brief references to the Industrial Revolution and the general adoption of the factory system in manufacture were, however, necessary in this account of the *draw-loom* for pattern weaving, as it was almost at the beginning of the period in which it took place that Jacquard, a French engineer, completed the machine which

Introduction of Jacquard machine : its effect

still bears his name. This machine was introduced into England for pattern weaving, first for use on hand-looms, and afterwards on steam power looms. This enabled the hand-loom pattern weaver to do the whole operation without the assistance of a draw-boy, although with very great labour, for the machine was a much more difficult, complicated, and heavy appliance to manage and keep in order than the simple, ancient pulley box which it superseded. Many descriptions of this wonderful machine, for it is wonderful, may be found in the textile literature of the nineteenth century, but are unnecessary here;[1] it must, however, be noted that it *completely altered the character of the historic pattern weaving loom, and the artistic and interesting nature of the draw-loom weaver's occupation.*

[1] Barlow's *History of Weaving*, etc.

Chapter II

THE DRAW-LOOM OF TRADITION: ITS DESCRIPTION BY A MASTER WEAVER OF 1800

IT being quite probable that the reader may not have had the opportunity of studying the construction of the draw-loom and its harness as described in the author's book on *Hand-loom Weaving: Plain and Ornamental*, published in 1911,[1] it will be advisable, before proceeding to describe the new draw-loom and its various parts and mountings, to quote a description written by a master weaver of Paisley in a *Treatise on the Art of Weaving*, the third edition of which was published in Glasgow in 1833.[2] This quotation will inform the reader of the names given to the different parts of the draw-loom and its harness at the time when, as stated in the preceding chapter, the ancient traditions of the loom and weaving were interrupted by the invention and adoption of the French "Draw engine," as Jacquard's machine was called when first introduced into Great Britain.

The draw-loom in 1811 as described by John Murphy

Chapter XI of the book deals with "the component parts and construction of the draw-loom," and is introduced as follows—

"Having explained in the preceding chapters the elementary principles of fancy weaving, exhibited some of their most useful

[1] *Hand-loom Weaving: Plain and Ornamental*, by Luther Hooper (Sir Isaac Pitman & Sons, Parker Street, Kingsway, London, 1911).

[2] *Treatise on the Art of Weaving*, by John Murphy (published by Blackie & Son, Glasgow, 3rd Edition, 1833).

combinations and illustrated the whole with numerous and appropriate examples, it now remains to show how these principles are extended beyond the power of *leaves* by means of the draw-loom.

"The principal parts of the draw-loom are the carriage, pulley box, harness, hole board, tail, simple and the lashes. Fig. 1 Plate II[1] is a front view of the common draw-loom, or rather an outline of it, for the whole could not be represented on paper without running into the utmost confusion. The frame, *AA*, is called the *carriage*, from its supporting the harness; it rests on the side rails, or *capes*, of the loom which are seen in section at *aa*. On the top of this frame is fixed the *pulley box e*, which contains the pulleys, over which the *tail cords bb* run, when any part of the harness is raised to form a shed. This box, a horizontal view of which is given in Fig. 2, is placed in a slanting position, the slope being made sufficient to allow the tail cords *b* to sink in opening the sheds, without obstruction from the frame or pulleys.

"The *harness* is that part of the draw-loom which supplies the place of the headles in the ordinary loom; and, exclusive of its appendages, extends from the figures, 1, 2, 3, etc., between *u* and *o* in the carriage, down to the leads *xx*. The harness is composed of the following parts: namely, the *necktwines*, which extend from the neck at the figures 1, 2, 3, etc., to the knots at *ee*; the *sleepers* connect the necktwines with the *eyes*, through which the warp is drawn at *dd*, and the twines which connect the eyes with the leads at *xx* are called *hangers*.

"*CC* is the front edge of the frame of the *hole board*, through which the sleepers pass, and it is the number of holes in this board which regulates the distance of the mails or eyes from one another and the fineness of the harness. One repeat of the face of the board is represented at Fig. 3."

[1] Plate I in the present work.

There follow minute directions for building the draw-loom harness.

. . . . . .

"The *tail* of the harness *bwb* extends from the knots at the neck to the tail stick *g* by means of which it is fastened to the roof or ceiling of the shop. From the tail at *w* descends the simple cords *f* or, as they are termed collectively, the "simple" or "symbolt," down to the floor at *z*, where they are fastened to another stick, similar to that of the tail. It is on this part of the draw-loom that the pattern is read from the design. The twines at *i* are termed the *lashes*, or *leashes*, and are necessary for separating the cords to be drawn for each line of a design from those that are to remain stationary; *nnn* are the heads to which the lashes are attached, and which are made with a noose to run on the gut cord *l* when necessary. The gut cord commonly extends to the roof of the shop above and to the floor below, parallel to the simple; *KK* are the bridles, which being connected to the lashes at equal distances draw them down in succession as they are wanted by the draw-boy."

The new draw-loom as compared with that of 1911

It will be clearly seen as we proceed to explain the principles and construction of the *new draw-loom* that it agrees in its essential details with the traditional pattern weaving looms from which it is derived.

Before closing this chapter it will be well to notice particularly the portion of the draw-loom which has been altered and simplified so as to enable the weaver to have full control of the whole mechanism of the pattern loom and dispense with the services of the draw-boy at the same time. During the latter part of the eighteenth century many contrivances were tried having this end in view, but with little success, until Jacquard took advantage of the

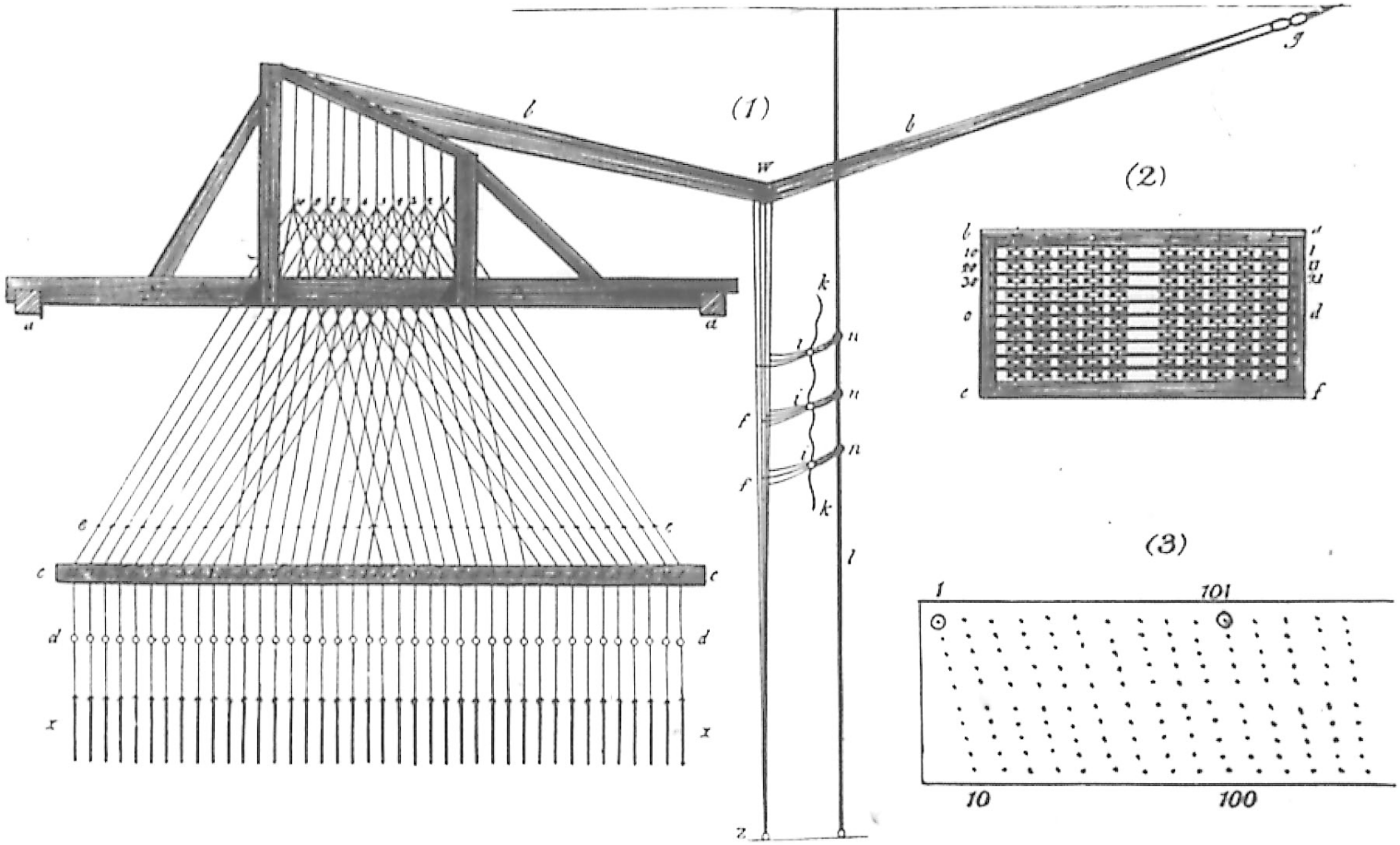


PLATE I

THE DRAW-LOOM OF TRADITION, A.D. 1800

(From John Murphy's Treatise on Weaving, 1811)

opportunity and introduced his machine which, as already pointed out, abolished the draw-boy, but, especially after it became a part of the mechanism of the automatic power loom, altered entirely the nature of the pattern-loom and did away with the necessity for skill on the part of the weaver.

Modern additions to the draw-loom

The parts of the draw-loom superseded by both the Jacquard machine and the new draw-loom, are the tail of the loom, *bb* Fig. 1 in Murphy's drawing, Plate I, and the outside *simple* or *symbolt*, the latter being, no doubt, the original name for the collection of cords on which the design was tied up for the draw-boy. This part of the loom is said to have been invented by a French weaver named *Simblot*, and the terms *simple* and *symbolt* are, no doubt, corruptions of the inventor's name.

PART II
CONSTRUCTION

Chapter III

THE FRAME OF THE NEW DRAW-LOOM

The frame of the new draw-loom

THE new draw-loom, like its predecessors for many, many hundreds, not to say thousands of years, is constructed almost entirely of wood; oak, or some other equally hard and workable wood in preference. The mountings, or *montures*, as the complicated harnesses by means of which the patterns are woven are called, are made of the best flaxen or cotton threads and twines of different degrees of fineness. The numerous pulleys, perforated comber slips, reeds, and small fittings required for the exact adjustment of the several parts of the mechanism, are made of brass, rustless steel, enamelled iron, lead, and fibre or box wood.

The mountings

The wood for loom frames: its nature

The lengths of wood selected for the frame of the loom must be clean, free from knots and shakes and thoroughly seasoned; it should be cut to the required sizes some considerable time before being planed and framed up, so that the warping or twisting of any of the several lengths may be detected and, if possible, corrected before it is too late. It is absolutely essential that the loom for fine pattern weaving should be true and square in all its parts, and strong enough to bear the great tension and strain to which it is subjected in the process of weaving.

The design and framing of an independent loom suitable for domestic or studio use is not such a simple work

Designing loom frames for factories

as that of the arrangement of a number of ordinary looms standing in rows in a large workshop or factory. In the latter case, the loom frames on which all the mountings rest are, or may be, merely two long horizontal parallel beams, made of lengths of timber joined together which reach from end to end of the workshop, the whole length being supported, at regular intervals, at a height of about 6 ft. above the ground on strong, square posts, mortised to the beams; to these posts the rollers of the loom are fixed, and on the beams between each pair of rollers, the various cross-pieces rest on which the harnesses are hung. Bearing this in mind, it will be readily understood that the design and construction of an individual loom that has to stand alone and be thoroughly firm, strong, practical, compact, convenient, and perhaps beautiful or even elegant, is not so easy a matter, especially if it has to be made suitable for the weaving of a great variety of ornamental webs.

Designing individual looms

Plate II represents the side and front elevations of a loom frame ready to receive the draw-loom apparatus. Its general appearance and several parts are common to all hand-looms, but this design has been made, after many experiments, especially with a view to enable the weaver to reach with ease any portion of the more or less complicated mounting of either the single or compound pattern loom.

Special features of draw-loom frames

The special feature which renders this design suitable for a draw-loom mounting is the unusual height to which the upright side frames, with their cross-pieces, are carried; these are required to support the *pulley box* and the long

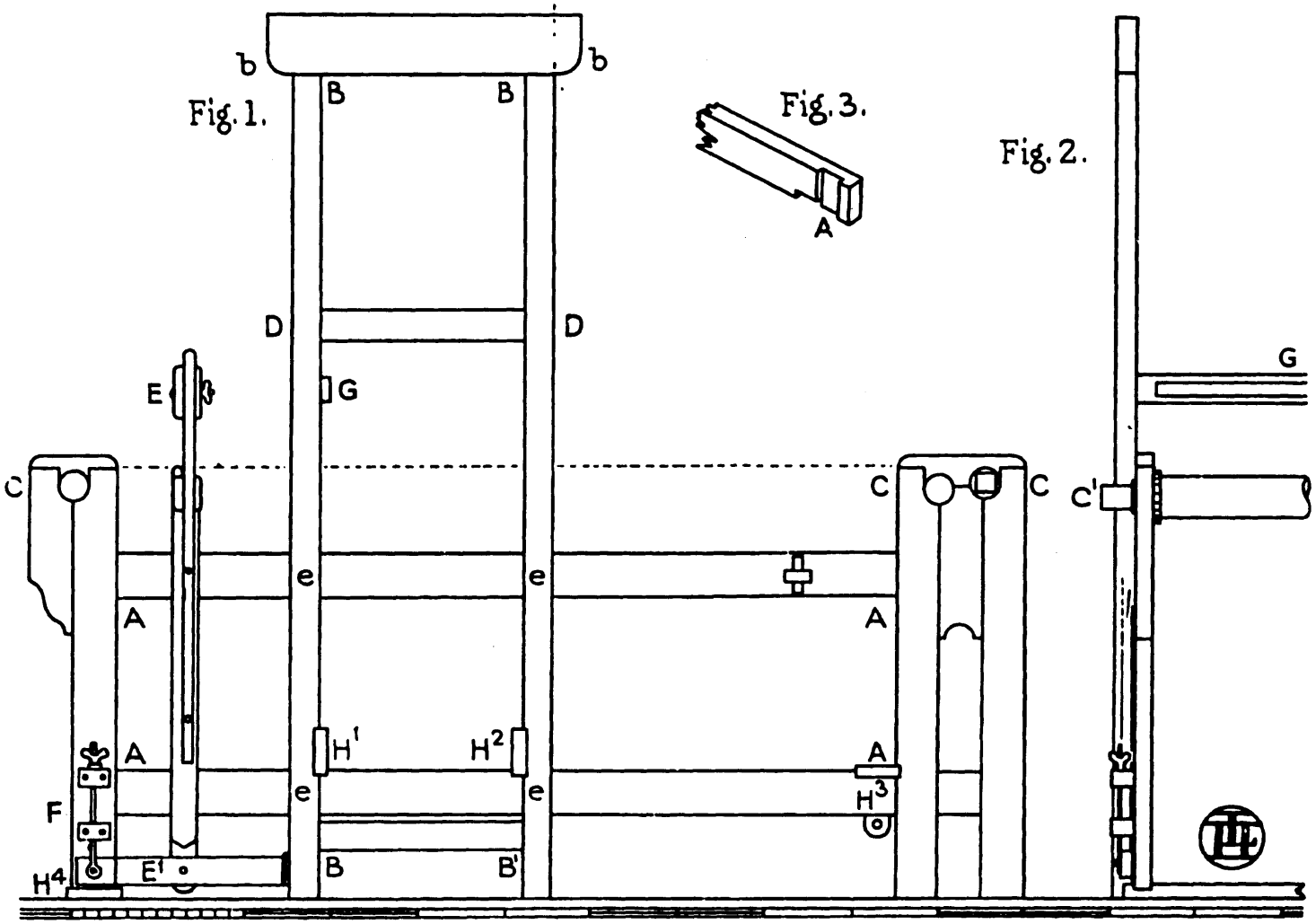


PLATE II

THE FRAME OF A MODERN HAND-LOOM

pattern-lifting cords at the front of the loom, as well as the couplings and lingo weights of the complicated harness at the back.

Construction of frames

For the most part, the loom should be constructed of good clean wood cut to the requisite lengths in two sizes, viz. 3 in. by 1¼ in. and 2 in. by 1½ in.

The sides of the loom consist practically of two oblong frames lettered severally in the drawing *A A A A* and *B B B B*. The first of these is placed horizontally, and is required to be very strong and rigid, in order to bear the great strain of the warp or warps, which are stretched at a very high tension between the front and back rollers when the loom is at work. In the drawing the ends of these rollers, which project a little beyond their bearings, are shown in position at *C C C* in Figs. 1 and 2 of Plate II. This frame must be truly mortised at every joint and fitted squarely. It is made from the 3 in. by 1¼ in. lengths of wood, the lengths including the tenons being 5 ft. exactly. The ends of the frame which form the loom posts with their brackets, bearings, and caps for the rollers are 2 ft. 6 in. in height, as will be seen from the scale.

Construction of loom frames

The vertical frame *B B B B*, Fig. 1, the joints of which must be mortised as well and truly as those of the horizontal frame, is made from the 2 in. by 1½ in. lengths of wood, except for the top cross-piece, *b b*, which should be 3 in. by 1½ in., as it has to bear a considerable weight. The centre cross-piece, *D D*, however, must not be mortised, as it has to be adjustable as to height; it is accordingly made with a shoulder at each end, and screwed to the inner sides of

the upright posts. The height from the ground to the top of the top cross-piece measures 6 ft. 6 in. The vertical frame is fixed in its position on the horizontal one by means of bolts and wing nuts at the places marked *e e e e* in Fig. 1, Plate II.

The rollers

In Plate II, Fig. 1, two warp rollers are shown mounted on two back posts. The second roller is only required when the work is to be woven on two warps, as will be explained later.

The baton

In order to keep the space in front of the weaver free and open as he requires for the manipulation of the pattern cords of the new draw-loom, the baton, or reed carrier, stands upright instead of being suspended from above, as is usual in most handlooms. See $E E^1$ in Fig. 1, Plate II. This shows the side view of the baton, and it will be seen that at its lower end the *sword* of the baton is pivoted to a hinged bar which can be raised or lowered by means of a screw and wing nut, letter *F*, fixed on the side of the loom post a little below the breast roller. This allows the height of the reed in the warp to be adjusted to a nicety, which is a very important matter. In Plate III, Figs. 1 and 2, both front and end views of the baton and its swords are given, and will be readily understood as regards this fitting. In Fig. 1, *A A*, are sections of the sides of the loom frame to which the baton is affixed, as described above. *B B* are sections of the hinged bars, showing the bolts by which they are attached to the metal plates *C C*, which are in their turn firmly screwed to the lower ends of the two wooden swords.

The reed frame

The upper part of the baton is simply a long, strong, heavy frame in which the movable reed, used for beating or pressing the weft together is firmly held. This is such an important part of the loom that a section of it is drawn, at Fig. 3, Plate III, much larger than the general scale. The upper part of the frame, called the *cap*, is attached to the swords by bolts, which, passing through slots (*d d*, Fig. 1) cut in the upper ends of the swords, allow it to be lifted sufficiently to admit the reed, and when lowered, fix it in a vertical position.

The reed holder: its careful construction

The most important part of the reed frame, however, is the *block* on which, in its groove, the reed itself rests and must be very securely held in its place. The block is most easily made of two pieces of hard wood (lettered in the drawing *A* and *B*). The front piece *A* is cut out at the top so as to form, when joined to the back piece *B*, the groove in which the reed will stand upright. The front piece is cut higher than the back one, and is surmounted by the shuttle race, lettered C^1, which must be shaped as shown, with a rounded top and be wide enough just to touch the reed, but not to press against it. When the reed is to be placed in the frame, it must be put into its groove from the back, held there in an upright position until the cap can be lowered so as to rest upon it and keep it perfectly steady after the bolts in the sword slots have been tightened by means of their wing nuts.

The reed holder must be attached to the swords of the baton in the space indicated in the drawing by dots, and there must be a clear run on the shuttle race C^1 Fig. 3, Plate III, in front of the reed and across the front of

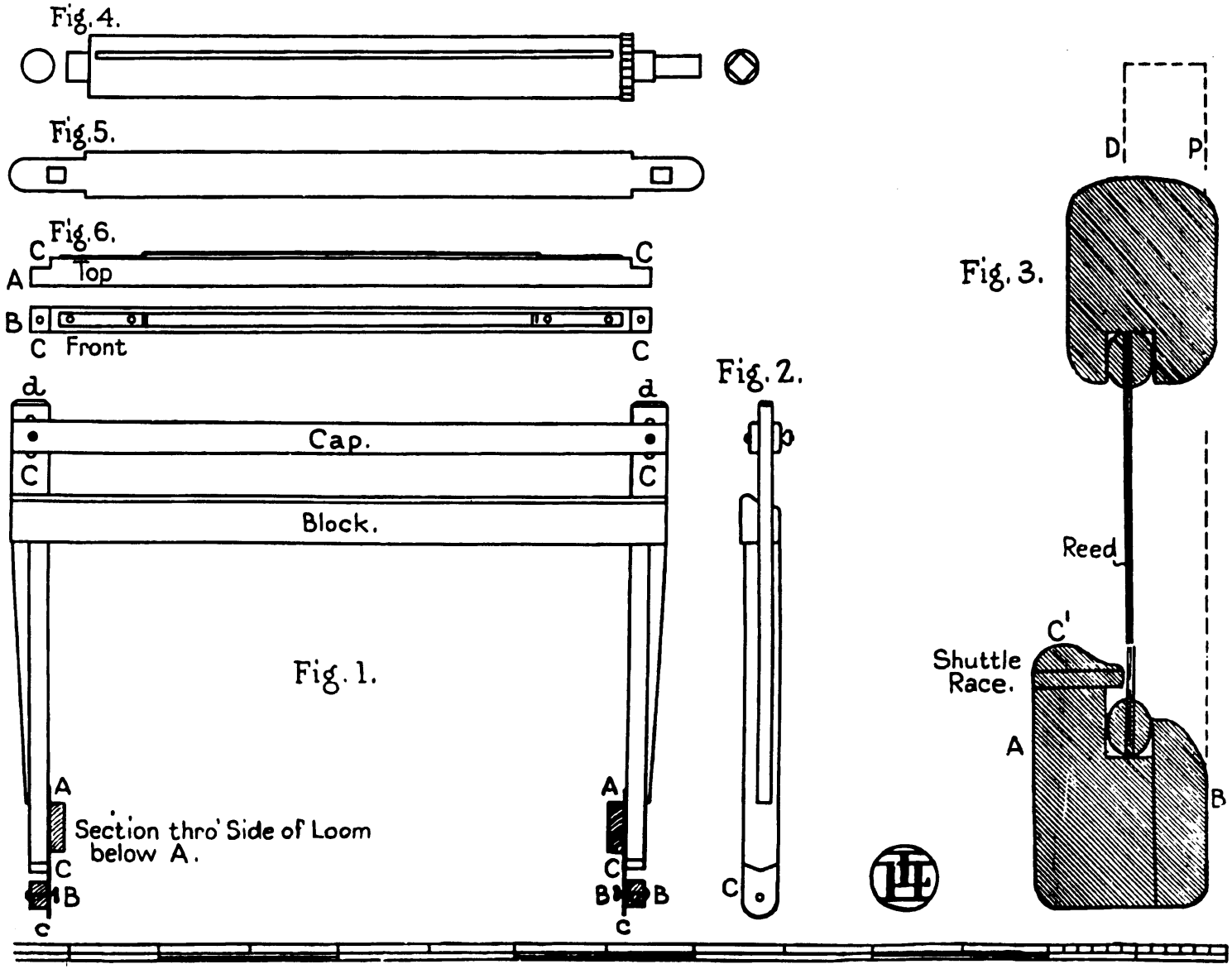


PLATE III

THE CONSTANT FITTINGS OF HAND-LOOMS

both swords from end to end, as shown at *C C* Fig. 1, Plate III.

The cross-pieces of the loom frame

The rollers of the loom and the cross-pieces, with the exception of one of the latter, which is wedged into the sides of the horizontal frame near the backposts, not only serve to keep the loom rigid and solid, but are so placed as to be useful for the necessary attachments of the different parts of the whole mechanism. All these must now be described with the help of Plate III, Figs. 4, 5, and 6.

The breast roller

At Fig. 4, Plate III, the breast roller, or cloth beam, as it is often called, is drawn; its diameter is 4 in. for a loom 36 in. between the posts. The round ends of the roller, which fit into the bearings in the posts, are $2\frac{1}{2}$ in. in diameter, and must be large enough to allow the roller to turn easily in the bearing, but not so easily as to wobble about. The other roller or rollers, if there be three, should be the same in every respect as the breast roller, except for the ratchet, and all three must have one of their round ends elongated enough to allow of a square being cut on it, which will have to project at least 2 in. outside the loom.

The back rollers

The slot in the rollers, reaching from end to end, must be cut exactly parallel to the sides, otherwise the weaving cannot be kept even, and all the slots must be $\frac{1}{2}$ in. wide to their full depth, which must be $\frac{3}{4}$ in. from end to end. They must be made perfectly smooth, especially if they are intended for fine weaving.

The ties of the loom frame

The principal tie for holding the sides of the loom together is shown at Fig. 5. It must be very strong and be

fixed by wedges in its place between the top of the side frames, near to the back rollers, see Plate II, Fig. 1. Its dimensions are 3 in. by $1\frac{1}{4}$ in. by 3 ft. 6 in. in the part which ends in shoulders $\frac{1}{2}$ in. deep, leaving the ends 2 in. by $1\frac{1}{4}$ in., which pass through mortises cut for them in the frame. These ends project $2\frac{1}{2}$ in. beyond the sides of the loom, and have square holes cut in them to receive the wedges which fix the bar firmly in place.

The drawing of the bar, of which the top and front are given in Plate III, Fig. 6, letters *A* and *B*, like all the rest of the ties or cross-bars, serves two purposes, as already mentioned; it had better, however, be described here in connection with its utility as a tie for steadying the frame of the loom laterally. Fig. 6 is a wooden bar of the same size as that from which the upright frame, Fig. 1, Plate II, is made, and it is strengthened by the iron attachment which is firmly screwed to its face (see top view, letter *A*). The purpose of the iron fitting will be described later on, but it will be seen that the use of the bar as a tie for steadying the vertical frame is very great when fixed by strong screws with its shoulders *C C* between the front posts of the frame in about the position shown in Figs. 1 and 2, Plate II, letters *G G*. Its exact position will be decided on when the loom is being mounted, with its draw-loom arrangement of pulleys and cords, and, at the same time, the purpose of the iron bar will be pointed out.

The cross-pieces

The four cross-pieces marked H^1, H^2 H^3, and H^4 in Plate II, Fig. 1, are all of the same dimensions, except for their length, as those of the wedged tie Fig. 5, Plate II,

and their ends project about an inch beyond the outer edges of the frames which they bind. The ends of H^1 and H^2 are cut as indicated at *A*, Fig. 3, Plate II, which enables them to clasp effectively at the same time the upright posts of the vertical frame, and the upper edges of the lower horizontal frame.

The treadles

So far as concerns the frame of the draw-loom, it only remains to say that the treadles which may be required for working the mechanism, whether there be only one or two or nine or ten, have their fulcrum depending from a fixture placed beneath the tie H^3, and that the tie H^4 holds the front posts, which rest in its grooves, firmly in their proper position.

Chapter IV

THE SINGLE-THREAD DRAW-LOOM HARNESS

The draw-loom harness

THE draw-loom harness, or monture, whether in its single or compound form, is by no means a new invention, for all the historic examples of automatic pattern weaving, the designs of which spread over any considerable number of threads of warp, have been woven on looms mounted with this most ingenious and admirable arrangement for forming the pattern sheds in the loom.

The limitations of the ordinary hand-loom

The ordinary hand-loom mounted simply with headles and treadles, however threaded, corded and tied up for the weaving of patterns, is naturally very limited as regards the scale of designs practicable by its means. This is on account of the great space occupied in the loom by any large number of headles, so that, unless very complicated threadings and treadlings are made use of, only designs which occupy a very few threads in the width of each repeat can be woven.

The thread monture

The single-thread draw-loom monture, which takes the place of the headle harness of the simple hand-loom, only occupies the same space in the loom as six or eight ordinary headles, whatever size the lateral repeats of design may be; in fact, many of the most splendid examples of Oriental and European textiles of large design, woven at the time of the Renaissance, have their whole width of warp,

consisting of several thousands of threads, woven into a single repeat on a comber board draw-loom.

The comber board: its importance

The astonishing difference, in this respect, between headle weaving and draw-loom monture weaving, is made possible chiefly by means of the part of the mechanism known as the *comber board*, so called because the repeats, anciently called *combers*, of a woven design were worked out on it, every single thread of warp in all the repeats having its separate weight and heald hanging through a hole pierced for it in the board.

The comber board is extremely important because it is the perfect ground plan or foundation on which the whole wonderful structure of the monture is built, by means of it the weaver can be in perfect touch, as he sits or stands at the loom, with every individual thread of the hundreds, or it may be, thousands, of the fine silk threads of his warp.

Plate IV will assist in the explanation of the comber board, and its importance and utility in the mechanism of the draw-loom will be readily understood by its means. In this plate two drawings, Figs. 1 and 2, of a similar board, are given, and in explaining them it will be best to notice their points of resemblance and general purpose before going on to point out and explain the particulars wherein they differ.

Construction of comber board

The construction of the board itself must first be considered. It is inconvenient for various reasons to use a simple, long, narrow board with the requisite number of holes pierced in it, which would at first appear all that is

THE SINGLE-THREAD DRAW-LOOM HARNESS

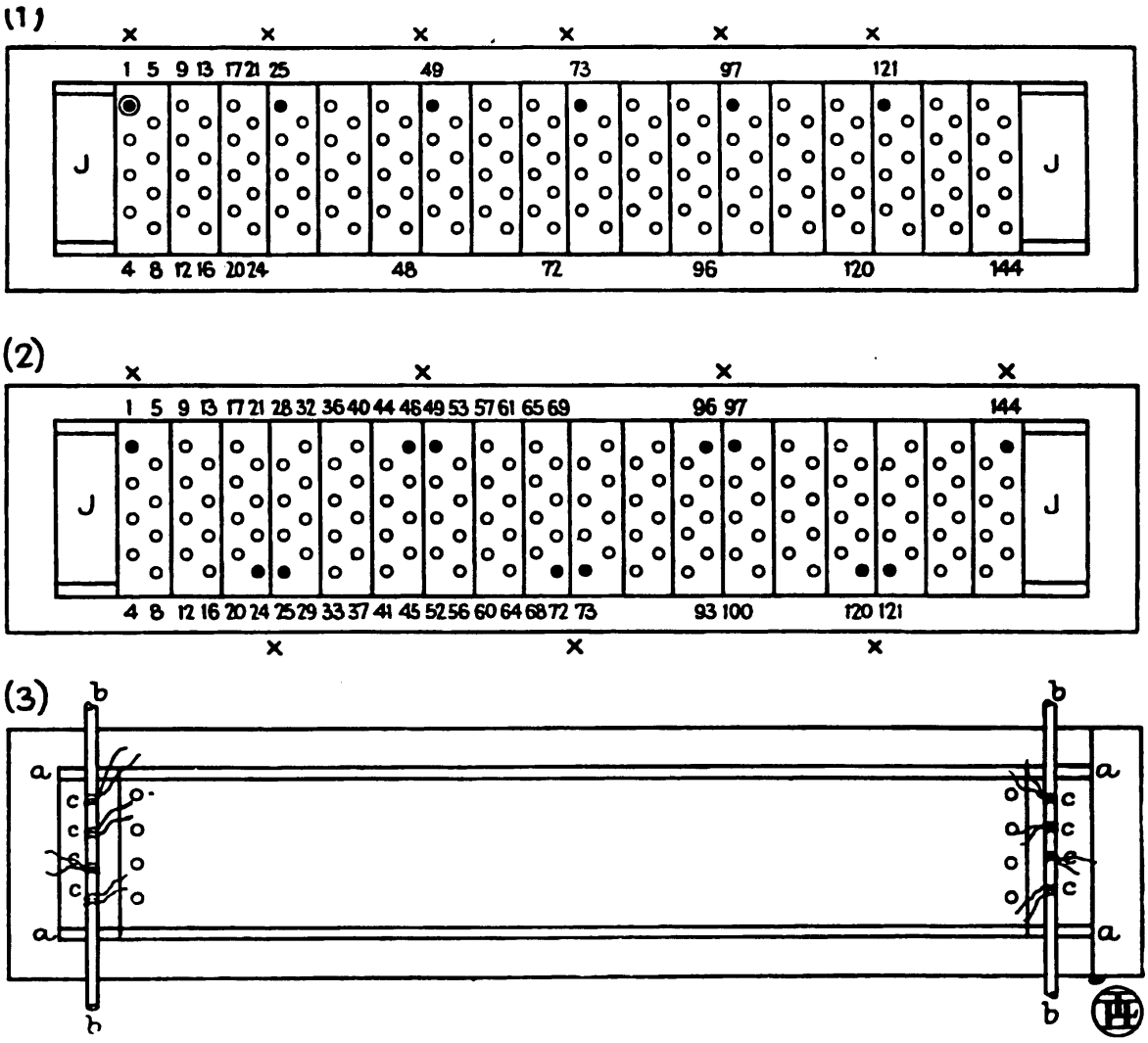


PLATE IV

THE COMBER BOARD—THE ESSENTIAL PART OF THE DRAW-LOOM HARNESS

necessary to serve the purpose, although, in fact, for very small narrow looms with low counts of warp, a well-seasoned, smooth, thin board with holes carefully spaced out and pierced would be quite practical; but for full-sized montures of 21 in. wide and upwards, the comber boards as represented at Figs. 1 and 2, Plate IV, are not only easier to make, but stronger and more perfectly adapted to their purpose.

The comber board

The perfect comber board, then, consists of a strong narrow frame which is long enough to rest securely on the bar *D* in Fig. 1, Plate II, near the middle of the upright frame on each side of the loom. The bar *D*, must be placed at such a height in the loom that when the frame of the comber board rests upon it, it will stand at about 12 in. above the tops of the rollers, which is, of course, the warp level. In Plate II, Fig. 1, this level is shown by a dotted line.

The inside upper edges of the comber frames 1, 2, and 3, Plate IV, are rabbeted to the depth of $\frac{5}{8}$ of an inch, so that a set of pierced slips of hard wood or vulcanized fibre can rest upon them and be secured by means of a small beading pinned to the edges of the frame. They will thus be prevented from rising when the healds, or couplings, which pass through their holes are mounted in their places and drawn upwards as required. In Plate IV, Figs. 1 and 2, the boards are shown without the beading, while at Fig. 3 the frame is shown complete with the beading *a a* but without the slips. The slips themselves need no other fixing, but are better left to be kept in their places by the weighted couplings which pass through them.

It will be seen that frames Nos. 1 and 2 are almost filled from end to end by 18 comber slips, each of which has eight holes pierced in it, and that a space in the frame is left open at both ends, the purpose of which will be explained later. The holes in the slips must be spaced and drilled most accurately, and must be very smoothly finished and countersunk on both sides. As the total number of holes in every comber board must equal the total number of threads in the warp they are to govern, the warp for either of the above boards would be one of only 144 threads; of course, such a very scanty count is only suggested for purposes of clear illustration.

The comber slips

In connection with the comber boards, Figs. 1 and 2, Plate IV, the only detail which remains to be explained is the very important one which relates to the method of working out the repeat of the design on equal numbers of threads of the whole warp. It will be readily seen that a few of the holes in each board are distinguished by being filled in with solid black at regular intervals; also that the holes so marked are differently arranged on No. 1 board from those of No. 2. It is by means of these marked holes that the division of the whole number of the holes of the board, and, consequently, the whole number of the threads of the warp, are divided into the several equal portions necessary for the repeats of the designs which will *eventually be made to correspond with them.*

The puller repeat: how designed

Fig. 1, Plate IV, is thus marked out for a design on 24 threads repeating six times on 144 threads. The numerals on the frame show the order in which the threads of warp

Design of the repeat

The comber repeat

which belong to each hole of the board will be entered in the eyes of the healds. The first hole at the back left-hand side, when the comber board is in its position in the loom, is No. 1, and the entering is straight forward to the fourth thread, which corresponds with the hole No. 4 at the front of the frame. The fifth thread is entered in the eye of the heald which belongs to hole No. 5 at the back of the frame, and threads 6, 7, and 8 proceed in a similar way from back to front of the board. This regular entering is continued until the whole warp, in this case 144 threads, is entered, and it will be easily realized that *the warp so entered and passed through the reed will form an unbroken succession of threads from No.* 1 *at the back on the left of the loom to No.* 144 *on the right.*

The point repeat

Fig. 2, Plate IV, is arranged for a warp of the same number of threads as No. 1, but the provision for the repeats of design in No. 2 board will be seen at once to be quite different from that of No. 1. The plan of No. 2, in combination with a reverse in the direction of entering the warp at certain points, automatically turns over the design and doubles its width; but, at the same time, gives it a more formal character. The separate effects, limitations, and advantages of both kinds of repeat, however, must be left for discussion in a subsequent chapter, but at this point it is only necessary to make the method and purpose of the design of the comber board quite understandable, and to indicate the points at which the entering of the warp threads must be reversed.

The marked holes in No. 2 board are not confined to

The point repeat

the back row as in No. 1 board, which requires a straightforward entering, but there are six marked holes on the back and the same number on the front. It will also be seen that the first and last holes of 1 to 24, 49 to 72, 97 to 120, which begin at the back row and end at the front, are marked in black, and that the first and last holes of 24 to 48, 73 to 96, 121 to 144, which begin at the front row and end on the back, are also marked in black; also the holes numbered 24 and 25, 48 and 49, 72 and 73, 96 and 97, and 120 and 121 are all side by side so that the entering of the warp beginning at the back at No. 1 hole can be traced across the whole width by closely following the succession of the numerals. By this arrangement there are only 3 repeats of design, each repeat consisting of 48 holes, instead of 6 repeats of 24 as in No. 1 board.

Chapter V

THE PULLEY BOX

The pulley box: its description and position in the loom

THE pulley box with its supporting frame is placed at the top of the loom as high above the comber board as possible and exactly over its centre. It rests, as shown in Plate V, Figs. 1 and 2, on the top of the two upright side frames of the loom to which it must be very firmly attached, as it has to sustain the whole weight of the heavy monture which hangs beneath it; a weight which varies from 40 lb. to 1 cwt. or even more, according to the richness of the warp for which it is intended. This weight is made up by the several hundreds, and sometimes thousands, of fine lead or iron wire weights, called *lingoes*, with which every separate heald of the harness is furnished, as will be presently explained. Before, however, giving any consideration to the monture itself, the structure of the pulley box and its correspondence with the *comber board* must be thoroughly described.

The front and side views of the pulley box, Figs. 1 and 2, in Plate V, show that it is erected on a strong frame, lettered *A A A*, which rests on the top of the upright sides of the loom marked *B B B B*. The frame itself is made of wood 3 in. by $1\frac{1}{4}$ in., and its outside measurements from front to back are exactly the same as the comber board over which it is placed, while its width depends on the number of pulleys it has to accommodate.

Four uprights, *C C*, supported by four strong brackets,

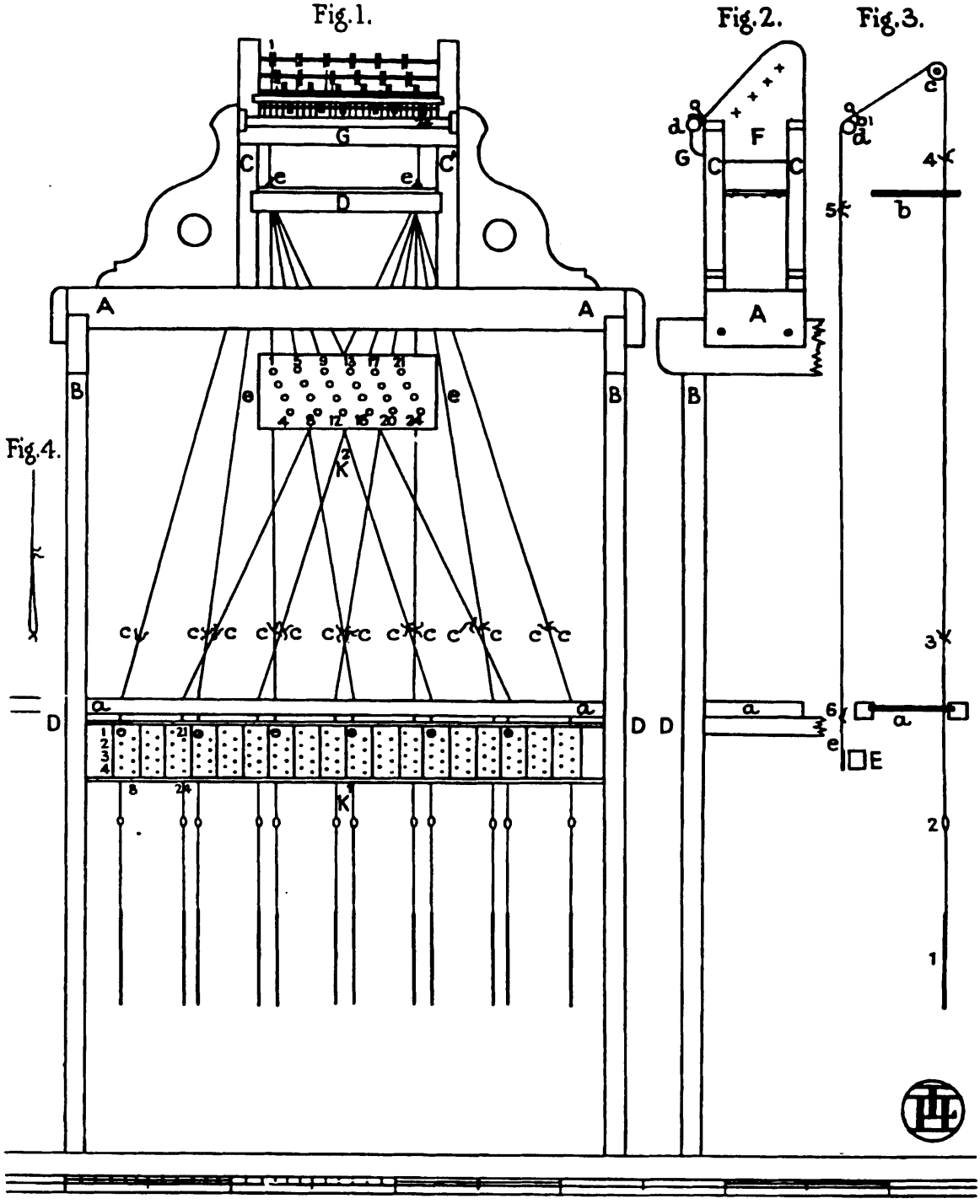


PLATE V

THE PULLEY BOX OF THE NEW DRAW-LOOM AND OTHER PARTS OF THE HARNESS CONNECTED WITH IT

General description of pulley box

are erected on the top edges of the frame *A A*, and between the uprights, both at the back and front, cross-pieces *D D* are securely fixed. These cross-pieces bear the bottom board of the box which is pierced with the necessary number of holes for *one repeat of a design*, should the comber board be arranged for a comber repeating pattern, or for *half a repeat*, in the case of a point repeating design. The edge of the bottom board is indicated at *e e* resting on its supporting cross-piece *D*, and there is, of course, another cross-piece supporting it at the back.

At this point it is necessary to pause in order to note that, so far, the details given for the construction of the loom, and the comber board frame as well as the pulley box, are suitable for any draw-loom, irrespective of the count of its warp, and the nature of the repeats of its design; but, from this point onwards the building of the monture, including the pulley box, must be specially adapted to the count of the warp and the repeat of the designs it is proposed to weave. Within the limits decided on, whatever they may be, the designer has perfect liberty to exercise his ingenuity, *but it is well-nigh impossible to break away from the limitations of a finished monture as regards width without entirely reconstructing it.*

The limitation of the monture

Description of monture

In order to make the explanation of the diagrams of Plate V clear and understandable, the sample monture first to be described must be one for a warp of very low count and for a small, simple, comber repeating design. Such a monture with all its separate members, comber board, pulley box, couplings, necking cords, etc., is

represented, at an early stage of building in the framework of the loom, in Plate V, Figs. 1, 2, and 3. Enclosed also between the loom posts *B B*, Fig. 1, are two supplementary diagrams K^1 which shows the upper side of the comber board, and K^2, which shows the perforations of the bottom board of the pulley box *e e*.

The comber slips

The comber slips, K^1, of which there are eighteen in all, are each about $1\frac{3}{4}$ in. wide, and are pierced with 8 holes each. There are six rows of holes, four holes in every row, and the first hole of every third slip is marked by a circle as the *first in each repeat of the design*, which is, therefore, a straightforward comber repeating design of 24 threads, 12 threads to 1 in., or 144 in 32 in.

The bottom board of pulley box

At K^2 the perforation of the bottom board of the pulley box *e e* is shown. Here there are also 24 holes corresponding with the holes in each three slips of the comber board.

It should be noticed, too, that the holes in the bottom board are arranged diagonally, and are numbered in the same order as the first three slips of the comber board, in Plate IV, Fig. 1. The purpose of this will be explained by the fitting up of the pulley box itself, which must next be dealt with.

Passing now to Fig. 2, Plate V, letter *F*, one of the solid, triangular sides of the pulley box will be seen. The sides rest upon the tops of the four corner uprights, two of which are at the front of the box *C C* (Fig. 1), and two at the back. The four crosses, drawn parallel with the front edge of the side of the box (*F*2), indicate the

The pulley supports

positions of four strong steel rods, which, as seen in the front view Fig. 1, are fixed between the sides of the box; each rod, from the highest at the back to the lowest at the front, advances about the space of an inch in regular sequence.

The pulley

On each of the four rods six small brass pulleys are fitted and spaced by washers of tubing in such a manner that each successive pulley, counting from No. 1 at the back to No. 24 at the front, is exactly above the corresponding holes in the bottom board *e e*, the perforations of which are given at K^2.

Just below the fourth row of pulleys, counting from the back, a projecting wooden bar, having its top edge hollowed out, is fixed across the front of the box; this is shown at *G* in Fig. 1, and its end is shown at *G* in Fig. 2. In the hollow of this bar a round glass rod, about ½ in. in diameter, is held at each end by two metal fasteners, and immediately behind it a narrow comb, or reed is fixed, so that, as the spaces between the wires of the reed are made to correspond exactly with the spacing of the pulleys behind it, any cord or cords passing upward, from the comber board, through a hole in the bottom board of the pulley box and on to the pulley above it, can be brought straight forward through the dent of the reed, over the glass rod, and be carried down and tied to a bar, the end of which is shown at *G*, Plate II, Fig. 1, as well as at Plate V, Fig. 3, letter *E*. In this manner every compound coupling thread of the monture with its eyes, loops, and knots, effectually connects its lingo weight, at one end below the warp, with

the bar *E*, to which its other end is tied at the front of the loom.

How a collection of hundreds, or even thousands, of such composite couplings can be arranged so as to form a complete monture for pattern weaving will be explained in the next chapter.

Chapter VI

BUILDING THE MONTURE

Preparations for building the pattern harness

BEFORE beginning to build the monture of fine linen thread, which is the most complicated part of the monture, the exact position of the comber board must be settled, and the board itself firmly fixed to its supports on the side frames of the loom. In a single thread harness such as the one at present under consideration, the comber board must stand not less than 9 in. above the level of the warp, which will be stretched between the back and front rollers of the loom. This level can be readily ascertained by resting a long cord, with a weight at each end, over both rollers in the position the warp will occupy between them. The bars *D*, therefore, in both the side frames of the loom, as shown at Fig. 2, Plate V, must be permanently fixed 9 in. above the level cord, and to these the comber board must be screwed down.

The lingoes

The part of the harness to which the lingo weights, which hang below the warp, are attached, are called the "*short couplings.*" They are made of the best linen thread about size No. 15, and consist of the eyes through which the warp threads will eventually pass; the short loops below the eyes to which the lingoes are attached; and the longer loops above the eyes, which are made long enough to pass upward through the comber board and reach a little above it. Each of these couplings form the first member of a composite or extended heald, the whole of which, together

The lingo couplings

with its position in the loom, is represented in Fig. 3, Plate V, which is a section of the draw-loom at its centre. It shows the comber board, letter *a*; the bottom board of the pulley box, *b*; one of the pulleys, *c*; the pulley box reed and glass rod, *d*; and the iron bar, *e*, to which the lower end of the long coupling is joined. It will at once be seen that by means of a whole collection of such couplings, a perfect and sensitive connection will be made between the lingoes, below the warp and the cords of the simple, in front of the loom. In Fig. 3, Plate V, the various parts of the extended coupling are distinguished by numerals: 1 being the lingo, 2 the eye, 3 the joint of the short coupling and the necking cord, 4 the joint of the necking and pulley cords, 5 the joint connecting the pulley cord and the simple cord, and 6 the attachment of the simple cord to the loop of the simple bar, *E*.

The short couplings

The whole number of short couplings, which extend from the lingoes themselves to the joints of the necking cords, required for the monture, which, of course, equal the number of holes in the comber board, should be made or provided before starting to enter the comber board or build the rest of the monture.

Can be obtained ready-made

If made by hand, which is not at all difficult, though rather a tedious job, the couplings are knotted on a long board having pegs fitted into it at regular intervals, as shown in Fig. 1, Plate VI, but, as similar couplings are always being used for power-loom pattern weaving, they can be obtained to order from any firm of Jacquard machinists, and, as they are made by machinery, the machine-made

couplings will be found more exact in all their dimensions, which is a very important matter. For power-looms they are generally supplied varnished, which makes them last longer when the loom is worked at high speed, but for hand weaving they are better unvarnished.

Making short couplings by hand

For making the couplings by hand, the board with holes and pegs, shown at Plate VI, Fig. 1, letter *A*, will be required. The board should be about 30 in. long and 6 in. wide; it should be heavy enough to rest firmly on a table, or it may be clamped to a table edge. The holes, $\frac{1}{2}$ in. in diameter, are bored $\frac{1}{2}$ in. apart along the centre of the board, and three hard wood pegs, letters *a*, a^1, and a^2, are made to fit firmly in them where required. The upper part of the fourth peg, letter *b*, Fig. 1, is best made of $\frac{1}{8}$ in. metal wire, fixed in a groove in the side of a short wooden peg which can be turned round in its hole. This thin upper part which remains above the board must be strong enough, when fitted in its place, to bear without bending the strain of several knots being tied against it. The advantage of using this turnable peg is that the eyes of the couplings can be regulated to almost any size required. The pegs are drawn enlarged at Figs. 2 and 3, Plate VI. In use, the pegs are fitted into the holes, as shown in Fig. 1, ready for making a coupling. At Fig. 4 the board is represented with a completed coupling upon it, its dimensions being from peg a^1 to peg a^2 not less than 7 in.; the eye $\frac{1}{2}$ in., between a^2 and *b*, and from the eye to peg *a*, 20 in. or more if required.

When beginning to make a coupling, the two pegs, *a* and

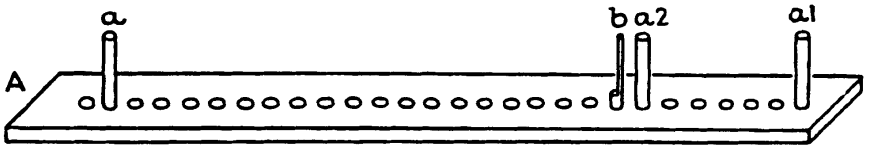


Fig. 1.

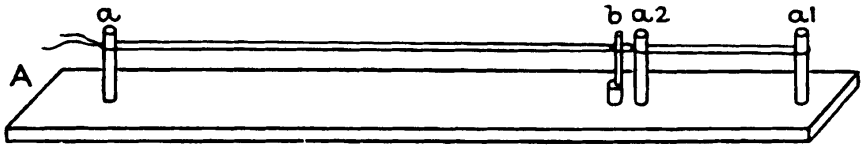


Fig. 4

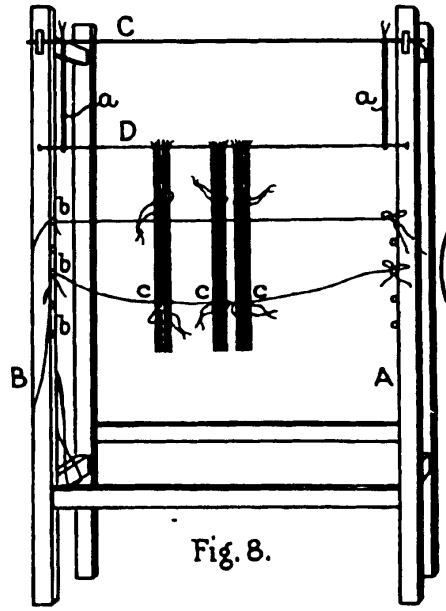


Fig. 8.

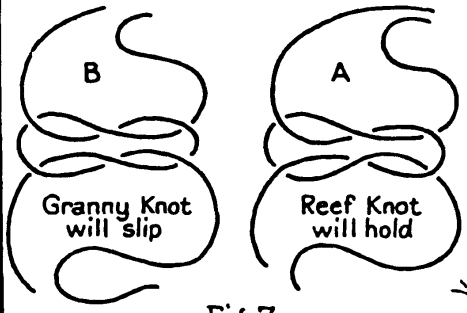


Fig 7

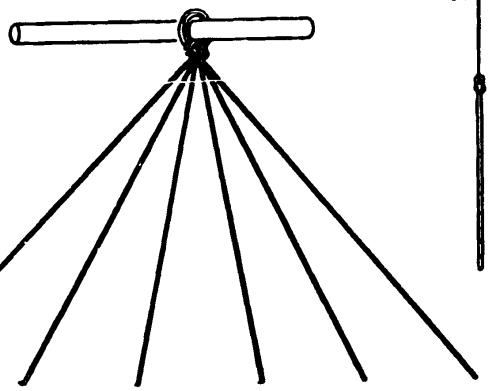


Fig 9

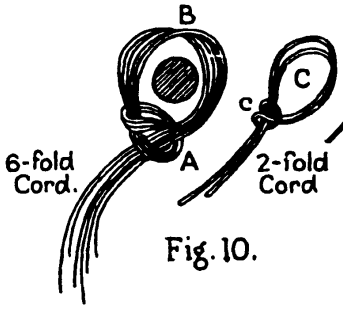


Fig. 10.

Fig. 2

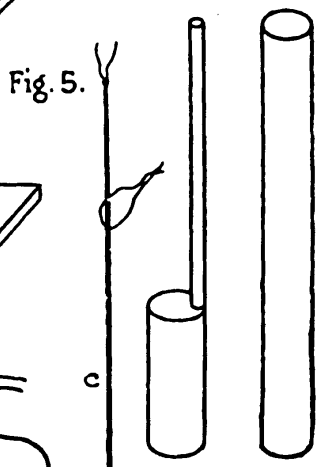


Fig. 3.

Fig. 5.

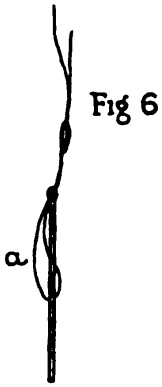


Fig 6

PLATE VI

APPLIANCES FOR HARNESS BUILDING AND SUNDRY DETAILS

a^1 must be placed in position, and, for a single thread monture, they must be 27 in. to 30 in. apart. For making the ½ in. eye, the peg with the wire top must be placed with its wire as near as possible to peg a^2, which should be 7 in. from peg a^1.

The operator making a coupling should sit at the end of the board at letter *A* Fig. 4, Plate VI, with the board in front of him at right angles. A fine linen thread, rather more than twice the length of the board, must be doubled in half and looped over peg a^1, brought without twisting to the sides of peg a^2, and there the two single threads must be firmly tied together in a reef knot. Next the *eye* must be formed by tying another reef knot after passing the wire peg, care being taken to keep the knot close up to the peg. This being done, the threads can be taken still without twisting, to the sides of peg *a*, and fastened securely behind it by a third knot of the same kind. It is essential that all the couplings should be of the same measurements in all their parts, and that the knots should all be reef knots, not grannies, which would slip. Fig. 7, Plate VI, shows the difference between the reef knot and the granny, which latter must be carefully avoided.

The couplings should be made in groups of tens, twelves, twenties, or any convenient number for counting, and before being removed from the pegs, thin threads of strong coloured cotton should be passed, in the same direction, severally through the long loops, the eyes, and the short loops between a^1 and a^2.

The lingoes The lingoes, which are made of lead or iron wire (lead for preference), should weigh from 30 to 60 to the lb.

according to the fineness of the warp they are intended for. They should not be less than 7 in. in length if made of lead, but, should they be made of iron, they must be twice that length, if of the same thickness, iron having about two-thirds the specific gravity of lead.

Attaching the lingoes

The lingoes are attached to the couplings in the manner shown at Fig. 6, Plate VI; the short loop of the coupling is passed through the eye of the lingo, far enough to allow of the lingo being passed, in its turn, wholly through the loop, to hang there securely when released.

For the scanty harness represented in Plate V, only 144 couplings with their lingoes will be required, but for a fully mounted draw-loom any number from 500 to 5,000 might be wanted.

It will be readily understood that the counting out, handling, transferring to the loom and hanging in the comber board, even such a moderate number of couplings as 144, must require some method and convenient appliances for systematically manipulating them. To supply this need, a simple, upright stand consisting of 4 posts framed together at the bottom, so as to stand firmly on the ground, is used by the harness builder. Such a convenient appliance is shown on Plate VI, Fig. 8. Its construction is quite simple, and requires little description beyond stating that it must be strong enough to bear a considerable weight, that its height should be about 5 ft., its depth from front to back 2 ft., and its width from 3 ft. 4 in. to 4 ft. Near the top of the frame notched side bars are fixed for resting cross-rods upon, on which shafts, healds, and

Handling the couplings: a frame required

harnesses can be hung, counted, and otherwise manipulated. To complete the building frame, on the inner edges of the front upright posts *A* and *B*, 12 screw eyes, 6 on either side, are fixed, to which any necessary cords can be attached when required. The two iron rods, *C* and *D*, belong to the building frame itself; the rod *C* has two long strong loops of cord hanging to it, and must be strong enough to bear a considerable weight without bending. The other rod, letter *D*, rests in the loops, but can be easily removed. It is on the rod *D* that the groups of couplings, when taken off the heald board, are first hung by their long, top loop. In the drawing, the groups of couplings are shown hanging on the rod ready for spreading out, counting and attaching their lingoes. The short thread ties, safeguarding the loops and eyes of the couplings, which were passed through and tied to them before they were taken off the heald board, still remain in their places, and through the same openings long, thin threads are passed, their ends being fixed by double bows to the screw eyes *b b b b b b*.

The building frame, couplings, etc.

Spread out and moving couplings to comber board

In order to spread out the couplings, count them, and affix their lingoes, the original loose loops being removed, having served their purpose. If the couplings were made and tied up in bundles of 12 each, the necessary number of couplings on the rod will prove to be correct, viz. 36, and it will only remain to join on the lingoes one by one in the manner shown at Fig. 6, Plate VI, and described at page 43. It should, perhaps, be explained that, if the lingoes are longer than the lower loop of the couplings, it

will be necessary to draw out the long thread from the eyes of the couplings, and re-thread it after the lingoes are looped on. In replacing it, however, great care must be taken to prevent the upper loops of the couplings twisting together, as well as to make sure that the same succession in the row of eyes is maintained. This is easy enough, of course, where so few healds are mounted in each row, but the difficulty is much greater, and, consequently, requires extra care, when larger numbers have to be dealt with. *Moving couplings*

Turning now to Fig. 2, Plate VII, where the building frame is shown with the set of 36 couplings quite ready for transfer to the loom, there will be seen only two points of difference between it and Fig. 8, Plate VI, requiring explanation: (1) The ends of the long threads, which keep open the loops and eyes of the couplings, have been loosed from the screw eyes *b b b b* and tied together in bows, so as to remain for a future use, which will be explained in its proper place; and (2) That a metal rod, not too large to pass easily through the eyes of the couplings, has been placed in them together with the garding thread. The rod must be very smooth and have a pointed end; its use is to assist in the first regulating of the height of the eyes in the loom.

If the couplings with lingoes attached are supplied to order by a Jacquard machinist, they will be in bundles containing 100 each, and will be ready for hanging in the comber board. Great care must be used in undoing the bundles as well as in counting and arranging them. The same building frame, Fig. 8, Plate VI, and Fig. 2, *Method of handling "trade" couplings*

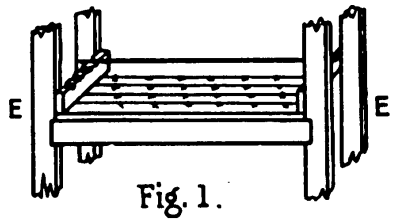


Fig. 1.

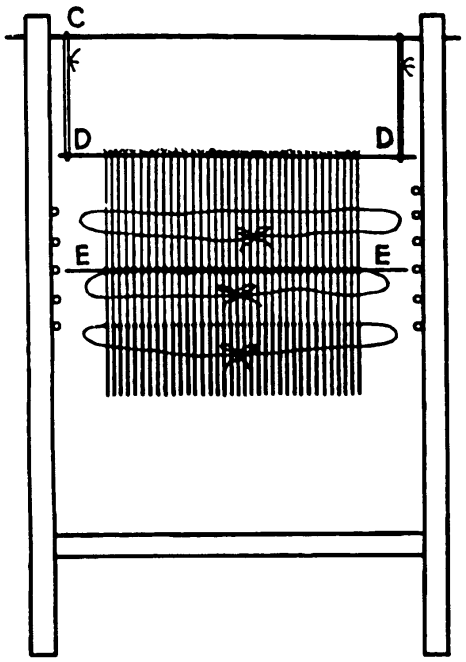


Fig. 2

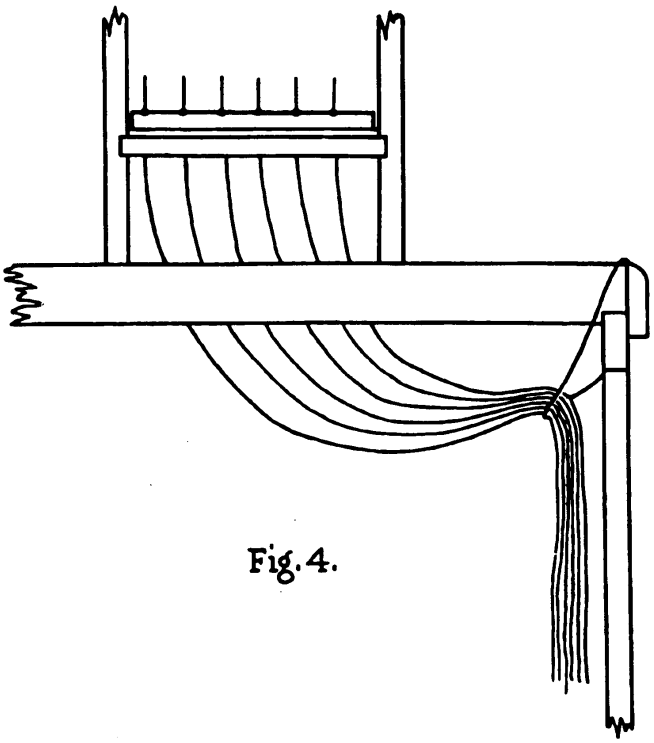


Fig. 4.

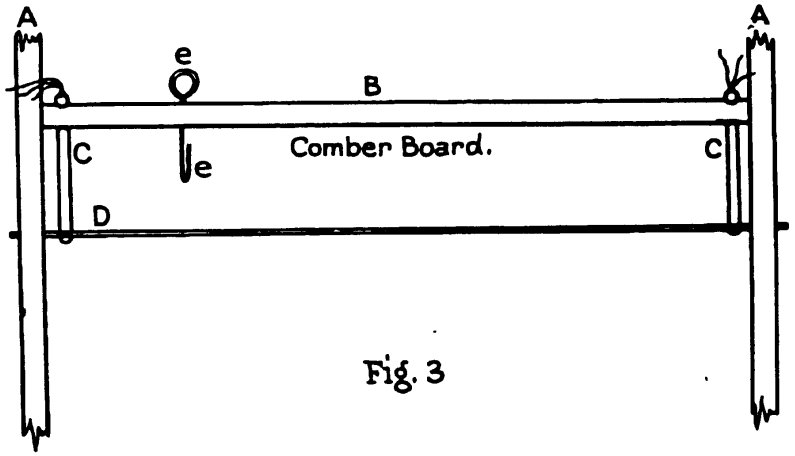


Fig. 3

PLATE VII

APPLIANCES FOR HARNESS BUILDING AND TEMPORARY FITTINGS

Plate VII, will be needed in order to arrange each row for the loom. All the openings in every bundle will be found carefully tied up, and *none of the protecting knots must be untied or cut until long threads or twines have been inserted to keep the openings clear.*

The best procedure is as follows: (1) Open the long top loop of the bundle; (2) Hang the whole bundle on the bar *D*, Fig. 2, Plate VII, keeping the bundle at the left end of the bar; (3) Pass long twines through *all* the openings; and (4) Very carefully cut off all the knots of the ties, so that the couplings may all hang loose. It should now be possible to count off the number of couplings required for each shaft, and if any remain over, they must be loosely but securely tied up again at every opening before being removed from the frame. When all is done, Fig. 2, Plate VII, will represent the finished work ready for mounting the loom.

Leaving the couplings on the building frame ready for joining to the necking cords, the making of the necking cords themselves must now be described.

The necking cords

The necking cords are made of the best linen thread, rather thicker than the thread of the lingo couplings, but not so thick as to make it difficult to join half-a-dozen of them together in a loop in the pulley box or prevent their passing freely in a group through the holes in the bottom board of the box, as they constantly have to do.

An examination of Fig. 1, Plate V, must now be made, in order to render this important part of the building of the mechanism quite clear: (1) The comber board is pierced

for 6 repeats of design; (2) Six single necking cords are required for the first lingo coupling of each repeat; (3) These 6 cords, gathered into one loop, after passing through the first hole in the bottom board of the pulley box, must be linked by a loop or ring of some kind to the first pulley cord so as to be actuated by it.

The necking cords to join pulley cords

In Fig. 1, Plate V, the single necking cords, lettered *c c c c c c*, are represented *diverging from the loop and joint at the first hole of each repeat of the comber board to the junction with the first cord in the pulley box.*

All the single necking cords along the *back row of the comber board* must be joined up in like manner to their corresponding pulley cords in regular succession, and when this is done, the second, third, and fourth row will naturally follow.

The necking cords and their pulley box loops are made as shown at Fig. 9, Plate VI. It will be seen in the drawing that the necking cord loops are made on a short round stick $\frac{1}{4}$ in. in diameter, and long enough to hold conveniently a reasonable number of loops close together so that they can be removed for use one at a time, as required.

Making compound necking cords

Three lengths of single cord will be wanted for each loop, measuring twice the length of a cord reaching from the *first* hole in the bottom board of the pulley box at the *left* to the *last* hole in the comber board at the *right*. The three long cords must be put together and folded exactly at their middle. After making sure that the six ends are practically the same length, a double snitch (Fig. 10, Plate VI, *AB*) must be made at the fold over and placed

loosely around the rod as at *A*. Before tightening the snitch on the rod, the single snitch, letter *B*, must be neatly and evenly tightened on the sixfold cord. The double snitch can then be drawn close to the rod, and the six cords, divided into two threefold ones, can be tied together in a single knot to secure the snitch as usual. Thus, the result shown at Fig. 9, Plate VI, will be achieved. Twenty-four such composite necking cords will be required to fill the pulley box and comber board of our example. It will, no doubt, be realized by the reader that in every case the pulley box, the comber board, and the composite couplings throughout the monture must all be exactly in agreement as regards number and every other particular, and also that all the joints, knots, and snitches must be very carefully and neatly made without any twisted or overlapping threads.

Preparation of pulley box for joining necking cords

In preparation for joining the shaft full of couplings which are waiting to be drawn up through the comber board, one row of necking cords must be drawn through the holes in the pulley box from above. In order to do this it is necessary to make the temporary preparation in the pulley box which is shown at Fig. 1, Plate VII. In this figure, the frame of part of the pulley box on which the bottom board rests is traced from Plate V, at *aa*, Fig. 1. It will be seen that at the two ends of the bottom board, which is shown in perspective, a small wooden bar is placed, having 4 notches at its top edge, which correspond with the 4 rows of holes in the board. These notches are intended to receive $4\frac{3}{16}$ in. iron bars to which the loops of

the necking cords will be transferred one by one, 6 to each bar. One such bar is shown in its place exactly over the first row of holes, counting from the back.

Preparations in pulley box

Before, however, placing the rod in the box as shown in the drawing, 6 necking cord loops must be transferred to it at the right-hand end. The operator, then, standing on a strong board placed across the loom at the front, must (1) put the rod in its place resting in the back notches; (2) Move the first loop to its place over the first hole; (3) Take the 6 cords belonging to the first loop by their ends, and push them all together through the first hole, pull them down from underneath the board, and, for the present, allow them to hang loose. The second and the four succeeding composite cords must be handled in the same way, and when the row is finished, the cords must all be gathered into a bundle, and, by means of a double twine and a tightly-drawn snitch, hung neatly to the frame of the loom on the right-hand side, to be drawn out, a cord at a time, for joining when the couplings are ready (see Fig. 3, Plate VII).

As soon as one row of necking cords are hung on the back rod, the second, and the third and fourth rows must follow in the same manner, until the whole of the pulley box is furnished and the necking cords from each rod are separately snitched to the side frame ready to be joined to the couplings a row at a time.

Arrangements can now be made for entering the couplings in the comber board; these are quite simple, but are absolutely necessary, especially in cases where a large number

Hanging short couplings in comber board

of couplings have to be dealt with. In order to describe them briefly and clearly, use must be made of Fig. 3 on Plate IV. In this drawing two short rods, letters *bb*, are shown resting across the comber board from back to front, over the vacant spaces between the comber slips and the ends of the frame. If the monture is of a heavy count, these rods should be made of iron, as they have to bear the accumulated weight of the whole set of lingoes; but up to 400 or 500 lingoes, wooden rods would be strong enough. Upon these rods, 8 adjustable loops, 4 on each, are hung, the snitches of which can be seen on the rods, placed there in order that the length of the loops can be regulated from the top when each pair are loaded with a row of lingo couplings. The loops must be long enough to allow a rod to hang 10 in. below the comber slips when resting on them, as shown in Fig. 3, Plate VII, in which *AA* are parts of the front loom posts; *B* the comber board; *CC* the loops; and *D* the rod on which the couplings are hanging, as shown in Fig. 2 of the same plate.

The space in front of the comber board must now be cleared of all encumbrances, batten, roller, etc., and then, *disturbing the couplings as little as possible*, the rod *D* in Fig. 2, Plate VII, must be lifted from the loops of the building stand; carried very gently to the front of the comber board (Fig. 4), and there deposited on either the third or fourth pair of loops from the front.

The rod *E*, which will be still hanging below the rod *D*, must now be raised to the same level and placed firmly in the *front* pair of loops. When this is accomplished, the

Hanging short couplings

rod *D* can be carefully detached from the comber board loops, and lowered and withdrawn, thus allowing the loops to fall lightly behind the other portion of the couplings, and so rest, pending the entering. When all is ready for the entering, the rod *E*, with all the couplings resting upon it, must be moved to the back pair of loops and there remain in its permanent place.

For the comber board entering, a small wire hook will be wanted (see *ee*, Plate VII). It must be made of thin steel wire, with its end filed very thin before being doubled over so as to go easily through the comber slip holes.

All the preparations being thus carefully made, the entering itself will be found quite a simple matter. The enterer must stand or sit in front of the comber board and push the entering hook with his left hand well down the first hole in the back row, and with his right hand below the board, place the long loop well across the hook and draw it through the hole as far as possible without disturbing the rod *E*, which hangs on the eye of the couplings. The top loop of the coupling must next be laid across the board so as to hang over the front. In this manner the 36 couplings of the first row must be entered, one by one, in exact order, and, after being examined and found undisturbed and correct, so left.

Joining the first row of couplings to necking cords

Before the second row of couplings can be hung in the loom, although they may, if convenient, be ready prepared on the stand, the first row must be joined to the necking cords.

It is most important that all the knots, loops, and

snitches of the joints of the necking cords and couplings be made as neatly and evenly as possible, and the two ends of the single fixing knot of each joint left, after being tied, not less than $\frac{3}{4}$ in. in length.

It must be observed that the lengths of the necking cords will vary considerably according to the relative positions of the holes of the comber board and the bottom board of the pulley box; this makes it very difficult to keep all the joints of the cords and couplings in an exact line. Fortunately, however, this is not a vital matter, and only affects the appearance of the harness and not its working; at the same time, it is well to keep in mind the level of the comber board, and make the joints not less than 3 in., and not more than 6 in. or 7 in. above it. The height of the joint will depend on that of the snitch loop of the necking, which, being single, needs to be held in position over the hole of its coupling, folded over 3 in. above the comber board, and tied in a simple neat knot, leaving a 2 in. loop, as in Fig. 4, Plate V.

In studying carefully Fig. 1, Plate V, where the first set of 6 necking cord joints are shown, lettered c^1 c^2 c^3 c^4 c^5 c^6, all being connected with the first pulley cord, it will be realized that unless the joints were all made simultaneously, the position of the first of the 6 joints and its necking cord and coupling would be slightly affected by the time joint No. 6 was made. Consequently, it is best to leave the final fixing of the joints by the single knot, until all the 6 loops of the couplings have been drawn through the snitch and gripped tightly enough to prevent their slipping easily.

As soon as the 6 necking cords hang in straight diagonal lines, the snitch knots are all at an equal distance above the comber board, the rod in the eyes of the couplings remaining at rest, and all is tidy above and below; the loops of the couplings can be divided, their ends tied together close to the snitch, cut off to within 1 in. of the knot, and the joints will be complete.

The same directions apply to the joining of the 5 remaining sets, or sheaves, of necking cords and couplings in the first, and, indeed, in all the succeeding rows of sheaves until all are joined, but it is necessary to give special emphasis to the statement that: *throughout the whole joining up from the first sheaf of 6 necking couplings to the last, every sheaf must be joined in front of the previous one; and, also, that there must be a clear opening between every complete row of the cords when viewed from the side of the monture.*

The steel rods may remain in the eyes of the four rows of lingo couplings until the loom is ready for entering the warp, when they can be carefully withdrawn, leaving the garding thread in its place for the assistance of the enterers.

Chapter VII

THE PULLEY CORDS, THE SIMPLE, AND THE LASHES

THUS far the building of the pattern weaving draw-loom and its mounting follows practically the same course as that of the traditional loom described by Murphy in his book, as quoted in Chapter II of this book; but, from this point forward, the arrangement of the monture for pattern weaving will be found to depart from that of tradition.

Reference to John Murphy's Plate

The cords from the pulley box, as shown in Murphy's illustration, Plate I, after passing over the pulleys, were continued at great length and fastened to the wall of the workshop, at a level with the pulley box itself, and were called the *tail* of the loom. Between the tail and the ground another set of cords of the same number were attached to the tail, carried downward, joined to a strong bar near to the floor at the side of the loom, and were called the *simple*.

Pulley cords of new draw-loom

In the case of the new draw-loom, however, the pulley cords are much shorter, and are carried forward over the pulleys to the front of the loom, joined to the top ends of the simple cords, and the latter are finally joined at their lower ends to a set of short loops attached to the simple bar *E* (Fig. 3, Plate IV)[1].

[1] If very large designs, requiring a great number of lashes for tying up the design, are to be produced, it might be better to place the pulley box sideways and to carry the simple cords over the glass rod down to the floor as before, which would, of course, make room for a much larger number of lashes to be mounted, but this arrangement would necessitate the use of a draw-boy as in the ancient draw-loom. It is quite possible, however, that a means of actuating, by means of a treadle, the side simple could be devised if required, but this has not been attempted at present.

Two persons needed for joining necking and pulley cords

All the necking cords being ready with their loops on the steel rods at the bottom of the pulley box, a little preparation must be made for joining them to the pulley cords and linking them up with those of the simple cords at the front of the loom, a process which requires two persons, in order to do it in comfort, one to stand at the front of the pulley box, and one at the back. The most important post is at the back, where the permanent joints of the necking and the pulley cords are to be made.

Preparation of the loom for joining the complete couplings

The only preparation in the loom required for joining the pulley and necking cords together, and making ready the former for joining to the cords of the simple, is to fit up a strong rod in front of the pulley box to which the pulley cords can be tied temporarily, one at a time, till the simple is made ready to complete the circuit from the bar *E* over the pulleys to the lingoes. The temporary rod is shown in position at *aa*, Fig. 1, Plate VIII. The method of fitting up the rod can be gathered perfectly from this illustration, if it be explained that *bb* are the ends of two rods which project from the corners of the pulley box sufficiently for the rod *aa* to rest upon them. The rods cross the box to the back on top of the ends of the necking loop bars and are prevented from rising at the back by being lashed to the back corner posts of the box, and at the front by the rod *aa* itself, which is secured from rising by the loops of cord *cc*.

The pulley cords must be double

The supporting rod being in its place, the cords for the 24 pulleys have next to be made. The same sized cord as that of the necking may be used, but it must be

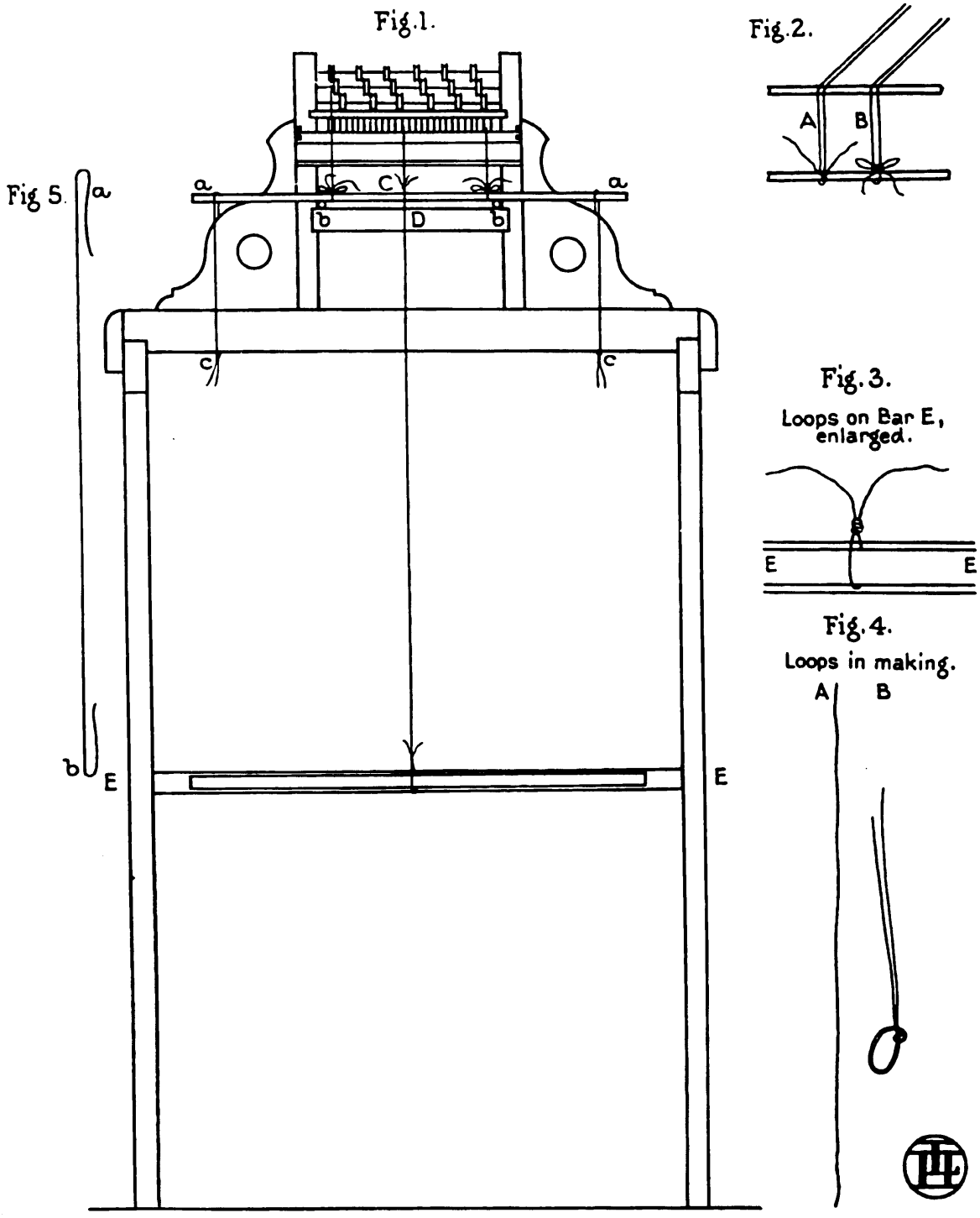


PLATE VIII

THE LOOM PREPARED FOR MOUNTING THE PULLEY CORDS, AND SUNDRY DETAILS OF FITTING-UP

double for the sake of strength; each length, therefore, must be cut long enough to reach to rather more than twice the distance from the bottom board of the pulley box at the back, over the pulleys, through the comb, and over the glass rod to the rod *aa* at the front, and there allow of its being tied in a double bow to make it secure.

The joining

The necessary number of cords being cut, a single cord must be folded at the middle, and the folded end passed through the first necking loop on the rod in the back row to the right of the operator, now standing at the back of the loom and facing an assistant, who must stand at the front. The double cord need only be drawn through the necking loop far enough to allow a double snitch to be made, through which the two long ends of the double cord can be passed; see the drawing, Plate VI, Fig. 10, letter *Cc*, in which the italic *c* is the first snitch to be drawn tight on the double cord, and the capital *C* the second snitch, to be drawn closely around the necking loop of the sixfold cord. As soon as the double pulley cord is snugly fitted to the necking loop, a perfectly strong, neat, and permanent joint will be the result.

The joining of complete couplings

The double cord must next be placed on the pulley and held there while the two long ends are handed over to the assistant in front, who, passing them both together through the opening in the reed opposite the first pulley, over the glass rod and down to the rod *aa*, must there tie it by a *double bow*, as shown by Fig. 2, Plate VIII, letters *A* and *B*.

Returning for a moment to Plate IV, the holes of

the comber board, Fig. 1, will be seen numbered in regular sequence from *back* to *front*, so that No. 2 is the *first* hole in the *second lateral row*; in agreement with this, it is clear that the second necking cord and the second pulley are the first on and over the second rod. The *second pulley cord*, therefore, must be joined to the *first necking loop* in the *second row of holes*; carried over its corresponding pulley and entered in the *second opening of the reed*; carried over the glass rod and tied close to the first cord on the rod *aa*. The third and fourth pulley cords must follow the same course and be attached in the same way and order. The first, second, third, and fourth pulley cords being settled, following the numerals on the comber board Fig. 1, Plate IV, No. 5 hole will be found next to No. 1 in the back row, No. 6 next to No. 2 in the second row, No. 7 next to No. 3 in the third row, and No. 8 next to No. 4 at the front.

No further directions should be needed for fitting up the whole pulley box to the finish with the twenty-fourth cord at the front, except to mention that all the cords must be kept straight, true, and of equal tension throughout their courses, while, at the same time, the rods in the pulley box still rest undisturbed.

The coarsest of the three sizes of linen thread chosen for building the monture is that of which the all-important part of the draw-loom mechanism, the *simple*, is made. *The simple*
It is shown in Fig. 3, Plate V, between the italics *d* and *e*, as well as in Murphy's drawing illustrating the quotation from his book in Chapter II. In that drawing it is shown

fitted up at the side of the loom as usual in the mediaeval draw-loom, although it is quite possible that in the most ancient looms its position was at the front or, as in the Chinese looms, at the top, in which case the new draw-loom is in closest accord with the more ancient tradition.

In Plate VIII, Figs. 1 and 2, which will be seen to correspond with the sectional view of the monture in Plate V, Fig. 3, the cording of the harness, including the simple, is shown completed.

Mounting the simple cords

In order to mount the cords of the simple, which have to be connected with the pulley cords at *aa* at the top end and to the flat iron rod *E* at the bottom, Fig. 3, Plate V, and Fig. 1, Plates VIII and IX, it is necessary to tie on the bar *E* as many short pieces of cord, not less than 10 in. long, as there are simple cords to connect with the other part of the long couplings. These short cords must be doubled and firmly looped to the bar by the double snitch, as shown in Plate VIII, Fig. 3, letters *A* and *B*, in which *A* shows the double cord passed around the bar and through a single snitch in the double cord itself, while, at letter *B*, the snitches have been firmly tightened around the bar, leaving the two ends of cord free for joining to a snitch on a simple cord. It will be found best to attach all the 24 loops to the bar *E* before beginning to join up the cords of the simple, which have to be connected to the pulley cords and the bar *E* one by one, beginning at the left-hand side.

The 24 cords for the simple must be cut at least 12 in. longer than the distance between the bar *E* and the

temporary rod *aa* to which the double pulley cords are at present tied by double bows. This extra length of cord is necessary in order to allow of a snitch being formed at both its ends, the one at the top to receive the double pulley cord ends, and the one at the bottom to clasp the two ends of the loop on the bar *E*, as in Fig. 5 *a b*, Plate VIII. It will be found that, after making the snitch on the folded-over end of the simple cord, passing the two ends of the pulley cord through the loop, in the usual way, and tying them together, the single knot, when the snitch is drawn tight, will make a secure joint.

Inspecting the joined complete couplings

As soon as the last of the simple cords are in place and all the separate parts of the monture, from the bar *E*, at the front to the lingoes at the back, are so joined and adjusted that no portion of the harness hangs untidily loose or unduly strained, the structure may be reckoned to be complete so far and ready for entering the warp. This must be done before the general revision and regulation of the monture can be undertaken, and all the temporary rods, rests, cords, etc., can be dispensed with.

The lashes

The elaborate system of *lashes* or *leashes* for actuating the cords for the production of designs, described by Murphy in the quotation from his book in Chapter II, and shown in his diagram, is not made use of in the new draw-loom, where a simpler and more ancient contrivance for drawing up each line of the design is adopted.

Chinese loom at Wembley described

Before describing this fitting of the simple, it will be interesting to the reader to make a quotation from an article written by the author and published in 1924 in a

craft magazine, describing the modern Chinese pattern-loom, from which he adapted the lashes of the simple for his new draw-loom.

Chinese loom

There was in a corner of the Hong Kong department of the Wembley Exhibition an exhibit which would have been of surpassing interest to hand-loom pattern weavers had they noticed it, which, as far as I can hear, few of them did. It was a loom at which three men were at work weaving grass matting of a geometric design in a few brilliant colours. The loom itself was a massive structure, and was intensely interesting to me, because it embodied in the details of its mounting and the methods of working it at once the pattern weaving traditions of ancient China, Egypt, India and Arabia. The method by which the pattern was produced was exactly the same as that represented in very ancient Chinese drawings.

. . . . . .

The loom at Wembley was worked by a team of three men, each man doing his part with extraordinary skill. First, the cords of the upright pattern harness were drawn upward to form the shed, by a man sitting aloft at the back above the warp in the ancient Chinese fashion. The pattern, which consisted of only eight or ten different lines in each repeat, was interlaced across the upright cords of the harness by separate strings, one string for each line. By means of these crossing strings the man aloft gathered the selected cords of the pattern into his arms and drew them vigorously towards the back of the loom by the whole weight of his body, thus opening the shed. While this was being done, the master weaver pushed back the heavy baton and reed and opened the shed; the third man pushed into the open shed a long, hooked stick which carried with it a length of coloured grass, and gave it a little shake, detaching it and leaving it in the shed: the weaver next drew the baton forward

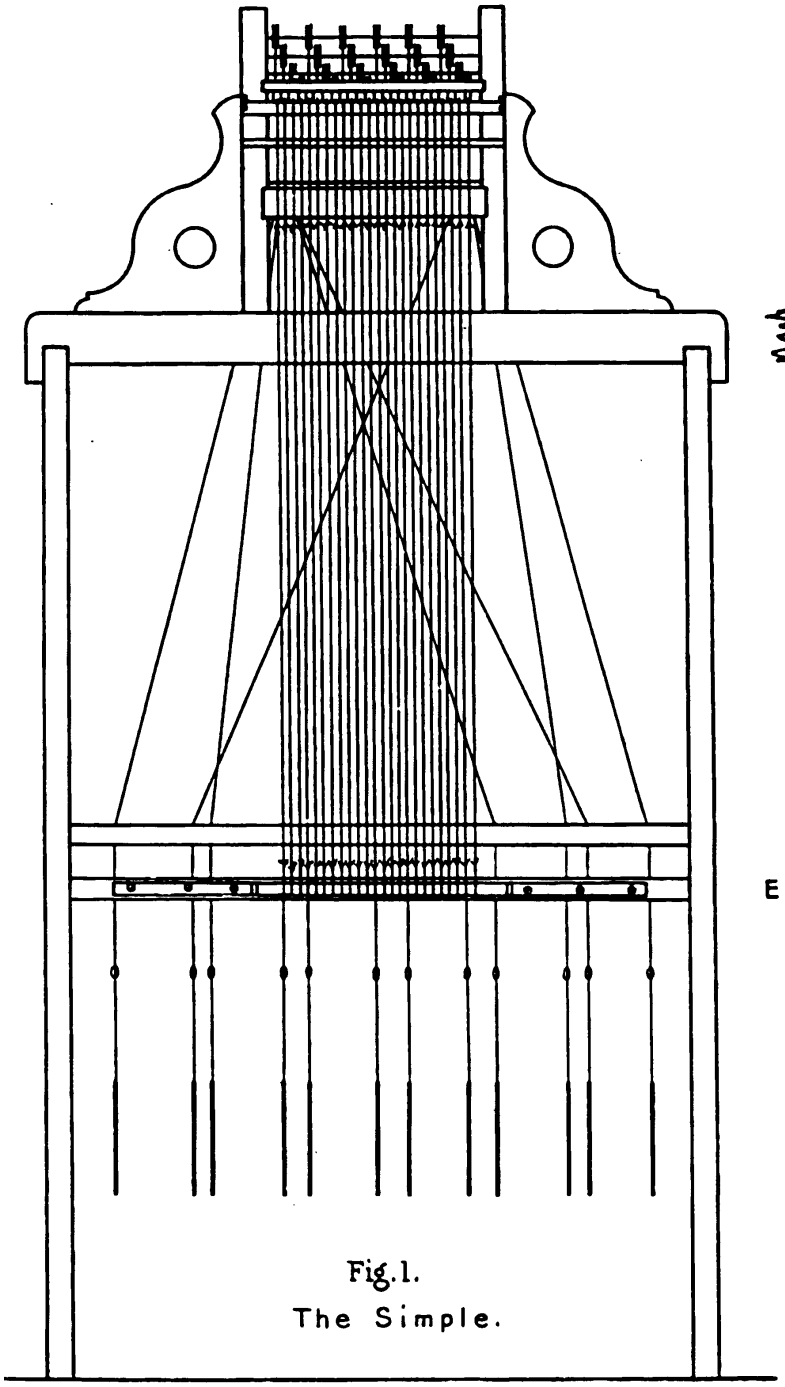


Fig. 1.
The Simple.

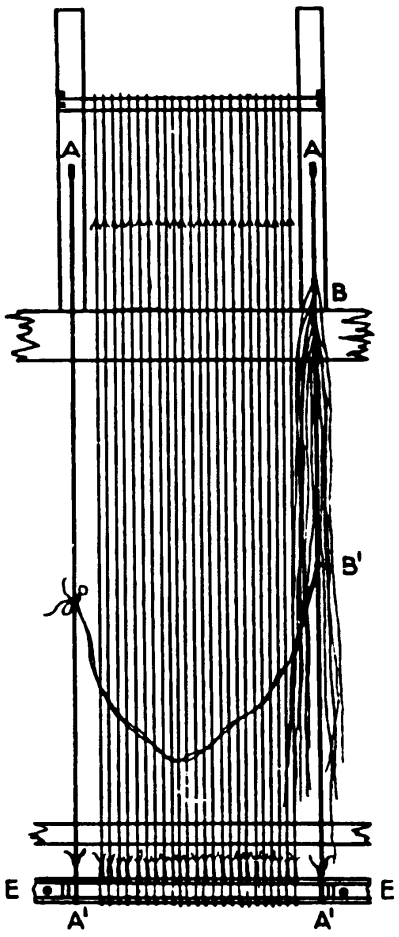


Fig. 2.
The Simple, with its side cords and lashes.

PLATE IX
THE LOOM MOUNTED WITH SIMPLE CORDS, PULLEY CORDS, ETC.

to beat down the weft, completing one line of the design, and immediately pushed the baton back ready for the next shed.

Preparation of simple for tying up designs

The similarity of the above ancient method of producing a pattern shed by means of single cords interlaced with the cords of the simple of the new draw-loom, will be realized if the description of the traditional loom be compared with Fig. 1 in Plate IX, where the completed simple is shown prepared for tying up a design.

The preparation consists only of two strong double cords which have been fixed by snitches to two strong screw eyes driven into the front uprights of the pulley box, as shown by the side view given at $A\,A\,A^1\,A^1$. The cords, after being attached to the screw eyes, have been carried down and fixed by a firm knot to the bar E, exactly parallel to the cords of the simple. On the right-hand cord, which is generally found most convenient for interlacing the design, a number of long, thin, but strong, double threads, are tied by a single snitch so that they can be readily moved up and down the side cord; they must be long enough to be taken across the simple and tied in a double bow on the opposite cord, as shown in the drawing by the lowest one of these ties or *lashes*.

Monture described very typical

It is, perhaps, hardly necessary to repeat here that the extremely scanty monture described above is only used for purposes of lucid explanation and definite illustration. The reader must, therefore, realize that the details of knotting and such-like small but very important things will not be repeated in further chapters when more rich and elaborate harnesses or variations of structure are being described. It

is, therefore, advisable that all the instructions as to handling threads, cords, knots, joints, measurements, etc., be thoroughly understood before advancing to the study of the more complicated, practical montures in which much more numerous groups of threads and cords have to be dealt with.

Chapter VIII

THE SHED-LIFTING APPLIANCE FOR HAND OR FOOT

THE shed-lifter for light work of narrow width can be managed quite easily by hand, but when the web to be woven is wide and the warp consists of more than 20 to 24 threads to 1 in., the weight to be raised will be much greater; consequently, the lifting of the pattern shed will be much less arduous if the lifter be connected with a treadle, so as to be convenient for the weaver to actuate it with his foot. The use of the treadle connection is advantageous, too, because it leaves the hands of the weaver as free for manipulating the shuttle as in plain weaving.

Comparison of new and ancient shed-lifting apparatus

The shed-lifter of the new draw-loom in either case is a much less heavy and complicated appliance than the " Draw-boy's fork," which was used for the same purpose and stood at the side of the old English and other more ancient pattern looms, facing the simple. The expense of paying an assistant for the sole purpose of working this appliance seems always to have been begrudged by the weavers, and many very ingenious machines were invented during the latter portion of the eighteenth century to render the work automatic. None of these, however, found favour with the weavers, who complained of the difficulty and labour of using them, and even Jacquard's ingenious machine failed to find any favour, either in his own country

or this, until long after his death, when the nature and condition of the weaver's craft had become totally changed by the introduction of complicated automatic machinery and the factory system of manufacture.

The new shed-lifter described in detail

The shed-lifter for use by hand in the new draw-loom consists of a strong horizontal bar $2\frac{1}{2}$ in. to 3 in. wide, and long enough to reach to the outer edges of the two front posts of the upright side frames of the loom. There it is firmly attached by strong hinges just above the comber board in such a manner that it will readily open out and fall forward. A little to the right and left of the simple, two strong, upright handles are erected on the top edge of the bar and each handle has a hole bored near its upper end, through which a hard wood rod, not less than 1 in. in diameter, can be passed and rest exactly parallel with the hinged bar on which they stand. With its hollow exactly in line with the holes in the upright handles, a wooden hook is fixed to the right-hand side post of the loom frame, so that when the rod is drawn out of the handles nearest to the right, it can pass through and rest in the hollow of the hook, thus leaving the front of the simple clear for the weaver to gather up and place on the rod any cords he may collect for opening a shed.

Before proceeding to explain the additional fitting required when the weight of the lingoes of the pattern harness is too great to be comfortably lifted by hand, it will be better to illustrate clearly the shed-lifter, as described above, by means of the diagrams of Plate X, which show the hand lifter complete and also the treadle lifter which

is, up to the part arrived at, of precisely the same construction.

In Fig. 1, Plate X, the appliance is shown fitted up in front of a very scanty simple and is represented as quite ready for opening a shed. It will be seen that the interlacement of the cords of the simple, which has been made by manipulating the lash *F*,*F*, in the manner described in the previous chapter, has been repeated on the rod, lettered *CC*.

How this transfer has been effected will be explained later, but first it is necessary that all the separate parts of the lifter, as described above, should be identified.

Details of shed-lifter

The hinged bar is lettered *A A*, and its position in relation to the bar *E E*, to which the cords of the simple are attached, will be easily realized. B^1 and B^2 are the handles in the holes of which the rod *C C* rests. *D* is a wooden hook, the shape of which is shown more clearly in the side view Fig. 2. This shows also the end of the bar *A* and its closed hinge. B^3 is the side of the nearest handle and C^1 the end of the rod resting in the hollow of the hook *D*. Plate X, Fig. 4, will explain a feature of the bar *A*, which cannot be shown in the front or side views. It is a section of the hinged bar of the lifter taken at the middle between the handles. Here the bar is seen to be chamfered, thus narrowing it at the top, whilst at the bottom it is thickened by means of a half-round beading being added to it, which presses against the cords of the simple when any of them are drawn forward by the rod and handles to the position for making a shed.

Fig.1.

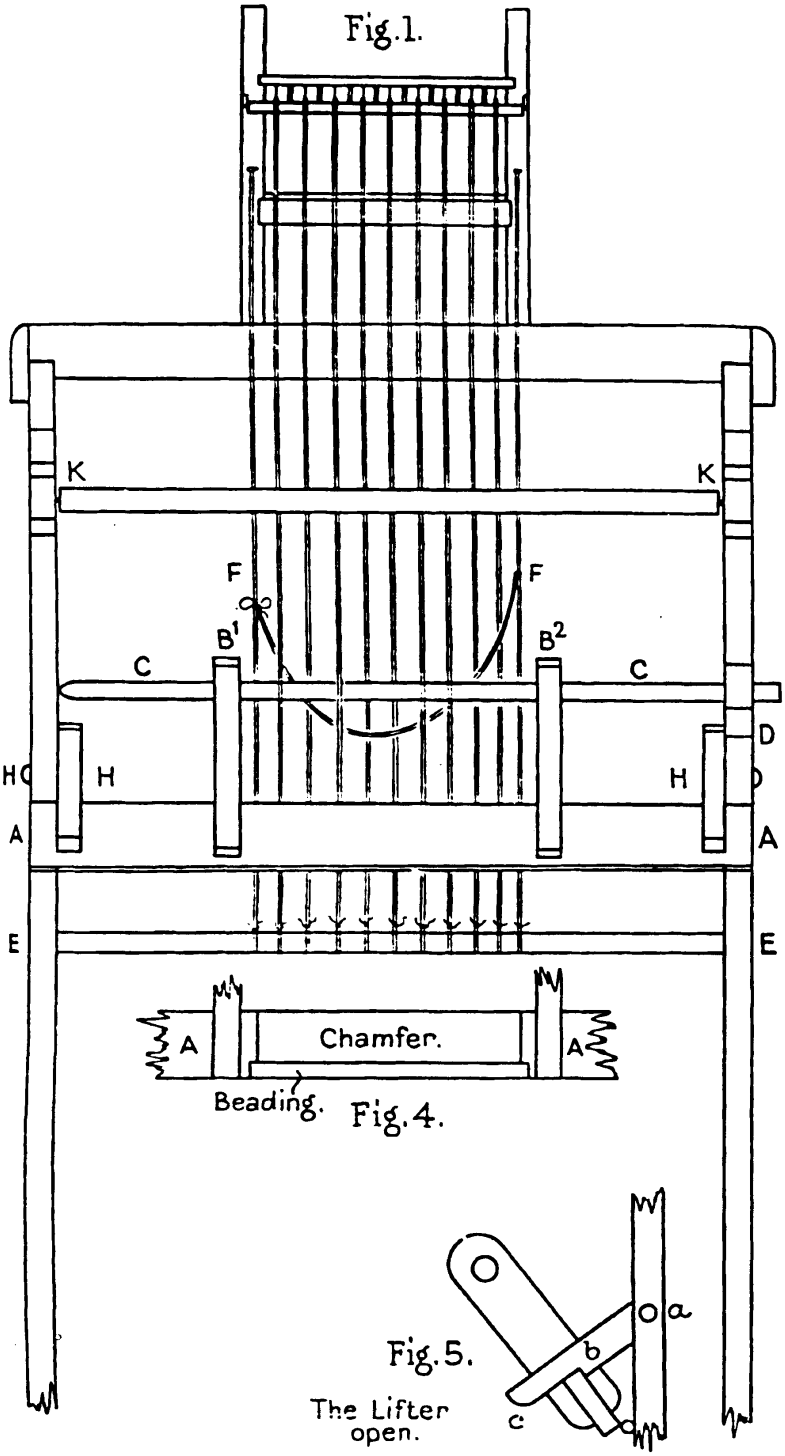


Fig.2.

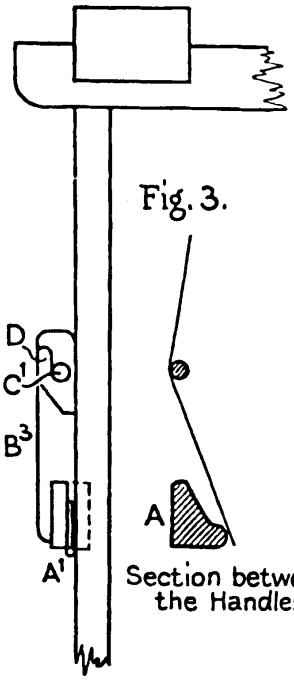


Fig.3.

Section between the Handles.

Fig.4.

Fig.5.

The Lifter open.

PLATE X

THE LOOM WITH SHED-LIFTER

Shed-lifter in use

The relative positions of the cords of the simple, some being on the rod and others behind it, has been reached as follows: (1) The bar has been drawn through the handle holes just far enough to allow it to rest on the handle and the hook on the post to the right of it. The front of the simple is thus clear for the operator to (2) make a selection of the cords behind which the lash has been carried and, having gathered them in his left hand and gently pulled them forward, to ($\bar{3}$) push the rod with his right hand behind the gathered cords and through the second hole until the rod is at rest, as depicted at Fig. 1.

In order to open the shed for weaving, it is necessary (1) to push the rod to the left clear of the hook; (2) to grasp the rod firmly by both hands, one on each side of the pair of handles; (3) to pull the rod steadily forward until the threads selected for rising to form the shed are seen to be high enough in front of the reed to admit the shuttle freely.

The catch at rest and in use

The shed having to remain open always to the same extent whilst the shuttle is being thrown, necessitates some arrangement to prevent it closing; this is effected by means of a catch which is strongly pivoted to the side frame of the loom just above the hinged bar, as shown at *H* in Fig. 1, Plate X, as well as at *a b*, Fig. 5, where it is shown in use. When the lifter is at rest, the catch hangs loosely on the top of the bar *A*, and as the bar is drawn forward offers no check to it. When, however, the forward movement ceases, after it has passed the shoulder of the catch, letter *b*, and the lifter is released, the weight of the lingoes, acting

on the simple cords, will keep from closing until the shuttle has carried the weft through the shed and the weaver touches the catch at the point *C*, Fig. 5, which will effectually release the lifter and close the shed with a snap. For a narrow loom one catch on the right-hand side is enough, but for wide work and a close heavy warp, two catches, as shown in Fig. 1, are necessary. As regards the catch, it only remains to note that the height of the lift and, consequently, the size of the shed will depend for regulation upon the distance between the shoulder *b* and the pivot *a*.

Regulating the shed as to height

Above the lifter, Fig. 1, a fitting is shown at *K K*, which greatly assists the steady working of the appliance, and prevents undue disturbance of the simple cords and lashes. It is a strong, smooth, easily turning roller fixed on brackets firmly screwed to the side posts of the loom frame. The roller must be so fitted that its surface stands not more than $\frac{1}{4}$ in. from the simple cords when they are at rest, so that when any of the cords are drawn forward they will press against the roller and revolve it with very little, if any, friction, and, moreover, the simple and lashes above the roller will remain practically undisturbed.

The roller of the simple

Plate XI, Figs. 1, 2, 3 and 4, show the additions to the hand lifter which are necessary when foot instead of hand power has to be used for opening a heavy shed. It must be admitted that, although the treadle lifter is invaluable for opening the shed when the weight of the lead lingoes and the metal shafts is too great for lifting comfortably by hand, it does not, however, free the hands from

The shed-lifter actuated by the foot

the light duty of gathering the cords of the simple, indicated by the lashes, and placing them on the rod ready for the opening of the shed.

Fig. 2, Plate XI, shows the pusher of the treader lifter when the loom is at rest, and Fig. 3 shows it in action with the shed open.

Details of the pusher

All the parts of the pusher, except the additional uprights *LL* which are fixed on the bar *A A*, and take the place of the catches of the hand-lifter, and the treadle itself, are made of iron, and great exactness in their individual construction, fitting, and adjustment is obviously required.

In the first place, the two wooden uprights must be described. They must be of the same strength as the handles *H H*, except that they must be a little shorter. They must also be fixed very firmly to the bar *A*, close to the side posts of the loom frame. Each upright is furnished with a stop, letter *d*, shown in Figs. 1, 2, and 3, which prevents it from being drawn too far back by the bar *N*, when the shed is closed.

By means of Figs. 2 and 3, the general construction of the pusher will be readily understood. At Fig. 2, the pusher is depicted as seen from the outside of the frame, and in Fig. 3, from the inside. It consists of two iron bars, *M* and *N*, each being 1 in. wide and $\frac{1}{8}$ in. thick. The horizontal bar *M* is fixed between the two posts of the vertical side frame of the loom by strong screws, on a level with the bar *A* of the lifter. Below each end of the bar *M* a strong pulley is mounted close to the inside of

THE SHED-LIFTING APPLIANCE

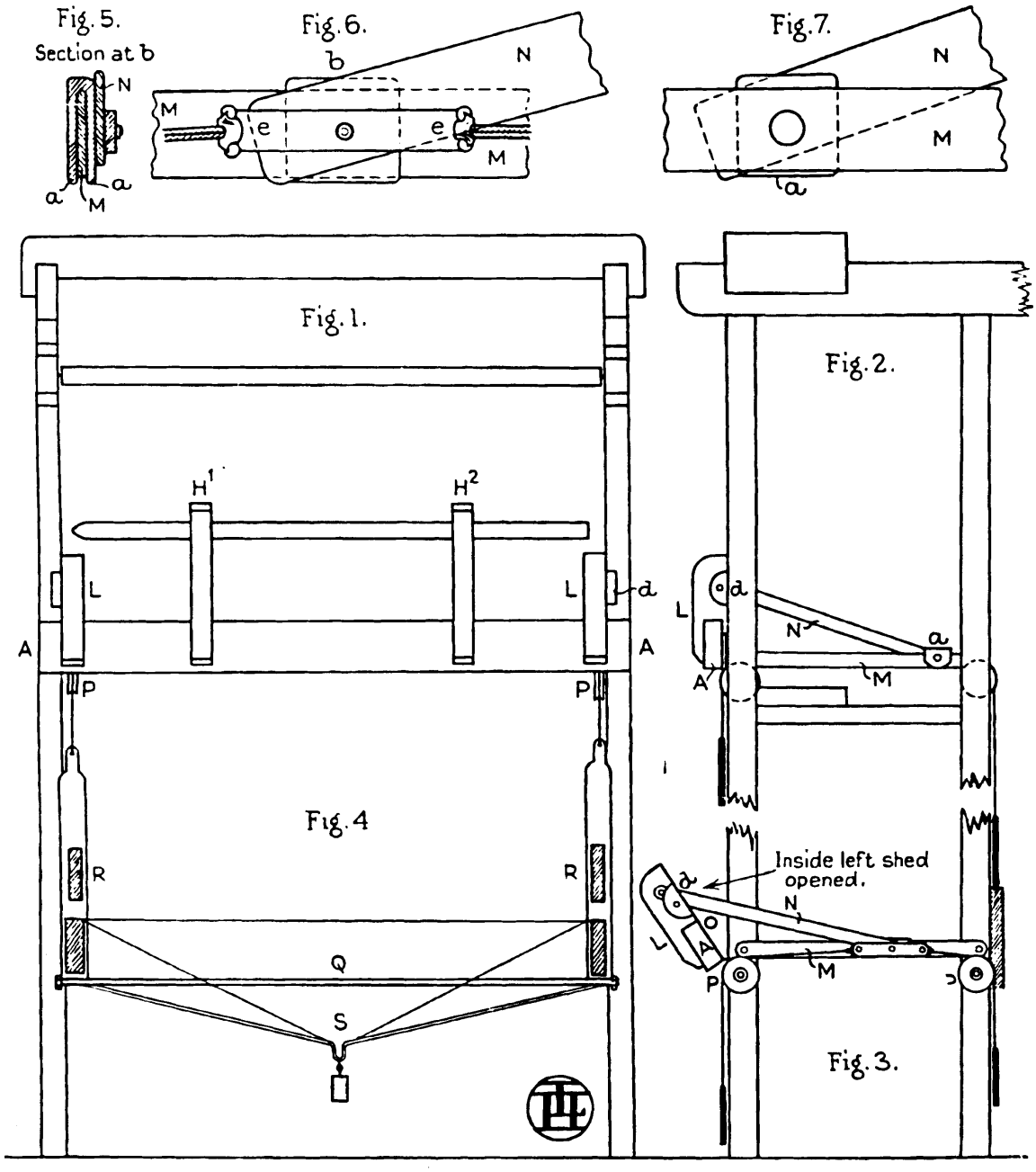


PLATE XI

THE LOOM WITH PUSH-BAR AND TREADLE FOR SHED-LIFTING

the frame in the position shown in Fig. 3. At *O*, Fig. 3, the inside edge of the short upright *L*, to which the end of the push bar *N* is pivoted, is shown: it is deeply grooved at the top, and in the groove the end of the bar *N* (seen in section in Fig. 5) is so fixed that it can move slightly and allow the upright to be pushed forward from the frame, as shown in Fig. 3, and drawn back to its normal position. The other end of the bar *N* is made to slide along the fixed bar *M* without becoming detached. This movement will be best explained by the three full-size drawings, Figs. 5, 6, and 7, at the top of Plate XI. Fig. 5 is a section of the sliding joint which consists of a saddle lettered *a a*, which rests on, but is unattached to, the bar *M*, a section of which is shown within it. This sliding joint is also shown in position at Fig. 7, letter *a*, as well as at letter *a* Fig. 2. The bar *N* is joined to the saddle *a* by a strong pivot, which passes through a hole in the bar itself and is screwed firmly to the strong slip of iron *e e*, Fig. 6. The slip is turned up and perforated at its ends, so that when strong cords are fastened to it and carried over the pulleys *P P*, Figs 1 and 3, below the ends of the bar *M*, the slip being drawn backward and forward by means of a treadle attachment will cause the bar *N* to be drawn backward or forward with it and push forward or draw back the lifter as required for opening or closing a shed.

The fixed and sliding bars

The saddle of the pusher

In Fig. 4, Plate XI, at letters *PP*, cords are to be seen which are connected with the iron slip and saddle to which the push bar *N* of Figs. 2, 3, and 6 is attached. From these two cords, two bent iron suspenders are hung which support

The connection of the pusher with its treadle

the $\frac{1}{2}$ in. iron bar, letter *Q*. The suspenders are made of $\frac{1}{2}$ in. by $\frac{1}{8}$ in. flat iron, or it may be $\frac{3}{16}$ in. steel wire, and are shaped so as to enclose the top bars of the horizontal frames of the loom which are seen in section at *R R*. The lower ends of the suspenders are finished with rings in which the ends of the iron cross-bar rest; the ends of the bar itself being finished off with about 2 in. of screw thread, the ends of the suspenders can be fixed to the rod by means of nuts, together with the bent rod which is attached by strong cord to the treadle, letter *S*.

The treadle stop for holding an open shed

When a treadle is thus made use of for pushing forward the lifter there is no need for the catches *H H*, Fig. 1, Plate X, as there is no difficulty in fitting to the treadle a stop which falls automatically into its place when the treadle is sufficiently lowered for opening the shed, and can be sharply released by a touch of the foot or the drawing of a cord when it has to be closed. Such a stop or catch can be readily attached to the bar *H* on which the front loom posts rest, shown at Figs. 1 and 2, Plate III.

Chapter IX

DESIGNS AND READING-IN ON "SIMPLE"

DESIGNS for pattern weaving in the draw-loom have to be accurately worked out on paper ruled in squares. The number of squares must agree exactly with the number of cords of the "simple" of the monture fitted up in the loom, as well as with the number of pulleys in the pulley box, the holes in each repeat of the design arranged on the comber board, and of course the ultimate number of threads entered in the eyes of the couplings throughout the whole width of the loom. Five examples of such working drawings made for repeats on 24 threads are given in Plate XII, Figs. 1, 2, 3, 4, and 5. It should be noticed that in each of the examples, both the lateral and vertical rows of squares in a repeat of design are numbered, the former from left to right, and the latter from the bottom to the top.

Ruled paper designs must agree with the monture

It will be remembered that in a previous chapter it was stated that the monture of the draw-loom has always to be determined, as regards the number of the threads it has to govern in each lateral repeat before the building is started or the comber board arranged, but, that there is no such restriction as to height, except by the number of lashes which can be crowded together on the side cords of the simple without impeding the action of the cords in opening the sheds line by line. In the designs at Plate XII, the numerals at the left-hand side of each indicate the

Width of repeat fixed; *height* ad libitum

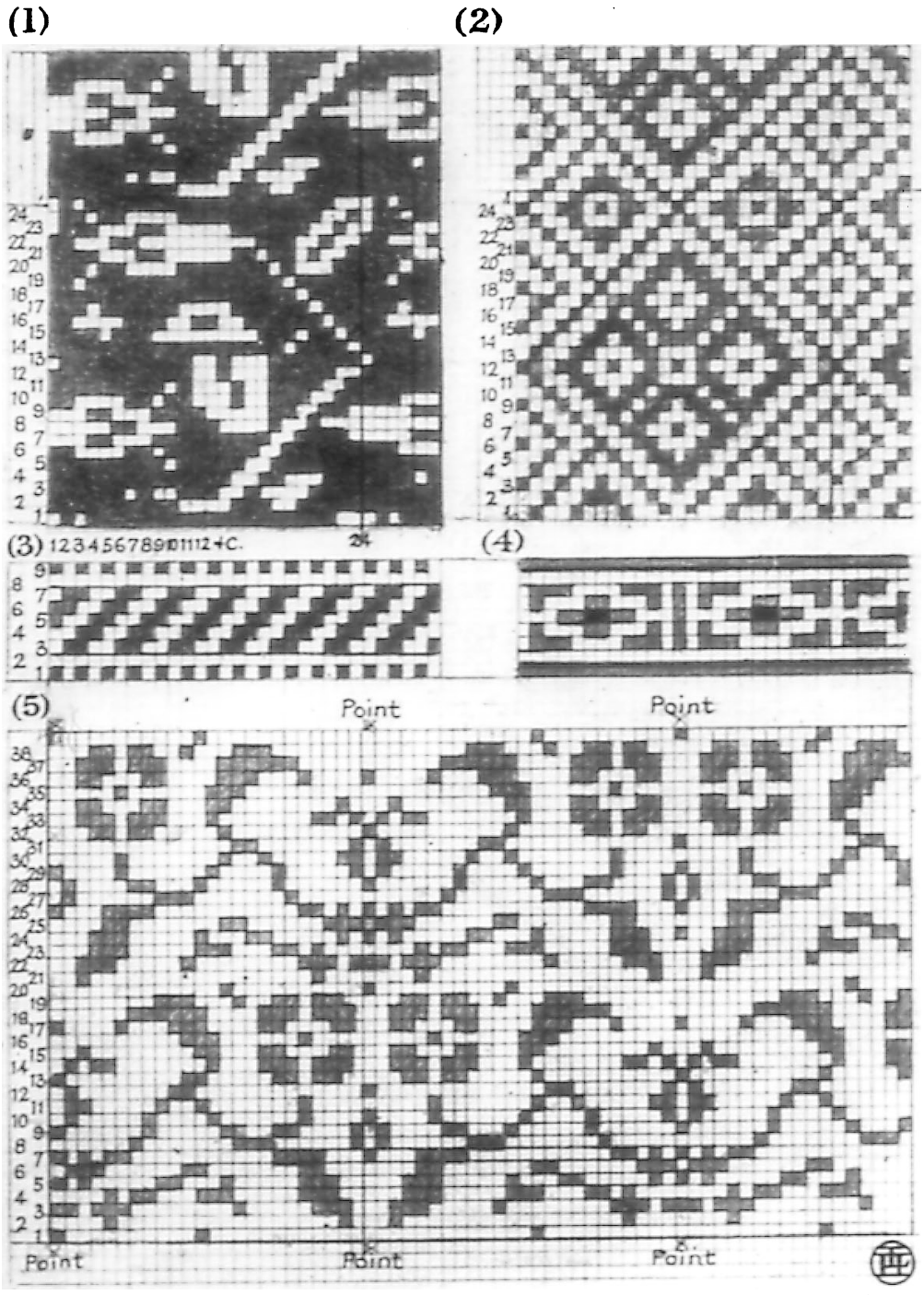


PLATE XII

DESIGNS FOR READING-IN ON THE "SIMPLE"

number of separate rows of squares of which the vertical repeat consists. These numerals, therefore, show the number of lashes which would have to be mounted on the side cords in the manner shown in Fig. 2, Plate IX, before the interlacement can be finished.

The unit *of design on ruled paper*

It is usual in making ruled paper drawings, to paint in the small squares of ruling which indicate the *weft* showing at the front, and to leave the squares plain which represent the *warp* in front. In the case of a thread monture such as that described in Chapter VII, each square, whatever its size, stands for only one thread of weft if filled in with colour, or one thread of warp if left plain. In drawings for compound weaving, however, where the threads are very fine and close together, as in the case of damask or brocade weaving, which will be dealt with in due course, each single square may represent a group of 2 or 3, or it may be 8 or 10, fine threads as a unit of the design.

Examples of design

Designs given in Figs. 1, 2, and 3, Plate XII, are suitable for weaving on a loom with a thread monture, in a coarse material with from 12 to 24 threads to 1 in. If the warp were 12 threads to 1 in., the woven pattern would be the same size as the drawings, which are on paper 12 squares to 1 in., but if the warp were 24 threads to 1 in., the design would only weave half the size of the drawing.

No. 1 design, Plate XII, is a comber repeating one, but No. 2, although actually a *point repeating design* for a simple of 12 cords, can be read in and tied up for 24 cords if the turnover repeat be drawn out on the same ruled paper as that of No. 1.

No. 3 design, Plate XII, is also on 24 squares; it is a border to No. 1 design, and is a comber repeat; Fig. 4, also a border, will weave either as point or comber repeat; Fig. 5 exhibits the chief advantage, if not the only one, which a point repeating pattern has over one of a comber repeat, viz. that the half design, which is all that needs to be arranged for on the simple, is turned over and repeated automatically in reverse, thus doubling the width of the design (see Plate IV, comber board No. 2).

A fourfold repeating point design described

The subject of Plate XIII illustrates an economy of design and tying up which results from arranging the pattern to repeat and turn over vertically from its centre. It also evades the necessity of shifting all the lashes from the bottom to the top of the simple after each successive vertical repeat is woven. It will be realized, if this design and the numerals indicating the order in which the several lines of the pattern are to follow each other in the weaving, so as to complete it as in the drawing, that lines Nos. 1 and 25 must be lifted only once each for weaving the full repeat, whilst all the other lines, 23 in number, will each be lifted *twice*, once in going up and a second time in coming down. Bearing this in mind, it is plain that over 25 lashes will be required in order to open the 48 sheds necessary for weaving the full design, and that the sheds must be opened in the succession shown by the numerals at the side of the design. When the design is half interlaced, the weaver can begin by pushing the ends of all the lashes on the side cords close together towards the top of the simple, leaving all the middle parts of them as

loose as possible in order that the cords which work through the midst of the mass may be drawn down and used quite freely. No. 1 lash will, of course, be the first to be used in the manner presently to be explained, and when the shed has been formed and the first line of design woven, the lash must be pushed down and the second lash must be drawn down and used in like manner. The third and all the succeeding ones must follow until lash 24 is reached, and half the design is finished.

The vertical repeat reversed

The reverse half of the pattern begins on the twenty-fifth line, but, unlike all the lashes of the first half, that of the *twenty-fifth is immediately replaced at the top of the simple* after it has been used for weaving the middle line or *point*. Then, in accordance with the descending numerals, lashes 24, 23, 22, and the rest, with the exception of No. 1, must be drawn, treadled, and follow No. 25 to the top of the simple, leaving No. 1 lash to be used for the *first line in the second full repeat and be returned to the bottom of the simple*. Used thus, No. 1 lash will always be at the bottom of the tie-up of the design, and No. 25 always at the top. Therefore it will be seen that not only does this point pattern repeat sideways automatically, but the repeat is vertical also, so that only a quarter of the full repeat has to be drawn on the ruled paper and tied up on the simple.

Reading-in and tying up

Before the "reading-in" of the pattern begins, a goodly number, if not all, of the lashes required for the whole design, whatever number it may be, should be attached to the right-hand side cord of the simple, as shown at Fig. 2, Plate IX, letter *B*.

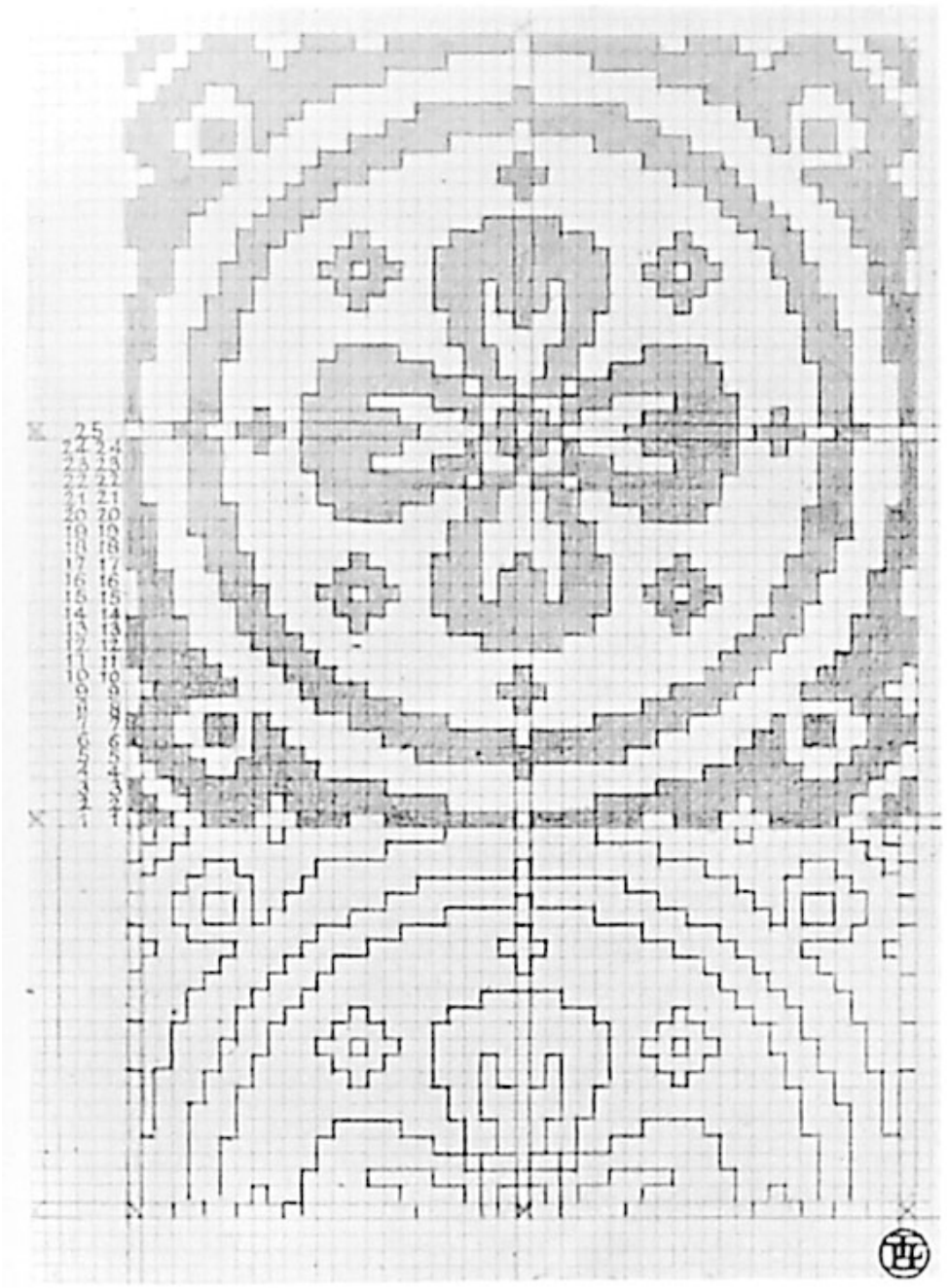


PLATE XIII

FOUR-FOLD REPEATING DESIGN

Reading-in the design

Although not absolutely necessary, it is much more convenient and speedy for one person to read aloud from the design, and another to manipulate the cords and lashes.

If the design of Plate XIII is to be " read-in," all being ready, the *tyer-up* draws down the first lash attached to the side-cord of the simple, and lowers it to the position shown at letter *B* (Fig. 2), Plate IX, and having done so, awaits the reader's call. The *reader*, looking carefully at the line, No. 1 of the design at the side next to the numerals, must count the number of dark squares with which it begins (if, as is generally the case, the white squares represent the *warp*, which is the *ground* of the pattern) and call " Take 1," and then pause. At this the tyer must take the loose ends of the lash, count 1 cord from the right of the simple, and gently pulling it forward, pass the ends of the lash behind it, draw the ends to the front, and wait for the next call. The reader having counted the 2 dark squares which represent the weft as well as the next 2 white squares, which follow in the line, must call " Pass 2 and take 2." At this the tyer must carry the lash in front of 2 cords, gently pull the next 2 forward, pass the ends of the lash behind and bring them to the front as before. The reader will then call " Pass 3 and take 3," and " Pass 3 and take 2," and on this being done, the last call will be " Pass 8 and take 1."

The first lash being interlaced, it only remains to secure the ends by tying them in a double bow to the left-hand side cord, and to draw down the completed lash to the lower part of the simple behind the lifter.

The second line of the design must be read " Pass 2, take 2."—" Pass 5, take 1."—" Pass 10, take 5."

It must be noticed that the above directions for reading and tying the two lines of the pattern begin one with the word " Pass," and the other with " Take." This difference is essential, and its reason must be explained at once. After the order " Take 1 " in the first line, a pause must be made before the reader gives the next order. The reason for this is that it is far easier for the tyer to wait after tying and bringing the ends of the lash forward, than it is to wait after counting and passing a group of cords to hear how many cords he has to take. As all the lines of a design, of course, begin with the order " Tie " or " Pass," it is well to observe this rule, and the habit of doing so will add greatly to the comfort of both reader and tyer, as well as to the correctness and speed of working.

PART III
VARIATION

Chapter X

THE TABLE-LOOM AND EARLY TYPE OF DRAW-LOOM

Origin of new draw-loom

THE table-looms, mentioned by the author in his introduction to this work, were designed by him for the use of young students of the craft of weaving. They were constructed in imitation of the ancient draw-looms insomuch as they were actuated by means of cords attached to the top of each pair of shafts, or leaves, of the harness of the loom. These cords, after passing over two sets of pulleys, placed above the shafts, were brought down the right-hand side of the loom and terminated in large beads, which, held in the slots of a rack fixed at the lower part of the loom, kept the eyes of the healds at the level of the warp when at rest. This position will be readily understood if reference be made to the drawing of a table-loom on Plate XIV.

The loom represented will be seen to be mounted with a harness of 8 healds, 16 pulleys, 8 cords with their terminal beads, and 2 racks, both racks having 8 corresponding slots cut in them. In the drawing, 1 bead, the fourth, is shown drawn down to the lower rack; the result of this is that the fourth headle from the front has been raised an equal distance to that of the space between the upper and lower racks. It is obvious then that any shed possible on an 8-headle harness, can be made by manipulating the beads between the two racks.

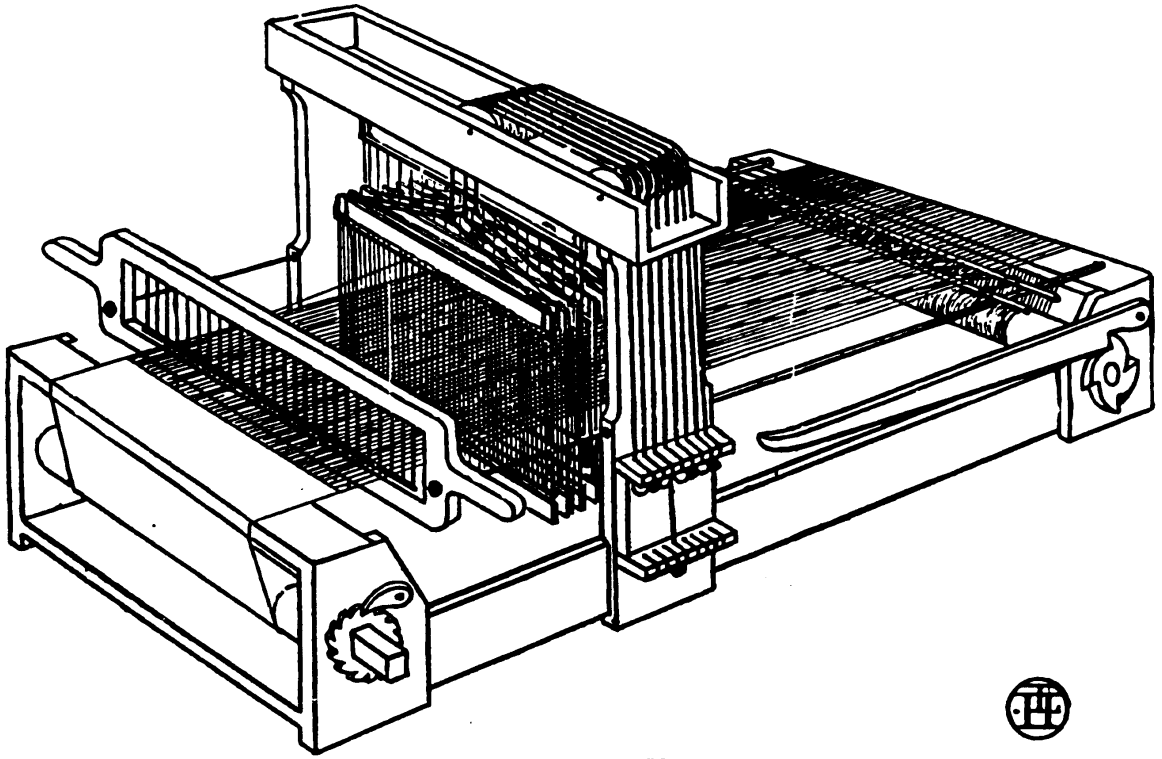


PLATE XIV

THE FIRST TABLE FOR YOUNG STUDENTS

The dimensions of the original table-looms were: Length, 3 ft. 6 in., and width, 18 in. to 24 in., inside measurements. The back and front rollers were $2\frac{1}{2}$ in. in diameter, and were furnished with ratchets for giving tension to the warp, and the upright headle frame and its pulleys rose about 20 in. above the side frames. The healds were the same size as those used for the ordinary hand-loom, and the shafts supporting them were generally made of 1 in. by $\frac{1}{4}$ in. hard wood.

Utility of table draw-loom

A table-loom fitted with the rack and bead motion for opening and closing the shed was very suitable for school use or for use in the home as a hobby. It gave occupation to two students who could take turns at drawing the cords and throwing the shuttle, but for general practical work it became necessary to devise some appliance enabling the weaver to actuate the whole mechanism without assistance, and also to make it possible to repeat the pattern automatically, whatever it might be. In order to meet these two important requirements, it was determined to bring the cords from the headles to the front of the loom facing the weaver and to revert to the traditional *tie-up* and *pull-over* motion of the ancient draw-loom. This led to the design of the new draw-loom, No. I.

Draw-loom, No. I

The first new draw-loom was built with a view to weaving webs 21 in. wide, with a warp of 48 single threads to 1 in.; 2 threads being entered in each split, or dent, or a reed having 24 dents to 1 in. It was intended to produce on this loom, without treadles, small damask patterns in fine linen or silk threads on 16 headles and a

"simple" of 16 cords. The design to be tied up on the simple and arranged exactly as described for the fully mounted draw-loom in the concluding chapters of Part I.

Important alterations required

Plate XV contains drawings of the additions which were necessary for converting the school table-loom of Plate XIV into the advanced and far more practical table draw-loom. The solid framework of the loom required no alteration, but the reed, the headles and the pulleys with their cords, beads, and rack, had all to be removed to make way for the finer and more complete mountings of the new pattern draw-loom.

The upright frame, in which the headles of the school table-loom hung and worked, required no alteration, as its eight shafts of wood took up as much space as the 16 shafts of enamelled iron which were used in their place.

Alterations of table-loom

Plate XV (Fig. 1) gives a view of the frame of the simple, which is firmly fixed by four strong screws to the front of the headle frame facing the weaver. Its outside measurement is: Height, 2 ft. 8 in. by 1 ft. 1 in.; its width inside is 11 in.; the wood of which it is made being 2 in. by 1 in. throughout. At the top of the frame between the two brackets which support a ½ in. iron rod, a row of 16 strong wooden pulleys are mounted, over which the cords from the headles pass to be tied near the top of the frame to the 16 cords of the simple, which, at their lower end, are joined by adjustable loops to another iron bar fixed on the face of the bottom end of the frame to receive them.

In Fig. 1, Plate XV, letters A A^1 A^2 and A^3 the

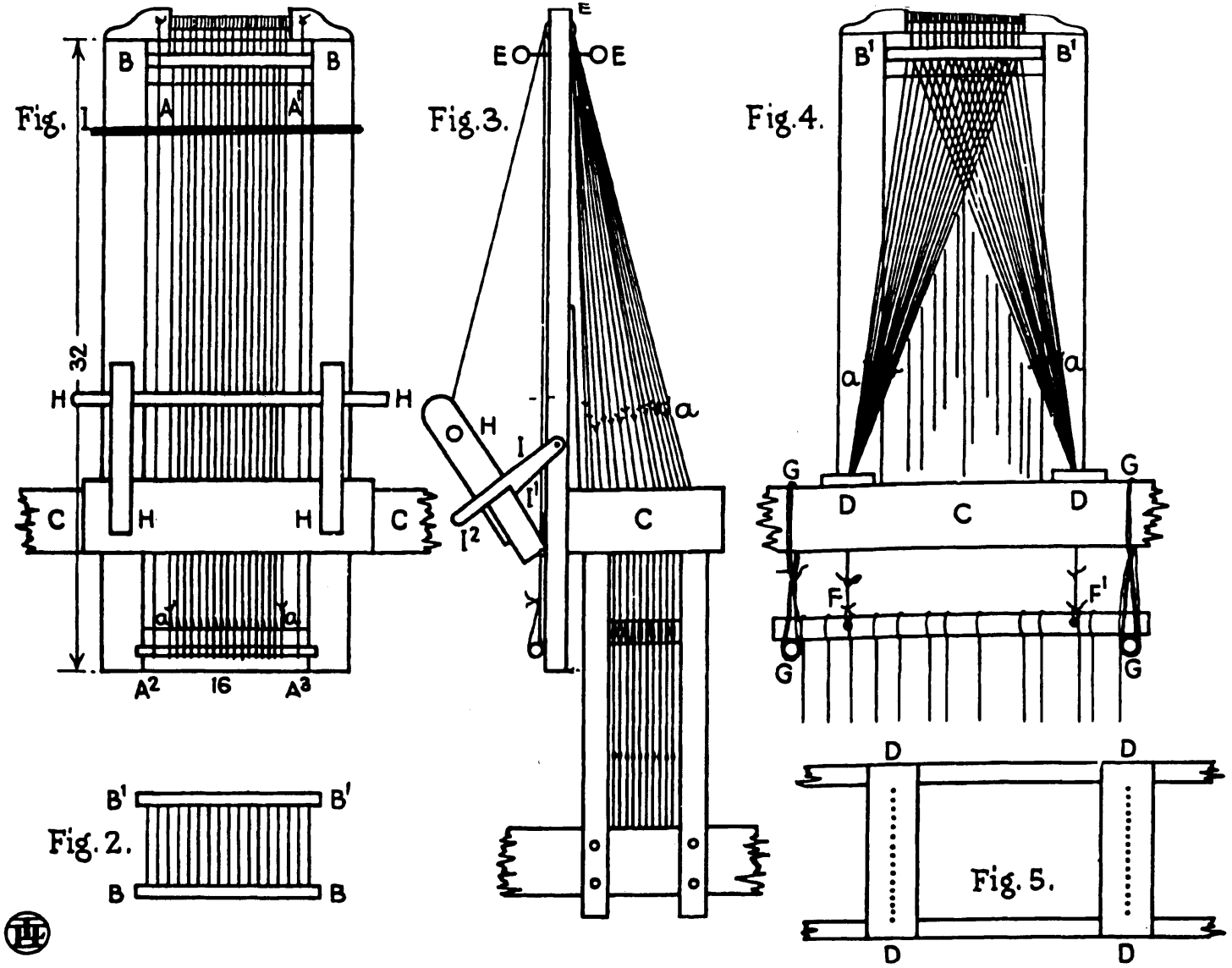


PLATE XV

THE NEW DRAW-LOOM FOR SINGLE-THREAD DESIGNS

The simple and its fittings

" simple " frame is shown fixed in its place on the headle frame. The top of the simple frame is 23 in. above and the bottom 6 in. below the top bar of the headle frame, which latter must be made of wood not less than 3 in. by 1 in. The 16 pulleys at the top of the frame occupy a space of 6½ in., and stand close together on an iron rod, but not so close as to impede their free action when in use. On the inside edges at the top of the frame, two strong screw eyes are placed to hold the side cords of the simple, which are carried down and tied firmly to the ends of the other ½ in. iron rod which bears the loops of the simple cords. For all these details, compare the above with the simple, Fig. 2, Plate X.

Details of the simple

At *B B*, in Fig. 1, Plate XV, a hard wood bar is seen; it needs Fig. 2 in order to make its purpose quite clear. It is really a short, strong reed with 17 wires and 16 dents. The wires are fixed firmly in one rod, and before the other rod, B^1, is fitted on to the wires, 17 holes must be bored in the frame exactly beneath the spaces between the pulleys and the brackets which support the rod on which they are fixed. The rods *B* and B^1 should stand, when fixed in their positions, as shown in Figs. 1, 3, and 4, at the top of the frame, 1½ in. from the front surface and the same distance from the back.

The headle frame and the comber slips

Fig. 5, Plate XV, gives the view of the top edge of the headle frame, portions of which are seen at *C C C* in Figs. 1, 3, and 4. Across the top of the frame, marked *D D* in Figs. 4 and 5, two hard-wood, or fibre, comber slips are screwed, and each slip is pierced with 16 holes. It is

through the holes in the slips that the cords pass which, being joined to cords continued from the cords of the simple over the 16 pulleys at the top of the frame, connect the 16 headles with the front cords on which the patterns are tied up, as fully described in Chapter VIII, where the building of the full monture of the typical draw-loom is dealt with in detail.

The headle cords, the pulley cords, and the simple cords

Each of the cords of draw-loom Fig. 1, which connect the loops on the bottom rod of the simple with the headles in their frame, consist of four different portions joined by snitch knots. At the bottom of Fig. 1, Plate XV, lettered in italics *a a*, the first row of snitch joints are seen connecting the cords with their loops on the bottom rod of the simple. Just below the reed *B B* another row of snitch knots join the simple cords to the double pulley cords, which are brought from the back of the frame, over the pulleys, passing through the same dent of the reed both at the front and back. This is clearly shown at letters *E E E*, Fig. 3. These cords must be long enough to reach easily to the headle frame *C* in Fig. 4. It must be particularly noticed here that just below the reed B^1 B^1 the double cords are divided in order that one may be joined to the two ends of the double cord which has been looped to the hole in the shaft of the headle at *F*, and the other to the ends of cord brought up from the opposite double cord, also looped to the same headle F^1.

Building the monture of the draw-loom

When this kind of monture is being built, it is usual to begin by hanging all the headles in their places before attempting to arrange any of the upper parts of the cording.

For this purpose it is necessary to hang two strong iron rods to four adjustable loops suspended from the top of the headle frame at the front and back to act as temporary supports, as shown at the points lettered *G G G G*, Fig. 4, Plate XV. Before being placed on the rod, the headle shafts must have double cords tied firmly to holes drilled near their top edges exactly corresponding with the holes in the comber slips. The double cords must be long enough to allow their two loose ends to reach through the holes in the slips about 6 in., the place where they are to be joined to the pulley cords *a a*. As soon as these cords are looped to the shafts, the headles can be rested on the rods, the first one being placed nearest to the headle frame exactly under the first holes in the pair of comber slips. When all the headles are in place, the double cords can be drawn up through the holes and allowed to hang loose while the pulley cords are prepared. Sixteen pulley cords will be required. They must be long enough to reach from the top edge of the headle frame at *D*, Fig. 4, through the reed B^1, over the pulley, down through the same dent to a point about 7 in. below the reed at the front, marked *a a* in Fig. 1, and back again to the starting point.

Building draw-loom No. 1

A temporary rod must now be fastened across the front of the simple frame in such a manner as to prevent it rising. It is required to hold the 16 pulley cords in position at $A A^1$, in readiness for joining to the cords of the simple.

The rod being ready, the joining up can proceed as follows: Returning to the back of the frame, a long loop must be made at one end of a length of pulley cord, and a

snitch being made in the loop, the two ends of cord from the first shaft on the left, as the operator faces the back of the frame, must be passed through it and secured as usual so as to make a regulating joint near *a*, Fig. 4, Plate XV. The other end of the whole length of cord must then be taken straight up to and passed singly through the first dent of the reed at B^1; taken over the pulley, down through the same dent of the reed at the front; then down and round the temporary rod; back again through the same dent, and over the same pulley; down through the same dent at the back and across to the opposite side of the frame, there to be joined in the same manner at about the same level, to the two ends of shaft cord hanging through the first hole in the right-hand comber slip, thus completing the round. This operation must be done gently but firmly and without disturbing the headle, which is only supported by the temporary rod *G G*, Fig. 4, until it is joined to the pulley cord as above.

Building draw-loom monture

The second headle from the front has next to be joined to the second pulley cord and must follow in the same way, but through the *second* dent of the reed, over the second pulley, and so on till it reaches the two pulley cords on the right-hand side of the frame and is joined to them. In exactly the same way and order without any twisting or entanglement, all the headles must be connected to the rod at the front ready to receive the simple cords and complete this important part of the lifting apparatus.

It is possible so perfectly to adjust all the snitches and knots that when the rods *G G*, Fig. 4, Plate XV, are

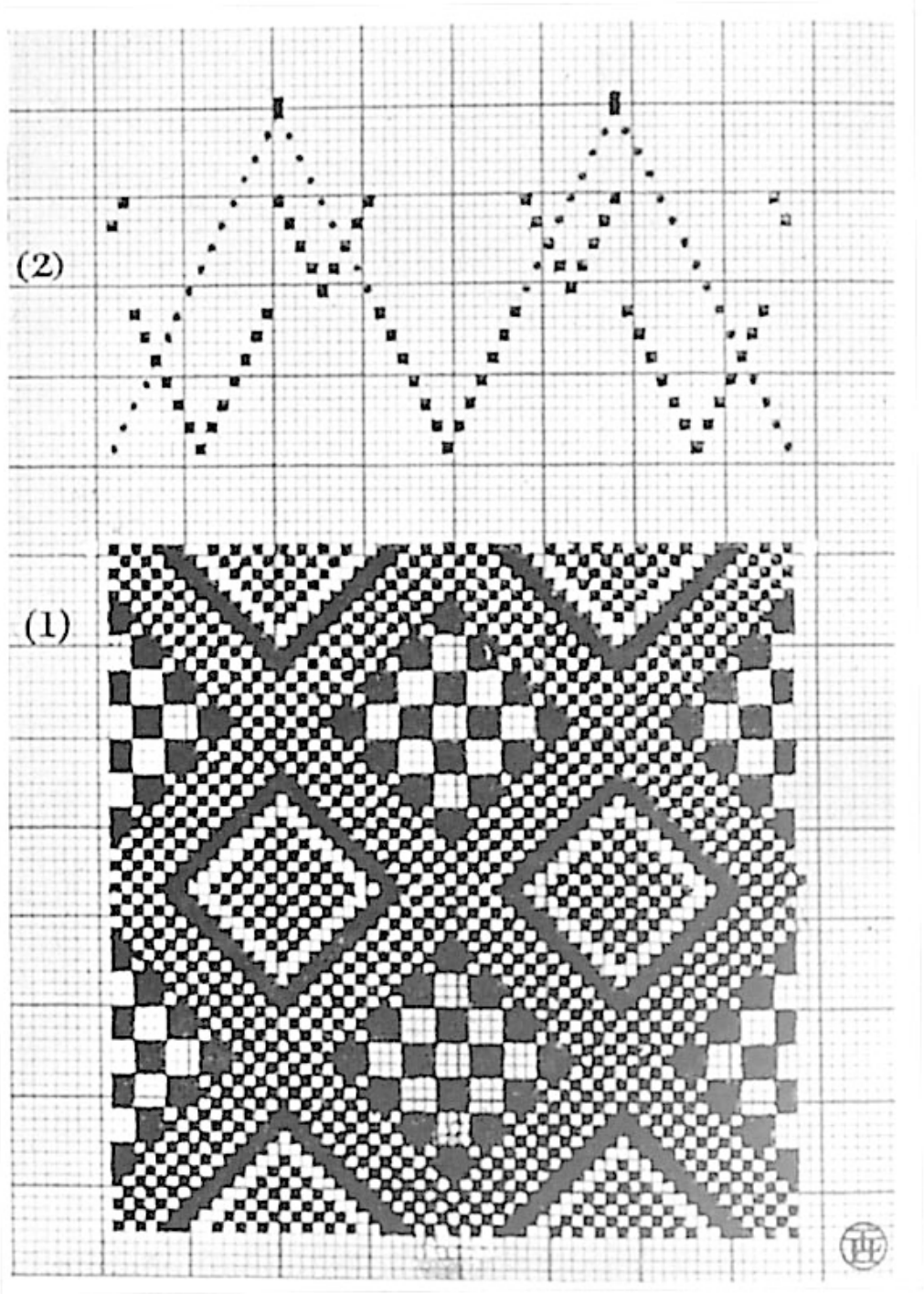
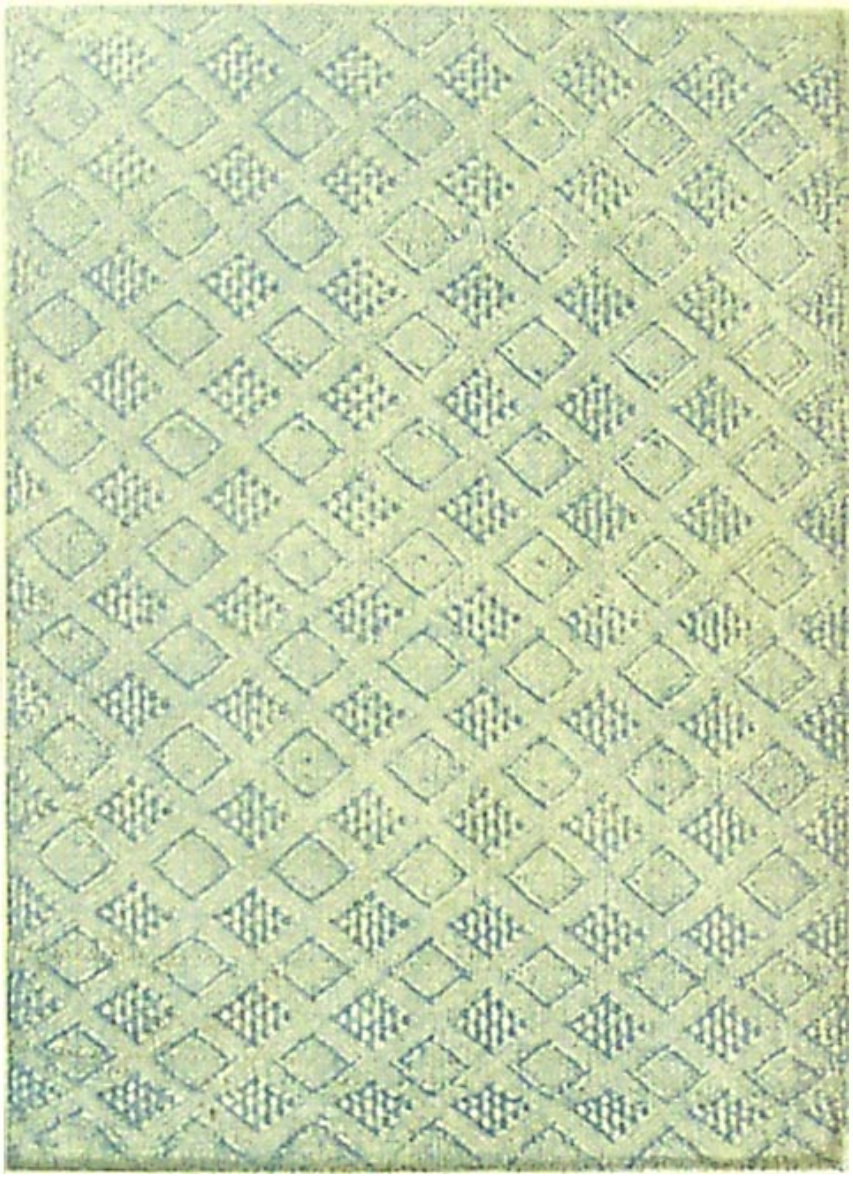


PLATE XVI

DESIGN FOR WEAVING ON THE NEW DRAW-LOOM No. I

PLATE XVII.



Woven Silk from the Old English Design of Plate XVI.

removed, very little readjustment is necessary. It is not, however, advisable to remove the rods until the simple cords have been attached both to the pulley cords at the top and to the iron rod at the bottom of the frame, all the joints, of course, being made with adjustable snitches.

The shed-lifter of draw-loom No. I

The shed lifter, which is clearly shown and lettered *H H H H H* in Figs. 1 and 3, Plate XV, will be amply explained and readily understood if reference be made to the shed-lifter of the full-sized pattern loom described in Chapter IX; in fact, if the reader is sufficiently interested in the construction and use of the less complicated forms of the draw-loom, and desires thoroughly to understand their capacity, a close study of the details of Chapters VI, VII, and VIII will be found very helpful in addition to Chapter IX.

Work produced on draw-loom No. I

The drawing on ruled paper which is given at (2) in Plate XVI, together with the point repeat entering for a warp of silk or fine linen is copied from an exquisite linen towel of eighteenth century hand-loom headle weaving. Plate XVII is an exact reproduction of the design woven in coloured silk, but the original is in fine linen thread of the same count, 48 threads to 1 in., with a reed 21 in. wide, 24 dents to 1 in., and the tie-up for it on the treadles of the loom is extremely complicated. The silk specimen was woven on a new draw-loom fitted up in the way described above. On such a loom any small point repeating design, that can be made on the same number of cords, can be woven *without any alteration of the loom except a fresh interlacement of cords and lashes.*

Nature of twines and cords used in all draw-looms

It should, perhaps, be added here, once and for all, that in the construction of the series of draw-looms in question, whatever the sizes of cords, twines, and threads made use of, only those of the best well-twisted flax should be selected.

Chapter XI

NEW DRAW-LOOM NO. II FOR COMPOUND WEAVING

Compound weaving: its great scope and utility

THE subject of compound weaving, that is, weaving in which more than one warp and two or more sets of harness of different kinds, working simultaneously in the weaving of a patterned web, is too vast to be extensively dealt with in the present book; nor, indeed, is it necessary, as the subject has been fully explained and illustrated in the author's previous book, *Hand-loom Weaving, Plain and Ornamental*,[1] which was published rather more than 20 years ago, and still holds a foremost place in the bibliography of the hand-loom weaver's craft. Fully half of that volume, of over 300 pages, is devoted to the description and illustration of compound pattern weaving, and the different combinations of harnesses, montures, and comber board arrangements, as well as the various interlacements of warps and wefts used both in ancient and modern times, not only in the weaving of the world's masterpieces of textile work, but in patterned materials for ordinary domestic and general use.

It is not impossible to do compound pattern weaving of very small designs on the student's table-loom, as described in Book III of *Weaving with Small Appliances*; in fact, the last chapter of that little book contains an

1 First published 1910, by John Hogg, in his well-known "Art and Craft Series of Handbooks," since 1914 by Sir Isaac Pitman & Sons, Parker Street, Kingsway, London, W.C.2.

illustrated explanation of its technique, but naturally the rather complicated work on such an elementary loom would be slow and tedious, and the opportunity for the designer would be very limited.

Compound weaving on No. I draw-loom quite practical for very small designs

Compound weaving could also be done on the table-loom fitted up with a draw-loom " simple " frame, as just described in Chapter X, and called draw-loom No. I. Here, again, as the loom is arranged for lifting every thread of warp separately, the designs would be very small, and as the set of 16 headles would have to work in two divisions of 2 and 14, or 4 and 12, and the tie-up of the " simple " would have to be made with two alternating sets of lashes, the progress of the weaving would be very slow and, probably, confusing and impractical. With, however, the additions and arrangements next to be described, the usefulness and capacity of the table draw-loom can be so extended that quite a large range of varied designs can be produced with much less difficulty and with reasonable speed. Plate XIX is a sample of the kind of design suitable for weaving on draw-loom No. II.

Draw-loom No. II was designed to weave materials of larger and bolder patterns on equally fine grounds as No. I, also to enable the weaver to work in more comfort and at greater speed. These two important advantages were obtained (1) by means of two harnesses being mounted in the loom, one immediately in front of the other, one harness being for the ground warp and the other for the pattern. The entering and details of the two warps will be presently explained. (2) Two rollers were required at

Advantages of compound weaving

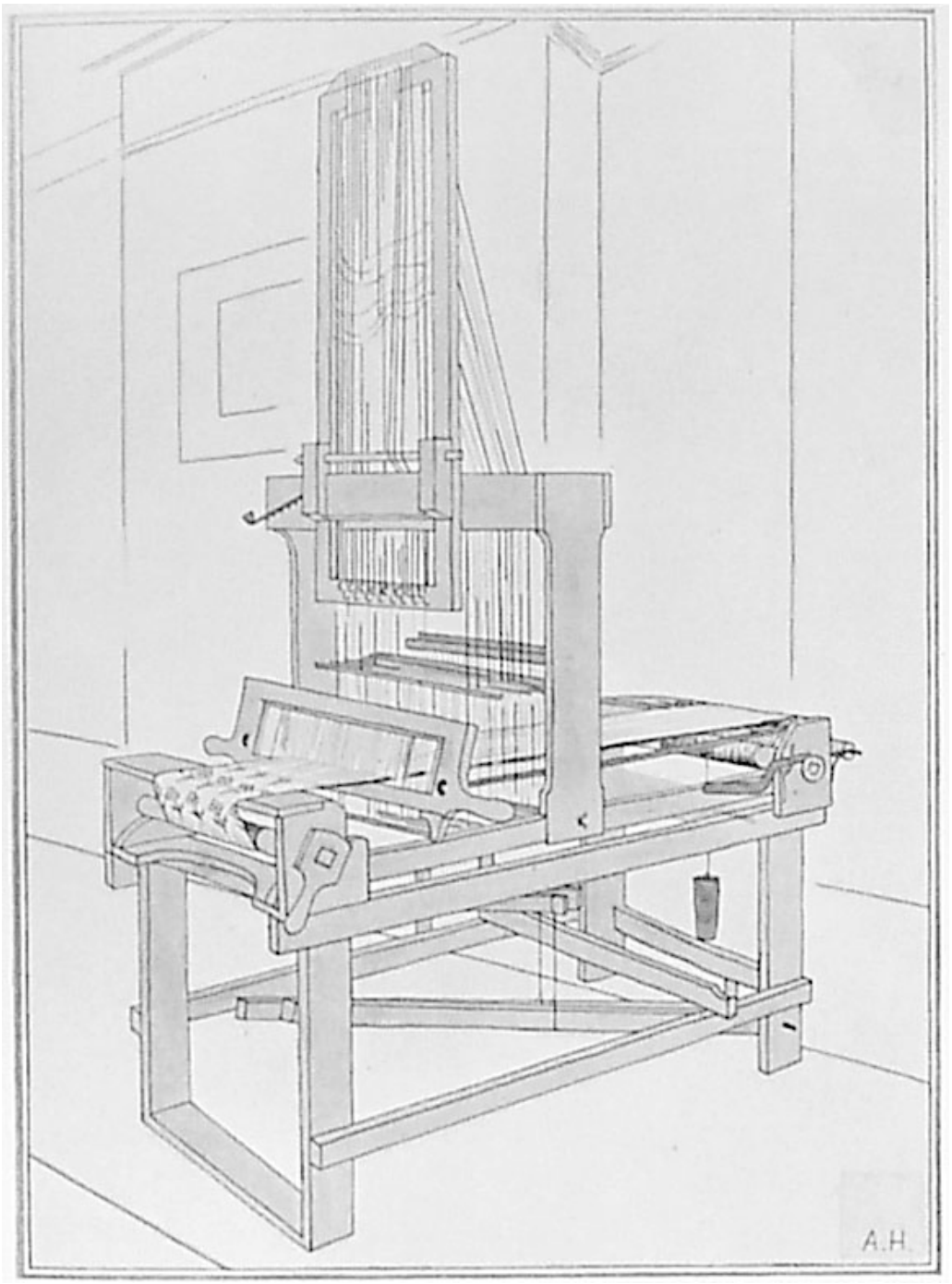


PLATE XVIII

NEW DRAW-LOOM No. II FOR WARP EFFECT WEAVING

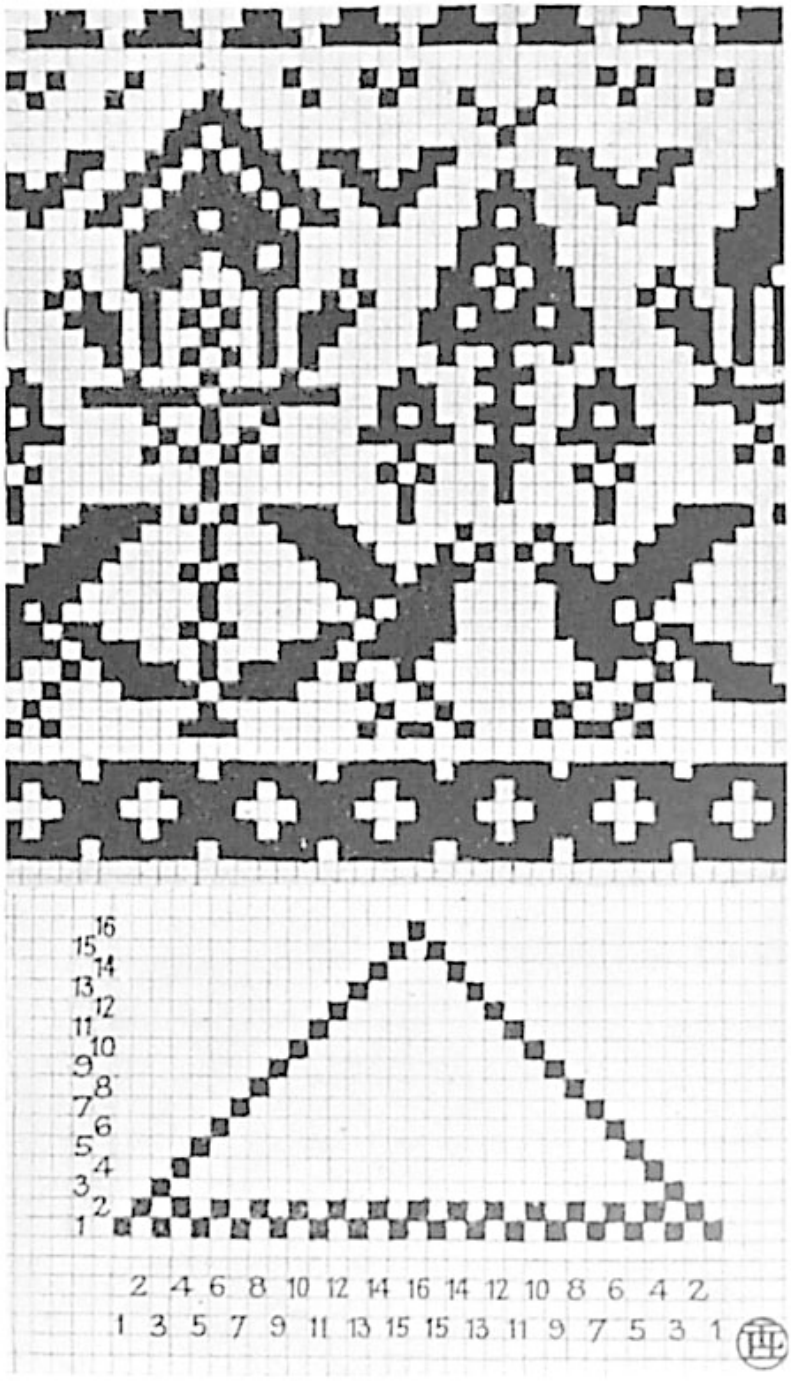


PLATE XIX

DESIGN FOR WEAVING ON DRAW-LOOM No. II

Warp effect materials woven on Draw-loom No. II.

PLATE XXI.

Warp effect material Designed and Woven by Alice Hindson.

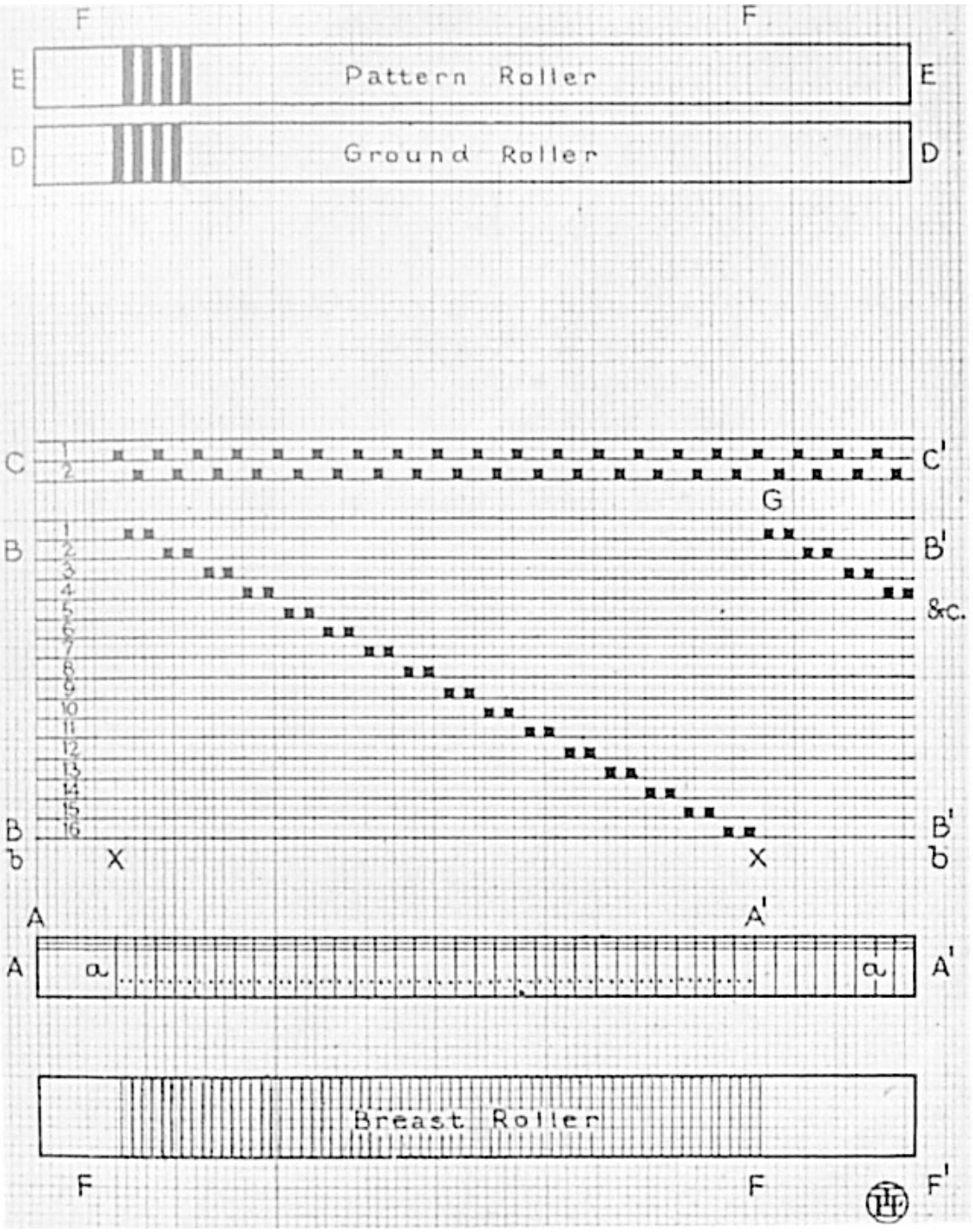


PLATE XXII

HARNESSES FOR COMPOUND WEAVING

the back of the loom, one to hold the ground warp and the other that of the pattern, the latter being generally of a different colour and sometimes of a different material, but the count of both warps was always the same. (3) A special, low table was designed for the loom to stand upon; it was fitted up with a treadle motion in such a manner as to allow the weaver to sit at his work and use his feet for opening the successive sheds. Except for these additions, draw-loom No. II was constructed in exactly the same manner and of the same dimensions as No. I, and the original fabrics of Plates XX and XXI were woven upon it.

The double harness draw-loom

The manner of fitting up two harnesses to work together in the weaving of a pattern web on draw-loom No. II will require the assistance of the diagram of Plate XXII in order to clearly explain it. The diagram is a bird's-eye view of a compound mounting drawn out on ruled paper. The reed is indicated by 32 short vertical lines between the letters *A* and A^1, and the spaces between the lines represent the dents of the reed. The shafts of the pattern harness, 16 in number, are shown by the 16 spaces enclosed by the 17 horizontal lines ruled between *B B* and B^1 B^1. The harness of the tabby ground, which only needs two shafts, is shown between the three horizontal lines lettered *C* and C^1. The roller for the ground warp is lettered *D D*, and that of the pattern warp *E E*.

The space enclosed by the vertical lines *F F* F^1 F^1 may be of any dimensions, according to the size of the loom and the number of threads to 1 in., but for the purpose

of illustration it may be presumed that the lines *F F* and F^1F^1 are 1 in. apart; it will then be realized that the reed is one of 32 dents to 1 in. It must next be noticed that each of the small black squares on the shafts of both the pattern and the ground harness represent a thread of warp entered in the eye of a heald hanging from exactly that spot on the shaft. This clearly indicates the relative position of every single thread of the compound harness as well as every thread of the ground harness, and is, therefore, most important to remember if the somewhat complicated arrangements of a compound monture are to be understood.

Entering a compound harness

At the centre of the reed, letter $a\,a^1$, a row of dots will be seen, there being two dots in each dent. This shows that two threads from the ground harness $C\,C^1$, and two threads from the pattern harness $B\,B^1$, are entered together in every dent, and that altogether there are 64 threads in the reed between *A* and A^1.

The next essential thing to notice in this diagram is the order in which the threads of the two warps are entered in the reed, and in the eyes of the healds, which are hanging from the square spots on the several shafts in the two harnesses, and to realize how the two harnesses can work together in producing a perfect web without interfering with each other's action. It will only be necessary to explain the interworking of the four threads, represented by the two dots in the first dent of the reed at letter *a*, in order to make the above point quite clear throughout the 16 dents, as well as throughout the whole width of the reed, whatever it may be.

Starting then at letter *a*, Plate XXII, it will be seen that in the diagram above the first dot in the first dent of the reed, a vertical column of empty squares leads the eye upward past a black square on the first shaft of the pattern harness straight to a black square on the back shaft of the ground harness, indicating that the first thread of the ground is entered below this spot to pass from thence to the ground roller *D D* at the back of the loom.

Starting again at the first dent of the reed, the column above the second dot, if followed upward, is soon checked by the first of a pair of black squares on the first shaft of the pattern harness, showing that the first thread of that harness is entered there, and can be traced without hindrance through both headles of the ground harness to the roller beyond *E E*.

The next thread of the ground harness, represented by dot 3, will be seen to have a clear course between threads 1 and 2 of the pattern harness to the black square on the front headle of the ground harness. The fourth dot, the second thread of the pattern harness, follows exactly the same course as the first with which it pairs, having a clear course after being entered in the eye of the first pattern shaft.

It will now be realized that if this order of entering the two harnesses be adhered to throughout the whole extent of the warps laterally, either of the harnesses can be used at will without interfering in the least with the other. For instance, plain tabby ground could be made and the pattern warp be left entirely unwoven below; or

the pattern warp could be all raised and tabby ground woven below it; or, again, if certain of the pattern shafts with their healds were selected to rise in succession in order to weave a certain design, the rising threads would form the design above the ground, and in the spaces between the pattern warp would be hidden by woven ground, as in Plate XX, where the birds and dovecote are on 16 pattern shafts and the tabby ground on two shafts of just such a harness as Plate XXII described above.

Advantage of lifting two or more threads together in the pattern harness

Still referring to Plate XXII, it will be noticed that on all the shafts of the pattern harness the threads are lifted in pairs which, of course, renders it impossible to lift one of the pattern threads singly. The object of this is to increase the size and boldness of a design without increasing the coarseness of the silk or whatever thread is used in the web. For instance, a design on 16 threads of draw-loom No. I, as we have seen, is very small and inconspicuous, but if by means of a compound harness the pattern threads can be raised in pairs, each square unit of design will be increased to double the width, and, by means of extra weft, to double the height, so that a design on single threads occupying 1 sq. in. of space would be increased to 2 sq. in. if woven on such a harness as Plate XXII. In fine silk weaving sometimes as many as eight or even ten threads are made to rise together to form one square unit of design. This arrangement, simple as it is, is the principle on which all compound weaving is founded, however complicated it may appear to be to the uninitiated.

Entering comber or point repeat montures: how they differ

Before leaving the consideration of Plate XXII, it must be pointed out that as it stands it is complete for a comber repeating design, the entering for the second repeat of which would begin again at letter *G*, shaft 1, of the pattern harness, and follow exactly the same course, but for a point repeating design No. 16 would be the No. 1 of the turnover of the repeat, and would be followed immediately by two threads on shaft 15, thus sacrificing a unit of two single threads and making the design two threads less in every repeat. The sacrifice is made in order to avoid four threads coming together at the points and making them blunt, which is generally rather detrimental to a point repeating design.

With regard to the second advantage provided for by draw-loom No. II, it remains to add that it is always necessary with a compound harness, when there are two warps, to have them on separate rollers at the back of the loom. The second roller can be mounted on a strong pair of brackets fixed at such a height as to allow one warp to rise a little above the other. As the two warps have to be woven simultaneously, they must both be turned on and spread on the roller, by means of the raddle, to exactly the same width and position on the rollers, so that unnecessary friction as they are unwound during the weaving may be avoided.

Special table for draw-loom No. II

The special table which was stated to be the third advantageous addition to draw-loom No. II, designed to be of such a height that the rollers, which fix the level of the warp, stand about 30 in. above the ground when the

loom is in position for weaving; (Fig. 1), Plate XXII, is a drawing of the table with the loom on top. It is simply the framework of a table without a top, and the top corner edges of the frame exactly match the bottom corners of the loom. In each corner of the table a strong peg, having a rounded point, is fixed, which projects above the top edge of the frame about ½ in., and fits into a hole, made in each corner of the loom at its bottom edge to receive it. These pegs prevent the loom and table parting company when weaving is in progress. Of course, the number of treadles and cross-levers or pulleys with which the table is fitted up vary considerably according to the nature of the fittings of the loom above it; but, for the small compound pattern loom under consideration the fittings only consist of a pair of treadles, a pair of cross-levers, or marches as they are called, and perhaps two or three small gadgets for the convenience of the weaver.

Table for draw-loom No. II

Chapter XII

PREPARATION FOR WEAVING ON THE NEW DRAW-LOOM NO. II

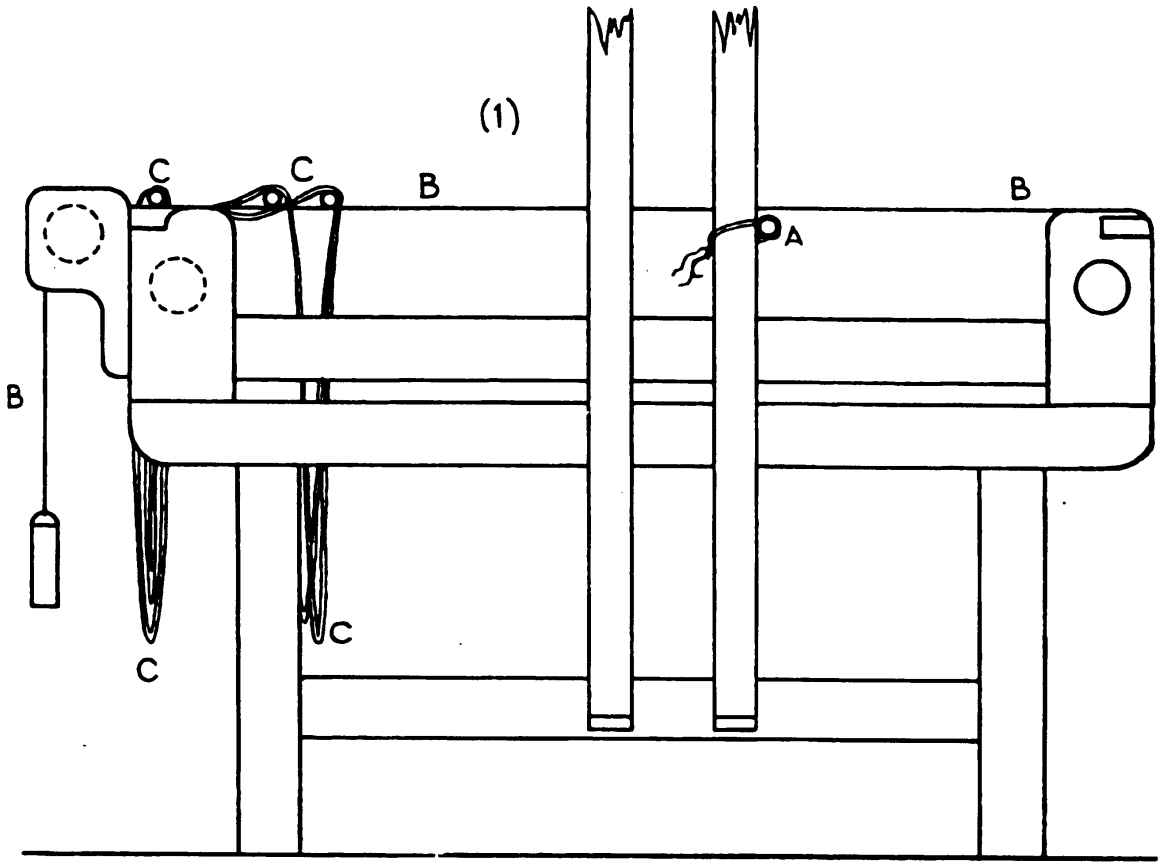
Draw-loom No. II furnished with warps

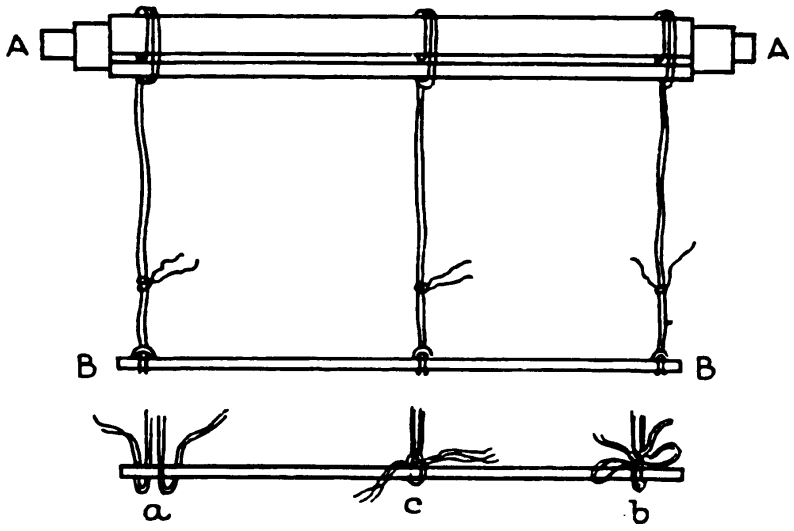
IT is not necessary in this book on advanced weaving to describe the method of preparing warps and turning them on to the rollers of the loom. These processes are, of course, precisely the same for pattern weaving as those described at length in previous elementary books. We will, therefore, suppose that the draw-loom is so far ready as to have its two back rollers furnished with their carefully laid warps in their places at the back of the loom and also fitted with the temporary side cords for holding the cross-rods while the entering is being done, as described in *Weaving for Beginners*, Chapter VIII, *Handloom Weaving*, Chapter VII, and *Table-loom Weaving*, Chapter IV.

Entering the warps

Before beginning to enter the warps, the reed-holder must be detached from the slide rods which run into their guiding tubes, by unscrewing it from them. This will clear the space between the harness and the front roller, and allow of the warp threads, as they are entered, being tied in groups to a rod firmly attached by cords to the sides of the upright side-frame across the front of the loom, just below the level of the eyes of the pattern harness. Letter *A* (Fig. 1), Plate XXIII, where *A* is the rod, *B B B* is the side cord, and *C C C C* are the warps.

All being in readiness, the entering must begin by the enterer sitting in the cleared space in front of the harnesses





(3)

PLATE XXIII

NEW DRAW-LOOM No. II PREPARED FOR ENTERING

and passing the long entering hook close to the pattern harness on the outside to the left and thrusting the hook well through the first eye of the back headle of the ground harness. In this position he must wait for his assistant, for entering a compound harness always requires two persons in order to carry out the work in comfort. The assistant, sitting at the left side of the loom, must select the first thread of the ground harness from the cross-sticks, draw it out of the portion of the warp which has been carefully brushed out, its ends cut and tied by a close-drawn snitch to a convenient part of the loom near the front, and hitch it on to the enterer's waiting hook. The enterer will then be able to draw the thread through the eye of the ground harness, past the first thread of the second headle of the ground harness, past the first leash of the pattern harness, and hold it in his left hand until sufficient threads are drawn through and added to it to form a small convenient group, say, of eight threads, for tying in bows to the rod *A*, in front of the headle frame.

For entering the second thread from the cross of the ground harness, the hook must be pushed *between* the first and second leashes of the pattern harness, through the first eye of the front headle of the ground harness, and between the first and second leashes of the first headle of the ground harness, so that when the thread is hitched on to the hook it will be drawn between the first headle of the ground harness, through the first eye of the second ground harness headle, and between the first and second leashes of the pattern harness. A re-examination of Plate XXII should

Entering draw-loom No. 2 with ground warp

be made at this point, in order that the position reached may be verified before carrying on the rest of the entering to the completion of the ground warp.

It being ascertained that the first and second threads of the ground harness have followed their proper course to the front of the loom, the third and fourth threads must be entered in the same way. These must be followed by the fifth and sixth and the seventh and eighth threads, and all the succeeding ground threads will follow in the same order until the opposite side of the loom is reached, but, of course, each group of eight threads must be tied up as soon as entered.

If the above directions be carried out carefully, both as regards the warp entered in the ground harness and the passing of threads between the healds of the pattern harness, *there should be found to be no break in the regular alternation of the ground warp threads and, moreover, every single empty eye in every leash of the pattern harness will have one thread from the ground on its left side.*

The entered threads from the ground warp must be neatly tied in bows to the temporary rod at the front of the headle frame in small groups of eight threads, and a little space must be left between each group, which will be filled by the same number of pattern threads as they are entered in their turn.

Entering the pattern warp

As soon as the ground warp is firmly settled, the entering of the pattern warp can begin. This should not be too difficult, for each successive thread of the ground, separated as it will be from its fellow, will reveal the empty

eye of the next pattern leash which has to be entered by its side. Guided then by the first thread of ground, the enterer's hook will find the first eye of the pattern harness, and, pushing it clear of all other threads between the first and second eyes of the ground harness, wait for the assistant to place the first thread of the pattern warp upon it to be drawn forward, through the eye, to the front. The second thread of the pattern warp, which is on the same shaft of the pattern harness as No. 1 thread, must be brought from between the second and third threads of the ground warp and entered in the second eye of the pattern warp of shaft No. 1. This will complete the first group of four threads, gathered from both warps, eventually to be entered in the first dent of the reed (see Plate XXII). The entering of the pattern warp in its harness must proceed in exactly the same order except that each pair of pattern warp threads will be found on a succeeding shaft from No. 1 to No. 16, No. 1 shaft being at the back of the harness.

As soon as eight threads of pattern warp are entered, they must be tied in bows to the space on the rod between the first and second group of eight ground warp threads left vacant for them.

When both warps are fully entered, examined, and found correct, the entering of both together in the reed can begin.

Entering both warps in the reed

For entering the reed, some weavers prefer to take it out of the holder and sling it from some part of the loom in a convenient position for clearly seeing the dents, which must, of course, all be filled in regular succession, and great

Entering the reed

care must be used not only to enter correctly the proper threads in each dent, but to avoid leaving any empty dents, which is very likely to occur if the reed be at all a fine one. If, however, two persons can work together, as in the previous entering, one to select the threads, and the other to draw the small groups through the dents, it will be found more convenient to leave the reed in its holder, fix it to its sliding rods and place it as far forward in the loom as possible, so that the assistant can have plenty of room to select each group of four threads, two from the ground warp and two from the pattern warp, and place them altogether on the hook for drawing through; also for making sure that they are separate from all other groups of threads.

After entering in the reed the first and every succeeding group of threads, it is well to call back and make sure (1) that no dents have been missed; (2) that no threads are crossed with others; and (3) that all the threads have a clear run from the front of the reed to the roller to which they belong at the back.

Tying up both warps in front of the reed

For tying up each group of 16 threads in front of the reed no rod is required, as it has to be tied close to the reed, and it must be ascertained that, before beginning to tie-up, the two rollers at the back are firmly fixed either by heavy weights or cords so that, as the groups are entered and secured, the whole width of threads may be held at an equal, but not too great a tension.

Before weaving can commence, it is necessary, of course, to join the warps to the breast roller of the loom with as

Attaching the warps to the breast roller of the loom

little waste of such material as they may consist of. There are several methods by which this may be done, but it will be sufficient to describe the one which by all expert weavers is considered the best.

For this purpose, two smooth, strong hard wood or iron rods will be wanted. They must be just long enough to fit into the groove of the roller, and thin enough to lie there and allow the knots and ends of warp which will be attached to them to be buried in the groove and covered up by a thin flat lath, so that the woven material may be wound on to the beam perfectly smoothly and lie flat, without knots, creases, or bumps. In addition to the rods, several loops of fine shaft cord, long enough to at least go twice round the roller, will be needed. If the warps be fine and close, there must be a loop for about every 2½ in. of rod. The loops must be as nearly as possible of equal length, and each of the loops must be joined to the rod by a double snitch drawn tight so as to remain fixed in their places at regular intervals of about 2½ in. The loops should be so arranged as to have one in the centre and one at each end of the rod; Fig. 2, Plate XXIII, at letter *A*, shows the rod in the groove with the loops of cord attached as described. The second rod must have as many cords about 2 in. long, doubled at their centres so as to form a snitch having two long ends to be joined in the usual way to each of the loops of the roller as at letter *B*, in Fig. 2, where three loops are shown joined as described above, and the rest hanging free ready for use.

Attaching the warp to the breast roll

All ends of cord arranged on the second rod must, of

course, be spaced so as to match exactly the spacing of the loops on rod 1, and when these are ready, the rod itself must be held by an assistant about 2 in. from the inner edge of the front crossbar of the loom, and about 8 in. from the reed in its holder, which must be fixed in that position while the warps are being tied to the rod. The rod being thus held, the first, the last, and the centre cords must be joined by single snitches and single knots in the usual way to the first, the centre, and the last loop on the roller in the groove of the beam. The first, the last, and the centre groups of warp threads must next be loosed from the reed and tied in bows to the rod so as to hold it in the same position, 2 in. from the inner edge of the front crossbar.

Attaching warp to breast roll

It will doubtless be found at this point that a good deal of general adjustment will be necessary, in order to fix the rod thus in its place exactly 2 in. from the crossbar and parallel with the bar and the breast beam. This, however, should not be difficult, as it only consists of adjusting the loops on the rods *A* and *B*, and firmly fixing the front and back rollers of the loom. The eyes of the healds of both harnesses may also require adjusting so as to bring both the warps to the same level.

Adjustment of the loom after entering

When all is ready, the final tie-up of the warps can proceed. It is generally necessary to tie up a rich warp twice, first for getting it to stand at an equal tension, and a second time for detecting loose and uneven threads and gently drawing them forward. Any great difficulty in this part of the work, however, usually results from faulty

Final tie-up of warps

warping and careless turning on; if, therefore, these previous processes are properly done, this part which finally settles the preparatory work for the weaver is comparatively easy.

The best knot for tying up

The best knot for this tie-up of the warp is shown at Fig. 3 in Plate XXIII. The group of threads to be tied is divided in half, brought over the rod to the front, taken under the rod, brought up half on one side and half on the other of the group, and finished (for the first tie-up) by a tie of two bows, and for the second tie-up by a reef knot.

Chapter XIII

WEAVING ON DRAW-LOOM NO. II

Regulating the tension of the warps for pattern weaving

IN fine pattern weaving, especially if it be with a compound harness requiring two warps mounted on separate rollers at the back of the loom, as described in Chapters XI and XII, it is necessary to give particular care to regulating the amount of tension at which the threads of each of the warps are to be stretched in the loom. This is a matter which must be very carefully adjusted if the weaving of the design in the web is to have its proper effect.

Fixed ratchets and pawls insufficient

The simple arrangement of ratchets and pawls with which the students' table-looms are fitted for this purpose is not delicate or manageable enough for fine weaving, even with a single harness and one warp, but, when two harnesses and warps have to work together in the production of a pattern web, whether the tension of both the warps has to be equal or unequal, a rather more complicated and adjustable arrangement, consisting of levers and weights, or weights and cords, has to be adopted.

The first thing to consider then after the warps have been entered and connected with the breast roller of the loom, as described in Chapter XII, is the important matter of giving proportional tension to them.

The weight box best for large looms

Undoubtedly, for a full-sized loom of sufficient length designed for a workroom where space is not limited, the very best method of giving tension to the warps and exactly adjusting it is by means of weight boxes and friction brakes

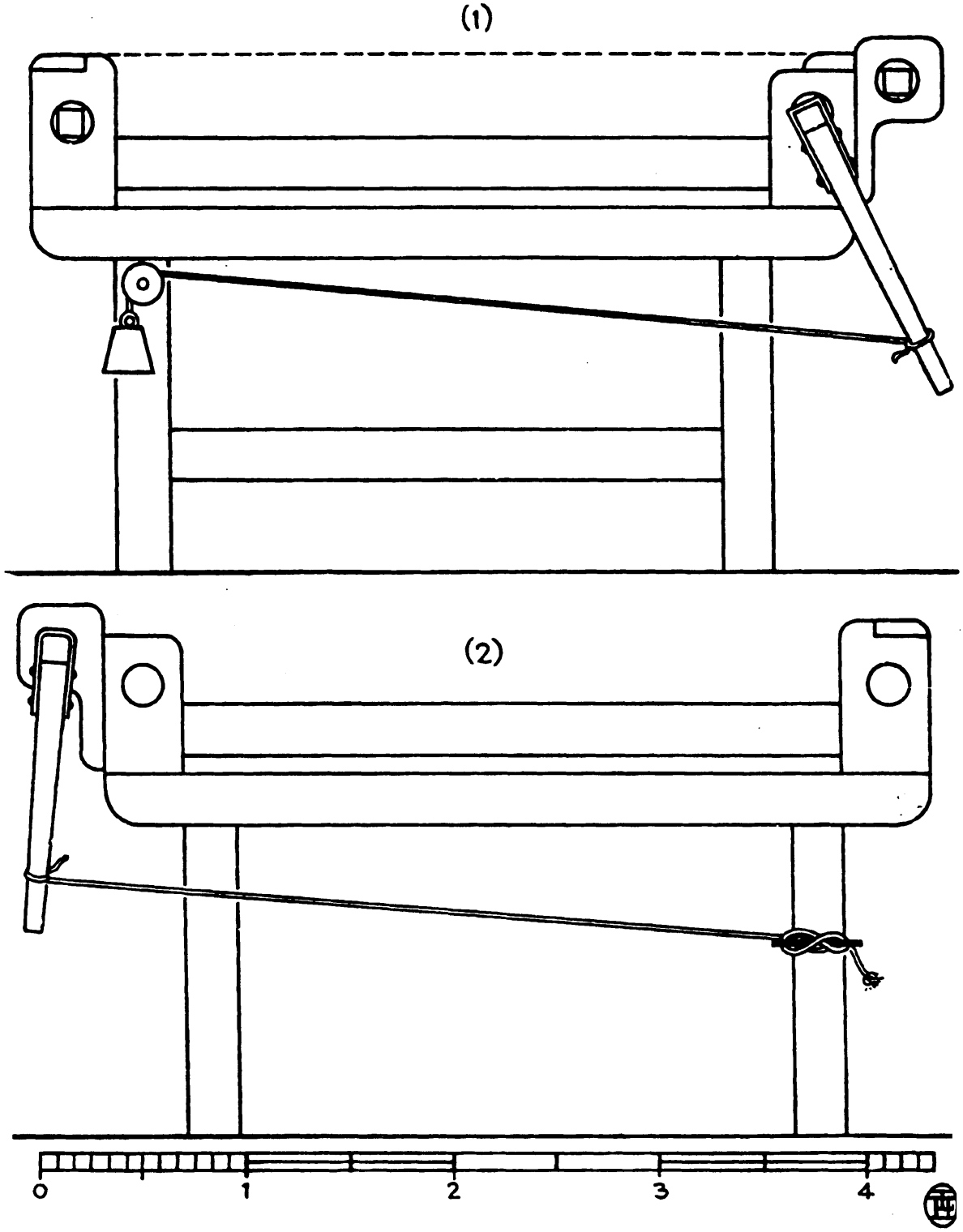


PLATE XXIV

ARRANGEMENTS FOR GIVING TENSION TO WARPS

of stout rope, a method which will be fully described amongst the specifications of looms and fittings in Part III. For the small draw-looms, however, now under consideration, an arrangement of levers, weights and pulleys, or levers, cords, and cleats, is preferable, being lighter, more easy to manage, and less cumbersome.

Levers, weights and pulleys for small looms

The two drawings of Plate XXIV, Figs. 1 and 2, represent the side of a draw-loom No. II, in position on its table, fitted up with lever, weight, and pulley as in Fig. 1, or with lever, cord, and cleat as in Fig. 2. For high tension, the lever actuated by weight is the better, because the weight is more constant, but for lesser tension, the lever, cord, and cleat is sometimes preferable, as it is more easily adjusted; the effect, however, of both methods is practically the same if properly manipulated.

In managing the lever, in both cases, it is necessary to keep its end, to which the cord is attached, always pointing downwards, as nearly as possible to the angle shown in the drawing, and never allowing it to be drawn forward above the level of the pulley or cleat fixed in the leg of the table. It should be possible to weave 4 in. or 5 in. of material without having to move the lever backwards by turning it over on the square end of the roller.

Giving tension to small looms

An examination of the diagram of Plate XXII will show that the ground warp consists of the same number of threads as the pattern warp, although only two shafts are required for the one and sixteen for the other; it might, therefore, be presumed that the same tension would be required for both the warps in weaving the complete web.

This, however, is not the case, for in warp effect pattern weaving, for which draw-loom No. II is specially designed, the warp for the ground has to be more tightly stretched than the pattern warp; this is in order that the slightly stretched threads, of which the pattern units are composed, may stand out or *flush*, as it is called, above the close, solidly-woven ground of the material when the work is finished and cut out of the loom.

Why two separate warps are necessary

Not only are two rollers, with their warps stretched at two different tensions, required in warp effect weaving in order to flush the design, but it is necessary to have two rollers and warps separately weighted, because the ground warp has three or four intersections with the weft to one intersection of the pattern warp. This being so, the length of the ground warp is used up more quickly than the pattern warp in proportion to the number of shoots of weft required to make up the size of the square units of the design.

Draw-loom No. II simple and easy to use

Draw-loom No. II, as described above, is the least complicated of the series of small pattern looms since constructed. It is also the speediest in working and the easiest to use. It is so, because when once the loom is made ready for work and the tie-up of the design on the simple is complete, the pattern will work out almost automatically as the plain ground is woven by the regular crossing of the weaver's shuttle, carrying with it the ground weft, which is the only weft used throughout the web. The regular crossing from edge to edge of the shuttle in this kind of weaving is only interrupted by the raising of a

new pattern shed after each row of the units of design is finished.

A careful examination of Plate XIX, which has been photographed and reproduced from a design on ruled paper, and the two specimens of warp effect materials, Plates XX and XXI, will fully illustrate and assist the above verbal description of this simple but effective method of hand-loom pattern weaving.

Designs for draw-loom No. II

The design of birds and dovecotes (Plate XIX) would work out equally well for a weft effect monture as for a warp effect one on draw-loom No. II, for which it was designed and used; this will be better understood after reading Chapter XIV, which will be devoted to the description of draw-loom No. III for weft effect weaving. When tied up, however, on the " simple " of draw-loom No. II, the design will work out as shown at Fig. 1, Plate XX, which is reproduced from the actual web, except that in this example the small blue units of which the design is composed are made up of threads of the pattern warp, three to each square instead of two, as shown in the design of Plate XXI, the only effect of this being that the number of threads, on which the whole design works out in the material, is increased in the same proportion. This is such an important principle in all compound pattern weaving that it requires stating in a brief paragraph by itself as follows—

Increasing the unit of design in size

Providing that the pattern warps have, say, 32 threads to 1 in. in the ground warp, as shown in Plates XX and XXI, two threads rising together for every unit of pattern will at once double the width and the design which will

work out on 64 threads equalling 2 in. If three thread units are arranged for, the design will be a 3 in. one on 96 threads, and if units of four threads are made use of, the pattern will be a 4 in. repeat and occupy 128 threads. In the latter case, the units of design would be $\frac{1}{8}$ in. square, whilst the ground of the pattern would remain of the same fineness and texture.

Warp effect weaving described

It will also be clearly seen that the blue threads of the units run parallel with the threads of ground warp, and have no connection with the work of the weaver's shuttle; for this reason it is called warp effect weaving. At the right-hand side of the sample, Plate XX, the material has been folded over in order to show the reverse effect of colour at the back, and also to show that the loops of blue warp covering the ground are of many various lengths, insomuch that the material requires lining if both sides are to be practically useful. This disadvantage can be avoided in such a manner as to render the back and front exactly alike in texture and utility, but it is obvious that they will always remain reversed in their colour scheme.

Binding warp at front only

At the front of the material the loops of blue pattern warp is bound at regular intervals by a shoot of weft being thrown across with all the pattern warp threads remaining below; this binds the pattern threads down after every two or three shoots in the front, but leaves the back loops of thread unbound of whatever length they may be. It is possible, however, to bind the back loops in a similar way, but naturally it makes the work slower and more difficult.

Fig. 2, Plate XX, is an example of this double binding which, if it is to be very neatly done, necessitates the use of a second shuttle carrying a weft of half, or less than half, the thickness; this can be easily effected by using the ground weft double for the ground shuttle and single in the binder shuttle. The manner of procedure is as follows: Supposing two shoots of double weft will be sufficient to make the units of design square, two shoots of binder must be made (1) with the pattern threads raised and remaining up, (2) *with all the pattern threads down.* Both these binding shoots of fine weft must be made with the second shuttle. *The first of these binding shoots must be made quite loosely so as to avoid forcing the pattern warp to the front,* but the second shoot which binds the front must be of the usual tension.

In the specimen of woven material, reproduced in colour on Plate XX, various coloured wefts are shot into the ground, while the key design of the pattern warp remains woven throughout in the dark blue. This does not interfere with the simplicity of the weaving.

Various effects of colour can also be woven in warp effect weaving by striping the pattern warp so as to weave it in stripes of different proportions to suit the design.

Chapter XIV

NEW DRAW-LOOM NO. III FOR WEFT EFFECT WEAVING

ALTHOUGH warp effect weaving, as described in the last chapter, has the advantage of being the simplest kind of pattern weaving on the draw-loom, also that its mounting for weaving designs in all sorts of material is the least elaborate and, consequently, the least expensive to build, warp effect weaving has four important disadvantages which render it less generally useful than the rather more complicated weft effect process which is free from them. These disadvantages are: (1) The pattern, however simple it may be, cannot be easily discontinued at will, so that spaces of plain weaving made to alternate with spaces of pattern—an arrangement which is often very effective, and, at the same time economical—cannot be woven. The reason of this disability is that the second warp, from which the pattern is formed, cannot be absorbed into the plain ground without materially altering the colour and texture of the latter. (2) The colouring of the design, whatever it may be, must remain the same throughout the whole length of the warp; (3) if, as is sometimes done, long spaces of loose pattern weft are left at the back and cut away when the web is finished, a great waste of thread is the ultimate result, which, in the event of the warp being of precious material such as silk, is, of course, a serious matter; and (4) the thickness and weight of the

Disadvantages of warp effect weaving

material, resulting from the interweaving of the two warps, render it unsuitable for use where light materials are required, although for furnishing and upholstery purposes this is, perhaps, rather an advantage than otherwise.

Less limitations in weft effect weaving

In weft effect pattern weaving, the weaver is not confronted with either of these limitations or disadvantages, although as regards the size and nature of repeats, the tie-up of the design on the simple and the necessity of binding the loose loops of the pattern, at the back as well as on the front of the material, the conditions are the same as for warp effect weaving.

More complicated looms required for weft effects

The loom for *weft effect* weaving, although naturally more complicated as regards its harness and mounting, the peculiarities of which will presently be still more minutely explained, is exactly like that of the warp effect loom previously described. The table, with its treadles and other fittings, the loom frame, with its front and back rollers governed by ratchets and levers; the simple frame, with its cords, pulleys, and lifting arrangements; the tie-up loops for the simple cords, hanging ready to be threaded according to any design prepared for it, as represented in various explanatory diagrams, may all be exactly the same in draw-loom No. III as in draw-loom No. II. The difference, therefore, between the two looms consists only in the construction and mounting of the harnesses, but here the difference is very marked and requires most careful and minute description. The explanation of this mounting, consisting as it does of two at least, but generally three, separate harnesses, which work together in unison, will be

facilitated by the use of the diagram of Plate XXV in comparison with Plate XXII.

The diagram of weft effect harness

Between letters *A* and A^1, Plate XXV, is displayed a portion of a *weft effect pattern harness* arranged on 24 shafts for a small comber repeating design 2 in. in width to be drawn on 24 squares of ruled paper counting laterally. On each of the 24 shafts, 1 group of small black squares indicates the position of a group of couplings or healds having ½ in. eyes and lead lingoes. There being 24 shafts bearing four healds in each space of 2 in. shows that the harness is for a warp of 48 threads to 1 in. or 96 threads in every repeat of pattern.

Between letters *B* and B^1 the ground harness is shown. It is mounted on four pairs of shafts in order that the ground may be woven either of a tabby or twill texture, and it is weighted with a lower shaft instead of with separate lingoes.

Between *C* and C^1 is the binder harness, mounted on two pairs of shafts and having healds with ordinary ½ in. eyes. This harness is only 12 threads to 1 in., a very scanty one, but it will serve well for illustration. When in use, it would prevent any loop of pattern weft flushing over more than eight single threads of a tabby ground warp, or four threads if the ground be woven as a four headle twill.

Healds of the harnesses

The construction of the healds of the ground and pattern harnesses must now be dealt with, as well as their arrangement on the shafts.

The healds of the pattern harness have already been

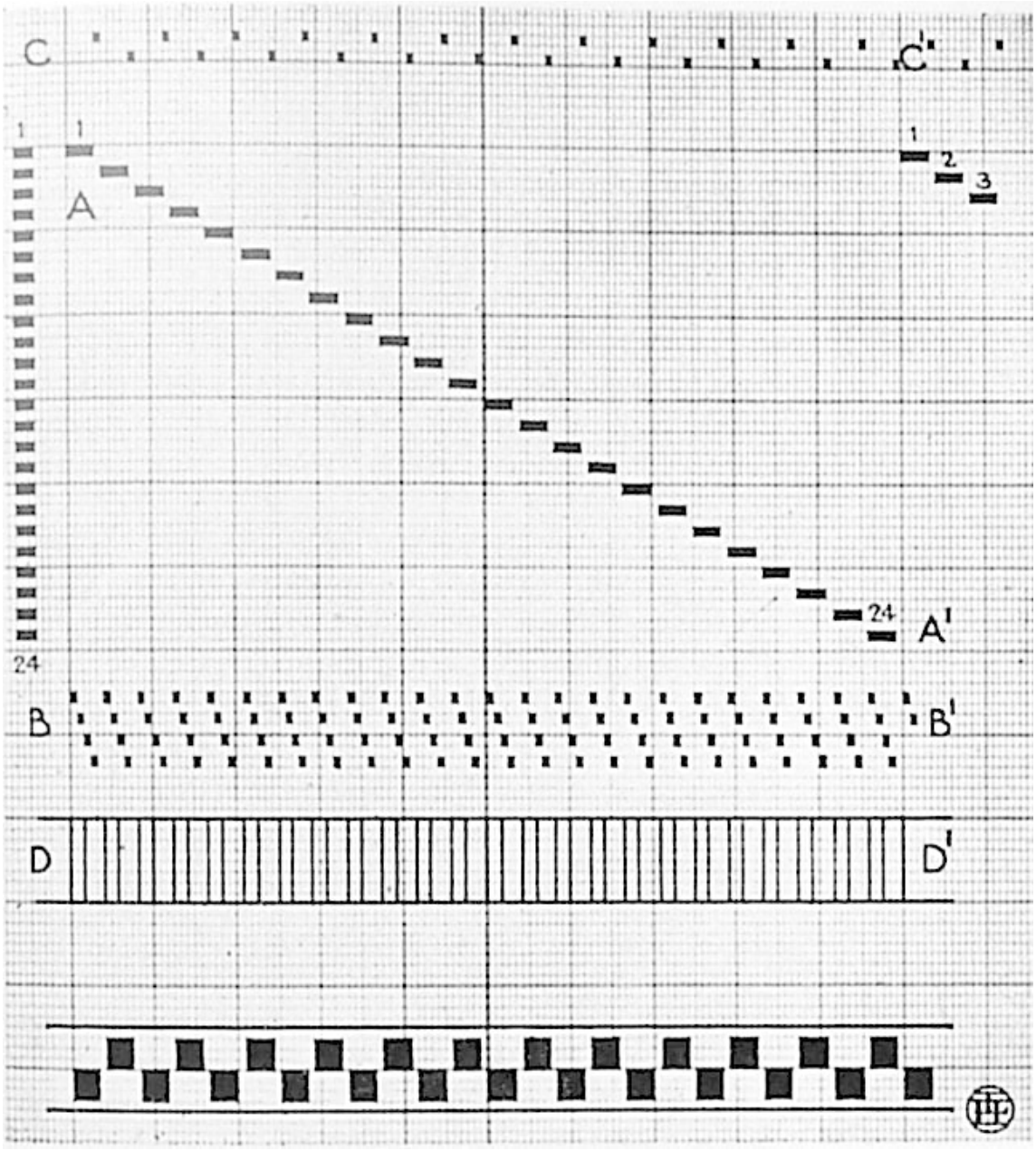


PLATE XXV

TRIPLE MOUNTING OF NEW DRAW-LOOM NO. III

Healds or couplings described

described under the name of couplings in Part I of this book, Chapter VI, and directions are there given for making them by hand or purchasing them ready made of "Jacquard" machinists. In that chapter, however, the top loop of the couplings is described as being 20 in. long, a length which is necessary for the harness of the full-sized draw-loom, but is not required for the simpler draw-loom No. 3. The details of the dimensions of the pattern harness under present consideration are: Lingoes, 8 in. long; weight, 50 to 1 lb.; the lingo loop, 6½ in.; the eye loop, ½ in.; the top loop which is joined to the shaft, 8½ in.; this length allows it to be securely fixed in its position on the shaft by a double snitch. It is necessary for the healds to be fixed on the shaft by a snitch in order to keep the groups of four in their places, as indicated at *A*, Plate XXV.

Healds of the ground harness

The healds of the ground harness consist of only two parts or loops instead of three, and have a pair of shafts for each of the four headles. The healds are made on the same board as those for the pattern harness, but they have only a knot near the centre, and no second knot above it to form an eye.

Relative position of the harnesses

A close examination of Plate XXV will show that the black squares on the pattern harness, being on the same vertical line as those of the ground harness, *indicate that each thread of warp is entered first*, as it comes from the ground warp roller, *in the pattern harness* and then *above the knot in the centre of the healds of the ground harness.* This arrangement of entering the ground warp threads allows each one to be actuated by either harness independently

as may be required. Thus, by raising a shaft by itself, or any number of shafts of the pattern, all the healds with the threads of warp depending from it or them will not be *prevented from rising* to make a shed by the ground harness when it is at rest, as there is nothing to hold them down. *It is clear then that the pattern harness can work quite freely by itself.*

The ground harness in action

As regards the ground harness, the knots at the centre of the healds, on which the threads of warp rest, will cause the whole row of connected threads to rise with each shaft in the necessary order to weave a twill or tabby ground, but, of course, will have no power to bring them down again, nor is it necessary; for, each thread being entered also in the eye of a single heald of the pattern warp which is *weighted by a lingo*, will be brought down by the latter as soon as the ground shaft falls.

The binder harness: its function

Between *C* and C^1, Plate XXV, the binder harness is placed, which is arranged to bind both the front and the back of the material woven. It is possible to bind the front of the pattern weft by the ground harness, but in a compound harness it is better to mount at the back of the monture a separate harness for binding both front and back at the same time. The binding harness shown in Plate XXV is one of the simplest kind; it is arranged on two headles to weave a very scanty tabby at intervals of nine ground threads.

The reed

The reed is shown between *D* and D^1, Plate XXV. The entering of the reed is two threads in every dent, and the binder, after being brought through the pattern and

ground harnesses *to the right of every fourth thread*, is entered with the latter in the same dent.

It is, perhaps, hardly necessary to explain that, although in the diagram on ruled paper, Plate XXV, the dents of the reed appear to be of unequal size, it was necessary to make them so in the illustration in order to show that the dents had to accommodate two and three threads alternately, the third thread in every second dent being the fine thread of a binder, but, of course, the dents of the actual reed are all equal.

Chapter XV

WEFT EFFECT WEAVING ON NEW DRAW-LOOM NO. III

AS stated in the last chapter, weft effect pattern weaving can be done without the binder harness shown at letters *C C*^{1}, Plate XXV. Although this is certainly true, the web when finished will not be so practical, for the weft of the design will be left loose at the back in all the spaces covered by the ground. Of course, the same thing would happen at the front in the spaces of design, if no means of binding the pattern weft at regular intervals were available. This, however, is not so, for, if the ground harness be mounted on four headles, as shown at letters *BB*^{1}, Plate XXV, a twill or tabby binder for the pattern weft can be borrowed from it. In the case of a twill binder, the order of raising the single headles of the ground harness would be 1, 2, 3, and 4, whilst for a tabby binder the order would be 1 and 3 alternatively, or 2 and 4 also alternating, and, in either case, the pattern weft would flush over three threads of warp and be bound by one.

Pattern weaving without a binding warp

The tabby and twill binders

When the above plan for binding the front of the pattern is used, it has the disadvantage of making the binder more prominent than it should be; for the finer a binder is, the less it will interfere with the formation of the units of design. A binding thread should be, if possible, less than half the thickness of the ground warp threads.

The entering and general preparation of the loom with

Preparation of loom for pattern weaving

the triple harness for weft effect weaving, as described in the last chapter, differs but little from that of the preparation of draw-loom No. II for warp effects. The relative positions of the two rollers at the back, one for a tabby warp, and the other for a pattern warp, are the same, as shown in both Plate XXI and Plate XXIV, one being the tabby warp for the ground of the warp effect harness, and the other for the binder of the pattern weft effect harness. The pattern warp of draw-loom No. III is spread out on a number of shafts in the same manner as the pattern warp of draw-loom No. II. The diagrams of both harnesses indicate that the threads of warp pass to the front of the loom *between* the healds of the pattern harness and never cross one another, so that each harness can be worked independently. The arrangements for entering both harnesses are exactly the same, as is also the method of fixing the warps to the front roller of the looms.

Warp threads must not cross

In the case of the weft effect loom, however, there is a striking difference in the rather complicated action of the harnesses in weaving pattern from that of the simpler warp effect loom.

Function of the pattern harness in weft effect weaving

In warp effect weaving it will be remembered that the threads of the pattern warp are really the threads of which the design itself is formed, and that they appear on the surface of the ground and disappear below it according to a plan tied up on the cords of the simple, but in weft effect weaving the work of the pattern harness, letters *A* and A^1, Plate XXV, only consists of selecting and raising certain combinations of the threads of the *ground* in such

a manner that a separate coloured weft can be shot across in front of the spaces where the ground warp is left at rest and pass behind all the threads raised by the pattern harness. The spaces of ground at rest, thus covered with a line of coloured weft, after the shed is closed and added to line by line, will form the complete design on the surface of the finished material.

Course of the weft in pattern weaving

So far it will be observed that the pattern weft has simply passed above and below the ground warp and, if continued line after line in alternation with each line of ground wefting, the design would show on the surface of the web *exactly interwoven with the ground as the lashes are interwoven with the cords of the simple.* The design would, therefore, consist of lines of loose loops of coloured weft varying in length from the width of 1 unit of design upwards. Hence, the necessity for a binder of some kind to tie down the long loops of weft at regular intervals in the manner already described for the front of the web when a separate binding harness is not provided.

Why a separate binder

For perfect pattern weaving in which, both at the back and front of the material, the weft required for the pattern is tied down by a fine binder, the addition of a separate binder harness on two or more headles, as shown at *C C*, Plate XXV, is necessary.

Process of weaving on new draw-loom No. III

The actual process of weaving on a new draw-loom No. III, mounted with the triple harness, is as follows—

1. *A perfect piece of tabby ground must be woven* in order to make sure that every thread in the ground of the web is in its place in the reed and clear from twisting

with other threads or any obstruction *from the cross in the warp, at the back of the loom, to the rod, to which every thread in the mounting, including the binder harness, is connected.*

Testing the pattern harness

2. The pattern harness must be tested in the same way as that of the ground, in order to prove the correctness of its entering and the perfect independence of its working. This will be best proved by weaving line by line alternately with the ground harness an inch or two of the checker pattern shown at Fig. 2, the bottom of Plate XX. This will require the simple to be *tied up* or interlaced by two lashes: (1) take four and pass four alternately right across the cords of the simple, and (2) pass four and take four also right across.

Checker design on pattern harness

This tie-up of two lashes would enable the weaver to make a checker pattern of 12 squares to an inch on a warp 48 threads to 1 in., each square or unit of design consisting of four threads of warp and three shoots each of weft both for the ground and pattern. Of course, it must be always remembered that the number of shoots of weft required to fill out the exact square of each unit depends entirely upon the relative thickness of the warp and weft threads, and the number of times the same pattern shed is shot over with weft. This can only be decided by experiment.

Ground and pattern sheds must alternate

Whether the pattern weft is tied down by the threads of a binding harness, as in the diagram of the triple mounting, or by threads borrowed from the ground harness itself, *the binder headle must be changed on every shoot of the pattern weft.*

WEFT EFFECT WEAVING

After the tension of the warps has been adjusted as near as may be at first; the correctness of the entering has been tested and proved correct, and the separate selvages, if any, have been added in order to keep the edges of the web neat and tidy; the loom will be ready for the weaver and assistant to read in and tie up on the simple the design which it has been decided to use for the first experiment in weft effect weaving.

Chapter XVI

WEAVING IN WEFT EFFECT DESIGNS AND THE ORDER OF WEAVING COLOURED WEBS

BEFORE beginning to read the present chapter, the student should re-read the instructions for tying up patterns on the simple of the typical draw-loom, given in Chapter IX.

Drawing on ruled paper described

Sometimes, drawings for simple weft effect patterns are made with the ground painted in, on the ruled paper, and the ornament left in plain white, but when the design is only of one colour weaving on a plain ground, it is more usual to paint in the ornament and leave the ground plain, in the same manner as for warp effect weaving, examples of which were given on Plate XII, Figs. 1, 2, 3, 4, and 5, but whichever plan is adopted, it is always necessary, in weft effect weaving, to raise the threads which form the *ground*, and leave the spaces of the pattern at rest *at the warp level.* Fig. 1, Plate XII, is a good example of a

Designing

comber repeating design, and being drawn on 12 × 12 ruled paper as well as being 24 square units wide, would be a suitable pattern for a first attempt at tying up and weaving on a draw-loom fitted up with the triple harness mounting described in Chapters XIV and XV.

Fig. 1, in Plate XII, having 48 lines of units in each repeat of the design, will require the same number of lashes attached to the side cord of the simple at the top of the right-hand side ready for tying up one repeat of the pattern.

Reading-in design for pattern weaving

Beginning then at line No. 1 of the design, the "reader-in," remembering that all the spaces of white squares are to be lifted, will call: Take 1. Pass 1, take 1. Pass 19, take 2. This will complete the first line, which, being correctly tied up, and the lash being fastened to the left-hand side cord of the simple and lowered to its place below the shed lifter, the second line will begin: Pass 10, take 4. Pass 3, take 2. Pass 5, and each succeeding line will follow, beginning either with the call "take" or "pass," until the whole design is tied up.

When more than one colour is used

In the case of designs, however, where two or more colours are used, especially if they be at all elaborate, the design has to be painted in, in all its colours, and the ground tinted with a very light wash of colour, also additional drawings, one for each colour, have to be made for reading-in. At letter *A* Plate XXVI, is an example of a small three-colour design reproduced in monochrome. In the original the ground is pale blue, the foliage green, and the flowers red and orange in alternate lateral rows, which can be arranged for by altering the weft colour on the flower shuttle. At letter *B*, the ruled paper drawing for the green foliage is given. The ground is left white and only the green foliage is represented in dark grey. At letter *C* the drawing of the coloured flowers is shown in a middle tint sharply outlined.

Brocading

Unless arranged in lateral stripes, as in Plate XXVI, or woven with small shuttles or needles in the method called *Brocading*, a process which will be explained in connection with draw-loom No. IV, each additional colour in a design

requires a separate shed for the wefting; this must be shown on a separate drawing on ruled paper in order to read-in and interlace a separate lash on the simple.

Order of wefting a one colour pattern

The method and order of weaving a weft effect web on draw-loom No. III with one colour, in addition to the ground, such as Fig. 1, Plate XII, is as follows—

(1) A shoot of ground colour, whatever it may be, starting at the right-hand side, must be made. This will, of course, be shot in the tabby ground shed made by one, or a pair, of treadles independently of the pattern harness.

(2) The first pattern shed must be made by gathering on to the rod of the shed lifter of the simple (see letter *H* Figs. 1 and 3, Plate XI), all the cords at the back of which the first lash of the tie-up of the design has been passed.

(3) The rod, standing as at Fig. 1, Plate XI, with the selected cords on it being drawn forward to the position shown at Fig. 3, and held by the catch, letter *I*, will have opened the pattern shed in front of the reed, and *keep it open* until the weaver is ready to close it by a touch of the finger at I^2.

(4) Before throwing the shoot of colour weft selected for the pattern, the first binding thread must be raised by means of the binder treadle No. 1. When this is done, the shed will be ready for the first shoot of pattern weft which must follow in the same direction as the ground shuttle.

(5) As soon as the pattern shed is closed and the binder

treadle released, the second ground shoot must be made from left to right by the ground shuttle, and before preparation is made for the second pattern shoot the second ground shoot must be firmly beaten down to fix the pattern shoot in its place. An examination of the work at this stage will show a thin line of coloured weft crossing all the spaces of pattern in accordance with the first line of the design, as regards width, which only requires adding to by *three or four similar lines in order to complete one lateral line of square units according to the design.*

More than one throw of weft generally required to make design unit

(6) The first pattern shed must now be reopened, held by the catch, the *second binder shed* raised, and the second line of pattern weft shot from left to right, bringing both shuttles to their first position on the right of the loom. After the pattern shed is closed and the wefts pressed together, the third line of ground weft must be shot and beaten close; it can then be determined how many shoots of ground and pattern will be required to fill out to their right proportions each lateral row of the design as drawn on the ruled paper.

Of course, the proportion of the design when woven can only be determined by experiment, as it depends not only on the number of shoots of weft in each row of squares, but on the size of the wefts, both of the ground and the pattern, and also the closeness with which they are beaten together by the reed.

Proportion of design must be kept

It must never be forgotten that the *binder shed* has to be changed for *every shoot of pattern weft, no matter how many shoots are required for each line of design units, or*

Changing the binder at every shoot

whether it is a tabby binder on two headles or a twill on four.

When in lines of weft two or more colours are thrown

In the case of designs, such as that of Plate XXVI, at *A*, where two colours are used in the same line of wefting of the pattern, either in certain portions or all over the design (as shown in the illustration at letter *A*), every line of ground weft is followed by a line made up of two different coloured wefts which appear and disappear in certain appointed places in the line not covered by the ground. This change of colour in a single line of weft is arranged for on the "simple" by having a separate lash for each colour to be used in succession after each single shoot of ground weft. This necessitates the making of a separate working drawing for each colour if the design be at all complicated. In reading-in, therefore, for the first lash of the pattern shed of the specimen sample of Plate XXVI, the drawing *B* would be used, and for the second lash the use of drawing *C* would be required, and this order would be maintained throughout *as long as two colours run together in the lines of the design.* The lashes are distinguished by being made of different coloured threads and, generally, the first shoot of pattern following each ground weft is for the leaves, stems, or structural lines of the design.

A clearing for each colour required in complicated patterns

When two or more coloured wefts are shot in the same line of a pattern, *the same binder shed is repeated for them.*

Chapter XVII

DRAW-LOOM NO. IV

THE bold step from draw-loom No. III to draw-loom No. IV proved to be a very great advance in the development of the table-loom series of draw looms. In effectiveness it brought the mechanism, for artistic pattern weaving, a little in advance of the traditional draw-looms of the early part of the nineteenth century: the time when the Jacquard machine was first used in the silk industry.

Draw-loom No. IV as great advance in development

This new draw-loom (No. IV) embodies in its small compass two important inventions which render it manageable by a single weaver and, at the same time, simpler in the method of extending the size of a design without interfering with the fine texture of the warp. The first of these innovations is the removal of the simple to the front of the loom, which is quite a modern innovation, while the second invention referred to, which is called the *split harness*, was made by John Gough, a Spitalfields silk weaver, about the middle of the nineteenth century. This was a very important invention indeed, and will require full explanation, as it effects in a much simpler manner the enlargement of the units of design, the principle of which is explained in Chapter XI on draw-loom No. II.

Two important inventions adopted in No. IV draw-loom

The general appearance of draw-loom No. IV is given in the exceptionally good free drawing of it made by Miss Alice Hindson, which is first of the group of six at the beginning of this chapter, in which it will be seen that

the framework very much resembles that of the full-sized draw-loom described in Part I.

Side elevation of draw-loom described

The side elevation of the loom is given in Plate XXVIII, sundry details on Plate XXIX, also a design on ruled paper suitable for it forms the subject of Plate XXX, a diagram of pattern and brocade wefting, Plate XXXI, and a brocaded sample of silk tissue, woven from the design, Plate XXXII, completes the special set of illustrations devoted to its description.

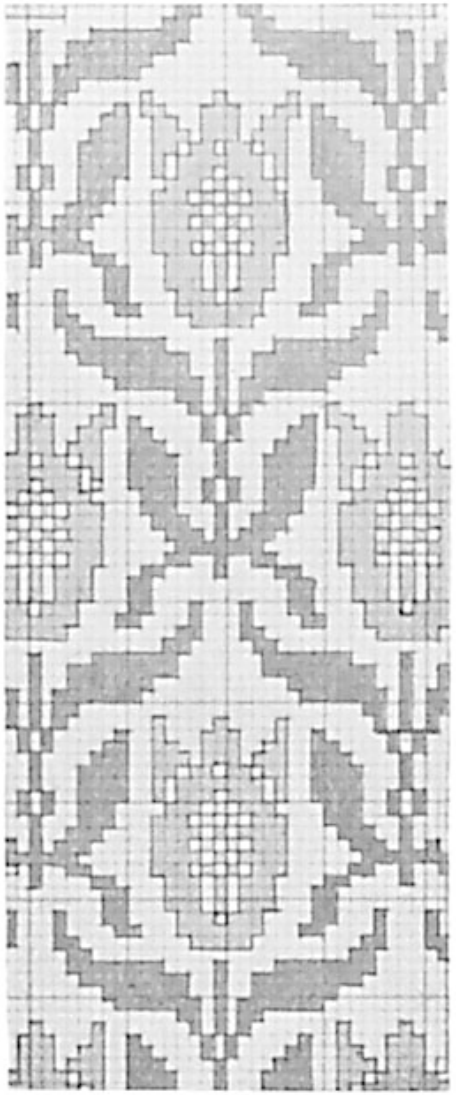
Why the comber board was introduced in No. 4 draw-loom

In draw-looms Nos. I, II, and III of this series, the pulleys, over which the cords pass to the front of the loom and connect the shafts of the harness with the cords of the simple, were placed on the top of the simple frame in a single row: but, as it was desired to make No. IV a draw-loom which would allow for the weaving of a *wider repeat of design* than was possible on a headle harness, the number of shafts of which is necessarily very limited, the perforated comber board with its corresponding appliance, the pulley-box, as well as the simple frame and cords to match the comber board, became essential fittings.

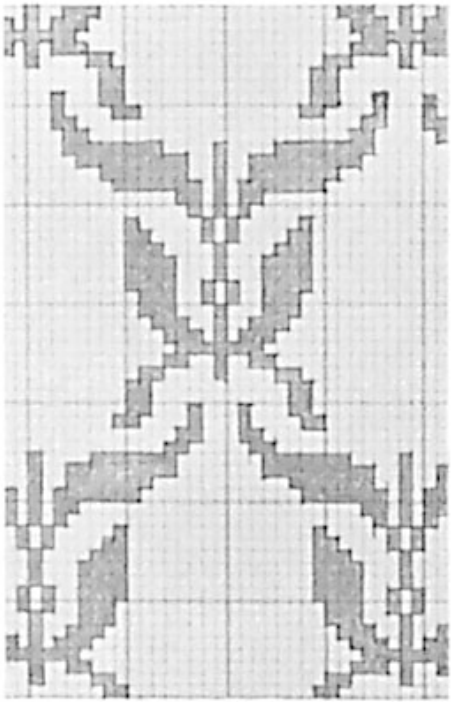
Parts of the draw-loom previously described

Full descriptions of all the parts of the single-thread draw-loom have been given in Part I. These will apply equally to several of the parts of the draw-loom No. IV. The comber board, the pulley-box, the simple frame and its cords, the composite healds of necking cords terminating in the couplings with their lingoes; which hang on the shafts and work independently of the pattern lifting mechanism of the simple; all, with slight variations, are adapted to the smaller loom. These variations will all

A

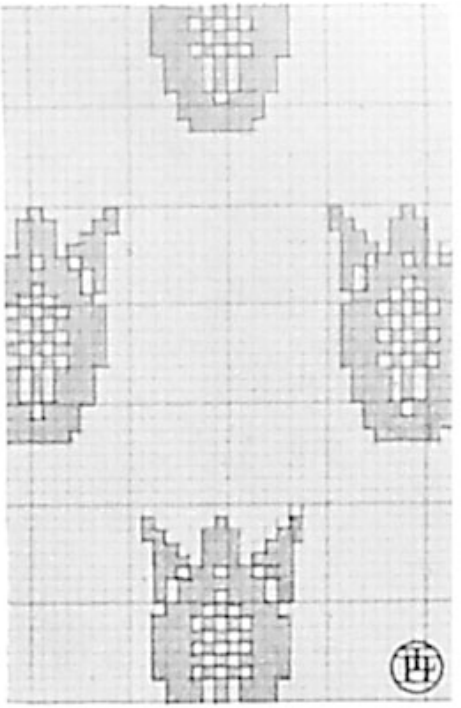


B



First Colour

C



Second Colour

Design

PLATE XXVI

Design in Three Colours, Represented in Three Tones, for Weaving on New Draw-loom No. III

require brief noting, but the nature and value of the " split harness," which has been referred to for the first time at the beginning of this chapter, will be fully dealt with later, together with explanatory illustrations.

Plate XXVIII described

In the drawing of the side-view of draw-loom No. IV, Plate XXVIII, the end of the comber board is shown in position at letter *A*, just above the row of pulleys *D D*, over which the cords pass, which connect the shafts of the harness to the treadles. The board in this case is not made of perforated slips held together by a solid frame, as in the full-sized looms, but it is simply a thin board of hard wood, 18 in. long and 4 in. wide. Its perforations will be presently explained, as well as its close agreement with the count and other particulars of the warp and the design. In these small looms it is necessary to keep all the fittings as light and open as possible so as to be easy to handle and adjust; hence, the adoption of this simple type of comber board. The board is held in its place in the frame by a pair of bent iron hooks fixed to a strong cross-piece which is firmly screwed to the back of the upright frame. An enlarged reproduced drawing of one of the hooks is given at Fig. 2, showing its attachment to the crosspiece, and the front of the board is further supported by a strong cord being attached to its corners and carried upward to the top of the loom frame, and there secured, as in Fig. 3, letters *C C*, Plate XXVIII, which show the relative positions of the pulley box, *A A*, the bottom board, *B B*, and the comber board, *C C*.

The comber board and pulley box of draw-loom No. IV

The perforation of the comber board and its division

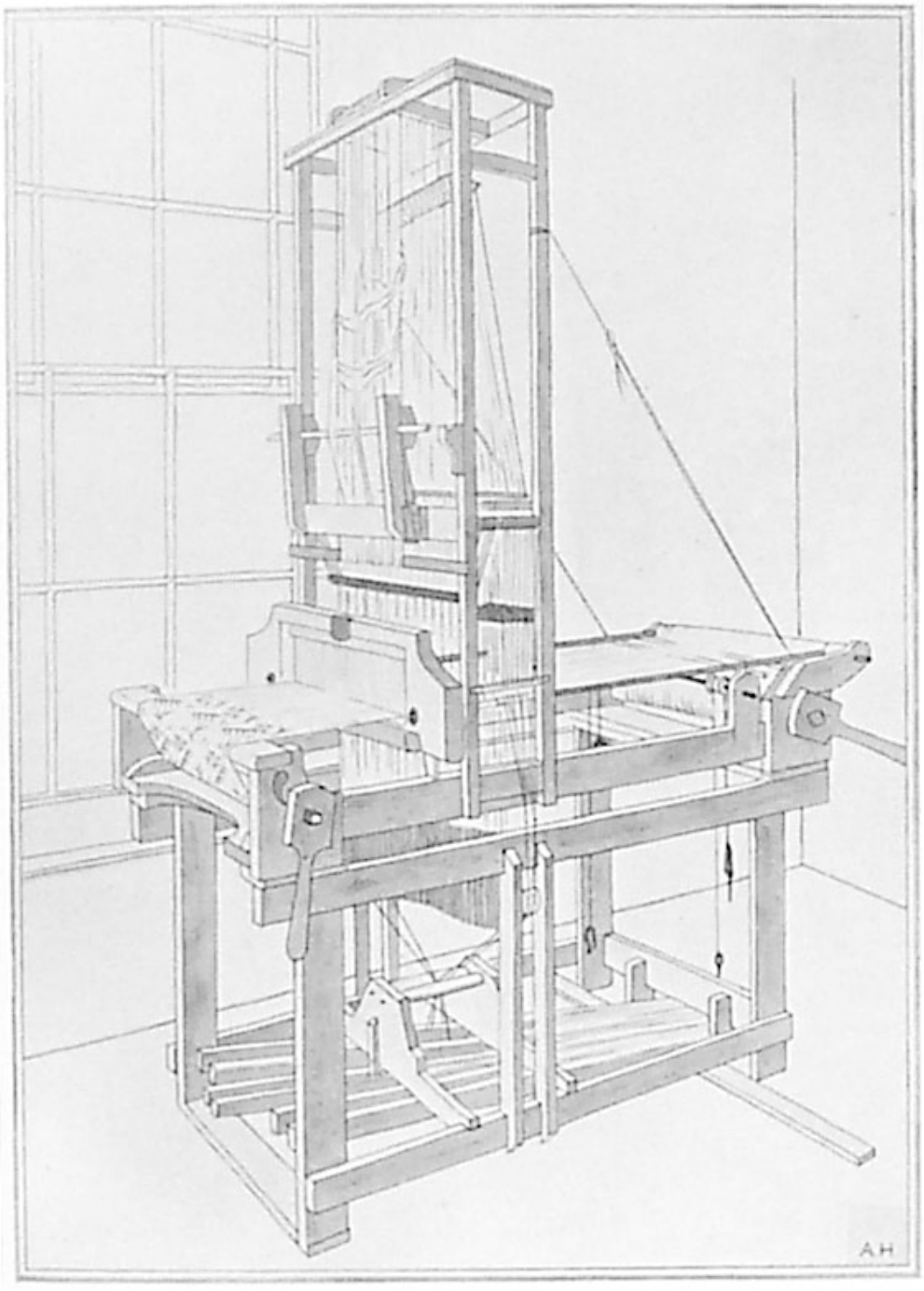


PLATE XXVII

NEW DRAW-LOOM No. IV

(From a freehand drawing by Alice Hindson)

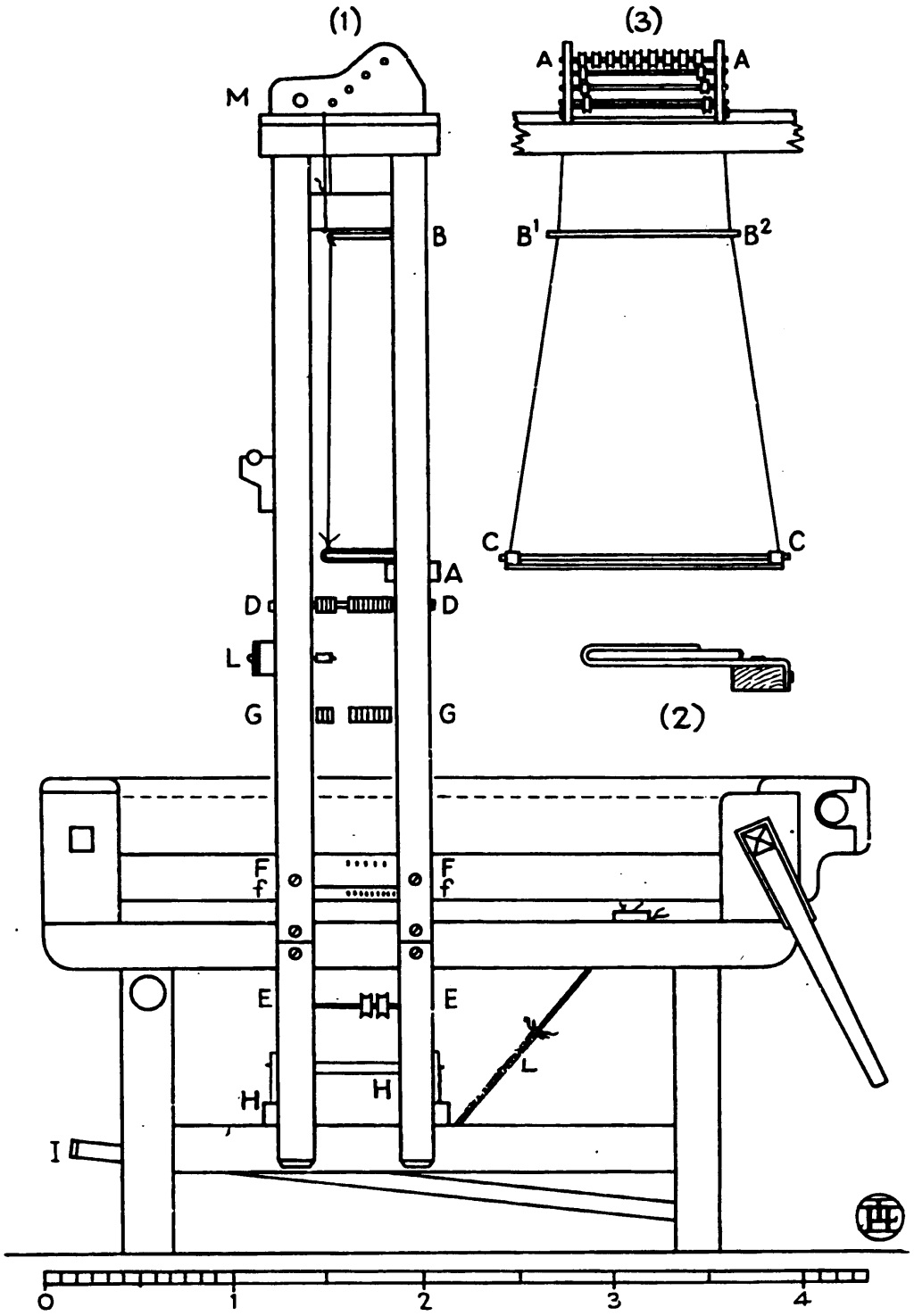


PLATE XXVIII

NEW DRAW-LOOM No. IV, SIDE ELEVATION AND DETAILS

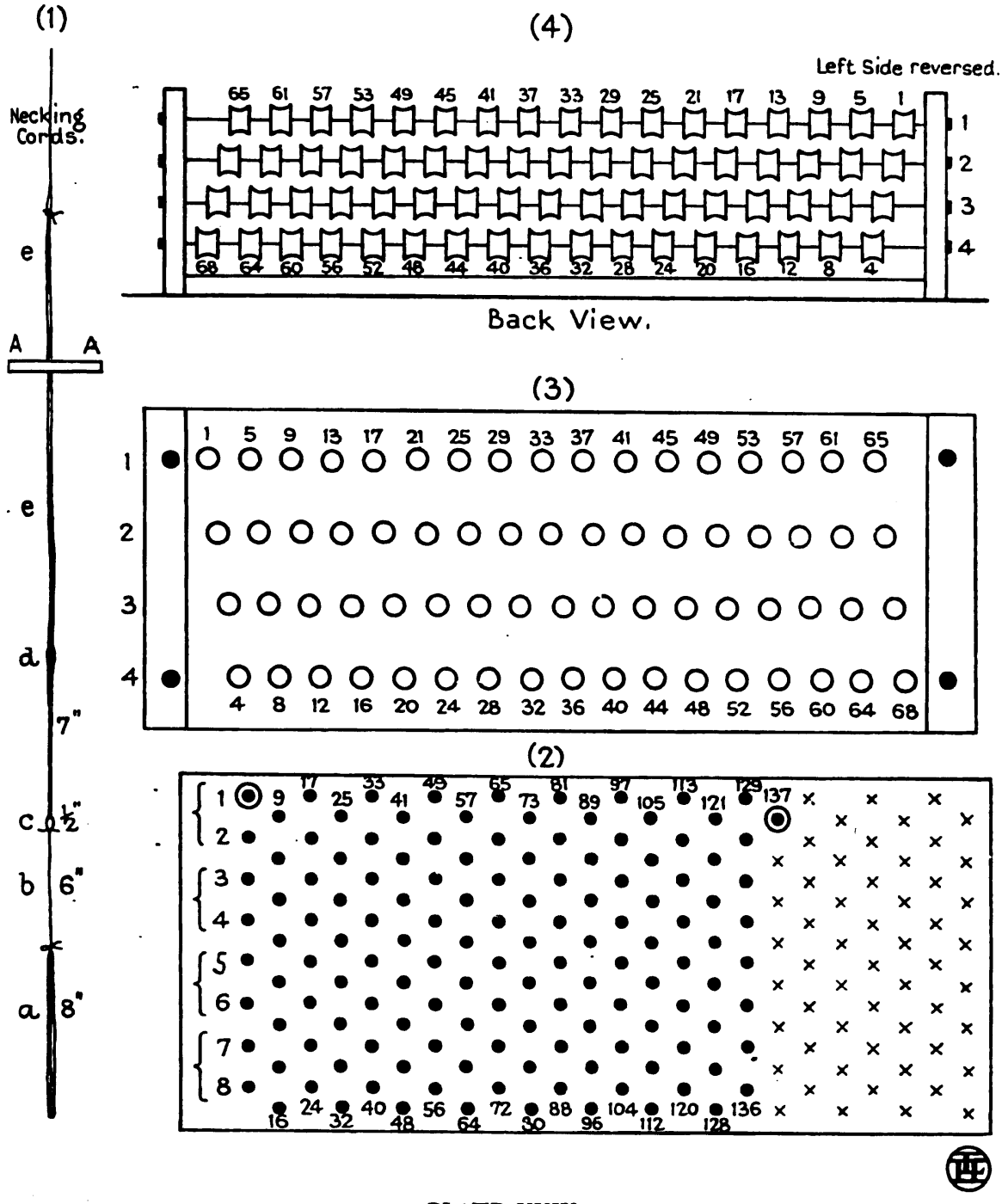
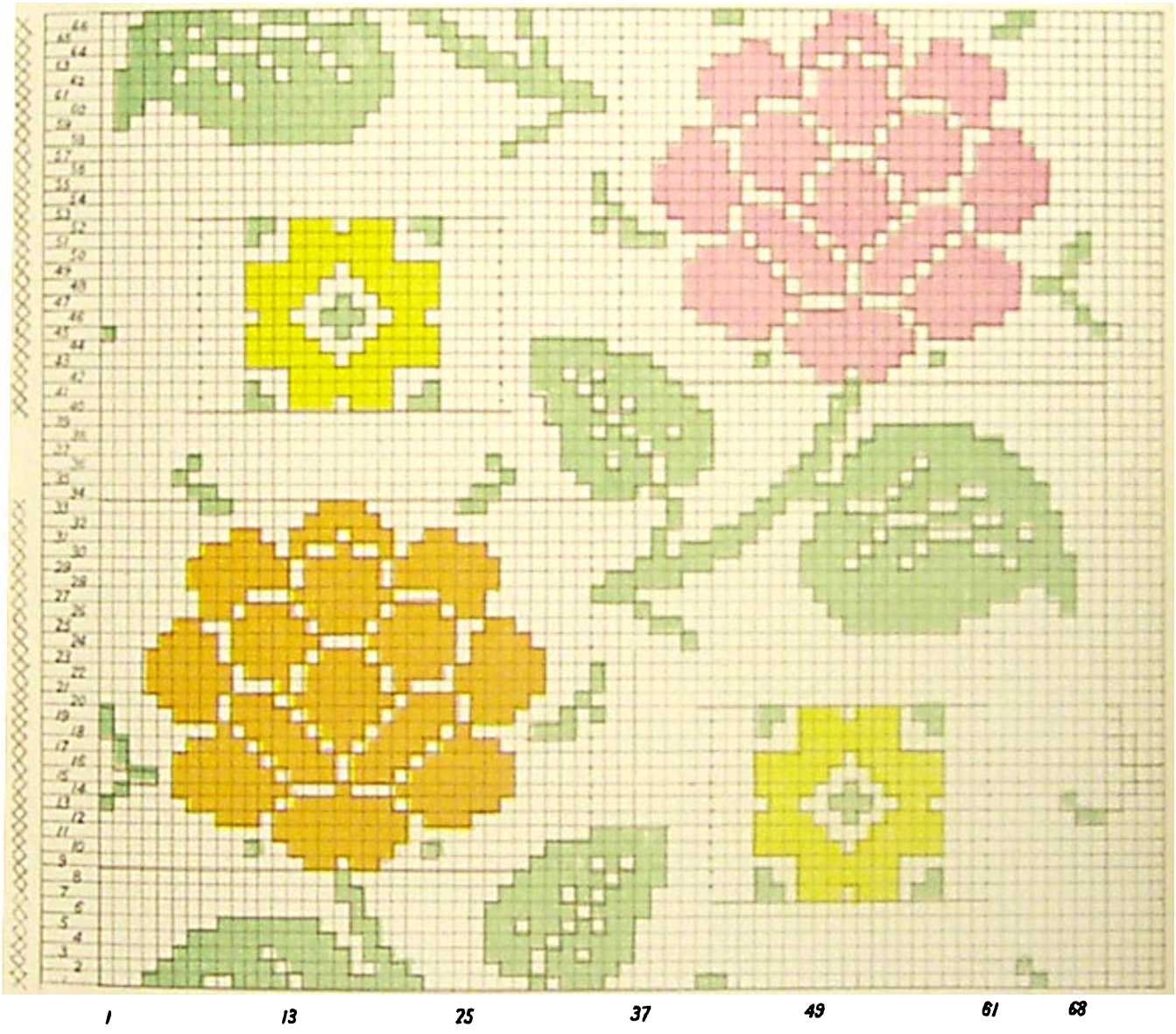


PLATE XXIX

COMBER BOARD, BOTTOM BOARD, AND PULLEY BOX OF NEW DRAW-LOOM No. IV



Design for Silk Brocade to be woven on Draw-loom No. IV.

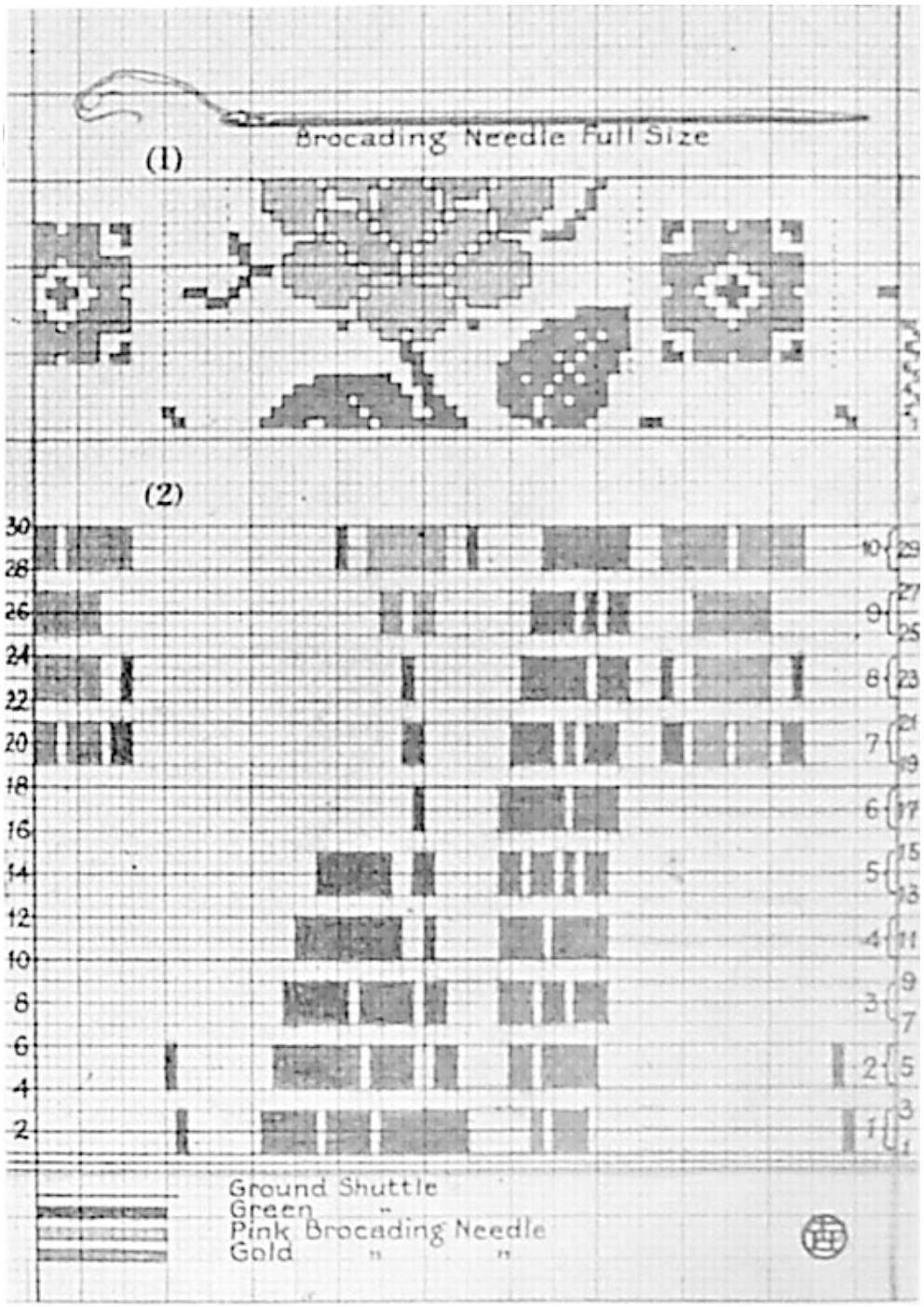


PLATE XXXI

Brocading for Plate XXXII

Silk Brocade woven by the Author on Draw-loom No. IV.

into repeats will, of course, depend on the count and width of the warp to be set up, each thread of which has its appointed separate hole in the comber board exactly above its place on one of the shafts of the harness.

The width of the warp, and the arrangement of the shafts and couplings, always being determined by the perforations of the comber board, it is, of course, necessary that all these several parts be in exact agreement.

We must now, therefore, examine in detail the separate parts of the harness of draw-loom No. IV in order to show how perfectly this agreement is maintained.

The board being 18 in. from end to end will allow a width for each row of the perforations of 17 in. This, of course, necessitates the use of a reed at least 17 in. wide, exclusive of selvages, making 18 in. in all, the same as the comber board. See Plate XXIX, Fig. 2, where one-third of the complete board is shown.

In 17 in., therefore, the warp, whatever count it may be, must be contained.

The reed for draw-loom No. IV and its warp

As draw-loom No. IV was intended for students' use, the yarn for the warp was chosen of such a size as to work freely 48 threads to 1 in., so that in 17 in. there would be 816 single threads. The reed selected for use was one of 24 dents to 1 in., or 408 dents in 17 in.

It was next considered that 48 threads to 1 in. would make a much finer tabby ground than was required for the design of the brocade it was intended to weave (see Plate XXX), therefore, the yarn was warped double, so that each coupling depending from the shafts had to be

entered with a double thread, and the two threads in each dent of the reed would rise together as a single thread.

The number of shafts for pattern harness

The next matter to arrange was the number of shafts on which the 408 couplings were to hang, and the number 8 was determined on because it is most convenient for weaving either plain tabby, twill, or satin grounds. 408 divided by 8 gives us 51 as the number of couplings to hang on each shaft, and as the eight shafts require 2½ in. space to hang and work in, the corresponding eight rows of holes in the comber board must occupy a space of 2½ in. by 17 in., and each row must have 51 holes pierced in it.

The short couplings

The short couplings which are to hang on the shafts, are made in the same manner as the couplings for the single thread monture described in Chapter VI, Part I, but, in order to hang them on the shafts of the " split harness," invented by John Gough, previously referred to, an additional knot has to be made 7 in. above the eye of the coupling, called the bannister knot. The " split harness " coupling is shown on Plate XXIX (Fig. 1), with its various parts lettered in italics, *a* being the lingo 8 in. long; *b*, the lingo loop, 6 in.; *c*, the eye, ½ in.; *d*, a shaft with the bannister knot 7 in. above the eye resting upon it; and *ee*, the long loop passing through the comber board, letter *A*, and reaching as far above it as the comber board itself is above the bannister knot.[1]

The bannister knot

In exactly the same way as described for the thread

[1] For a full description of the split shaft harness and its wonderful utility in silk weaving, consult *Hand-loom Weaving, Plain and Ornamental*, Chapter XVI.

monture couplings in Chapter VI, the split harness couplings must be prepared, hung on their shafts by their bannister knots, 51 couplings on each shaft, and the long loops drawn up through the holes of the comber board a row at a time to finally join the necking cords from the pulley box. *Hanging the couplings on shafts*

Turning now to the design for brocade weaving for which the loom is being prepared, Plate XXX, it will be seen that it is a comber repeating design, each repeat occupying laterally 68 square units of design. Three repeats, therefore, would fill out 204 squares of ruled paper, and supposing each square represents two couplings with their entered threads of warp to be lifted, the 408 couplings hanging on the eight shafts and drawn through the comber board will be accounted for.

Leaving for the present all the long ends of the 408 couplings hanging in an orderly manner over the front edge of the comber board, we must return to the first description of the monture building, in order to note that the long end of each coupling, after passing through its appointed hole in the comber board, is joined to one of the several necking cords which are connected in their turn to a single pulley cord above the bottom board of the pulley-box; the latter hanging, as it is always placed, immediately over the centre of the comber board; see Chapter VI and its illustrations, where full directions are given for joining the couplings and necking cords of a typical monture. *How connected with necking cords*

Returning to the side view of our draw-loom No. IV, Plate XXVIII, the position of the bottom board of the pulley-box is shown at letters B^1 and B^2, as well as a front

The bottom board of pulley box: its position

view of the box and its fittings at Fig. 3. In Plate XXIX, Fig. 3, the bottom board with its perforations is drawn as seen from the top, and above it the pulley-box is shown from the back.

At Plate XXIX, Fig. 2, a repeat of the comber board of draw-loom No. IV is also shown, and when all these parts of the monture are compared and thoroughly understood, the perfect and admirable agreement of the different parts of the mechanism will be realized. In order that all this may be made perfectly clear, the various figures in the two plates must be taken in their natural order.

Agreement of comber boards, bottom board and pulley reinforced

(1) The portion of the comber board (Fig. 2), Plate XXIX, must be explained. It is a bird's eye view of one-third of the whole board, and it contains 17 rows of eight holes, counting from back to front, as indicated by the numerals; its total number of holes is, therefore, 136, ending at the front of the board. Hole No. 137 at the back of the board begins the second repeat for a comber design, as explained fully in Chapter IV.

(2) Fig. 3, in Plate XXIX, represents the upper side of the bottom board of the pulley-box. It will be realized that its perforations, although numbering only 68 and arranged as they are only in four rows of 17 holes, agree with the perforations of the comber board, when it is remembered that each single cord from the pulley-box has to raise two couplings from two separate holes in the comber board; thus, couplings 1 and 2 will be joined by their top loops to a necking cord which, in its turn, is joined to No. 1 pulley cord; Nos. 3 and 4 in a like manner

will be joined to No. 2 pulley cord; Nos. 5 and 6 to No. 3 pulley cord, and couplings Nos. 7 and 8 will be joined to No. 4 pulley cord. Of course, the compound necking cords when all joined together to each pulley cord, as described in Chapter VI, Part I, will draw up the corresponding couplings in every repeat across the whole warp.

The principles of the "split harness"

Before passing on to describe the pulley-box arrangement of the pulleys, it will be most convenient to pause just here to point out that the principle of the split harness has almost explained itself, as it will have been noticed that the single couplings from the comber board, being joined in pairs to single pulley cords in the order indicated, are, in every case, *resting by their bannister knots on separate shafts*. This is a great advantage, simple matter as it may seem, for it allows the shafts with their single couplings to work quite independently of the pattern arrangement above them; also that the cords of the pattern can be raised in any combination without at all disturbing the unraised threads resting on the shafts.

To arrange pulleys in box

General particulars of the construction of the pulley-box will be found in Chapter V, and should be re-perused before the building of the special box for draw-loom No. IV is begun. This being done, the accommodation for the requisite number of pulley cords in the pulley-box must be made. We have already calculated that the number of cords to be accommodated with pulleys in the box for the harness of draw-loom No. IV is 68, and that they have to be arranged to match exactly the four rows of holes in the bottom board, as shown at Fig. 3, Plate XXIX. The

shape and details of the pulley-box decided on is given in Plate XXVIII, Figs. 1 and 3, the side view of the box being shown in Fig. 1, and the front view in Fig. 3. In Fig. 1, letter *M*, one of the two sides of the pulley-box is shown perforated near the front with a large hole, and four small holes rise one above the other from front to back, being the same distance apart as are the rows of holes in the bottom board. Fig. 4, Plate XXIX, gives the back view of the box, which has four iron bars resting in the eight holes of its sides. On these bars the 68 pulleys are placed and spaced and fixed by washers in such a manner that every pulley cord has a clear run forward to the front of the box. In order to do this, the pulleys have to be arranged on the rod diagonally, as shown in the illustration, which gives the back view of the box with pulley No. 1 on the highest bar to the right; but, of course, when seen from the front it will be exactly above No. 1 hole in the bottom board on the left.

Boring the bottom board of the box

The perforations of the bottom board of the pulley-box, Fig. 3, Plate XXIX, in order to be immediately beneath the pulleys to which they belong, are bored in rows with a bias from left to right, so that every pulley cord to which three necking cords, one from each repeat, are joined, may be drawn straight up and have no tendency to be diverted from the groove of the pulley to which it belongs. From this point the pulley cords are all carried to the front, over the glass rod after passing through the dents of the pulley-box reed to join the simple cords, and finally reach the bottom bar of the simple in exactly the same way as described in Chapter VII.

The course of the compound coupling to the simple

DRAW-LOOM NO. IV

The four-headle binder harness, in draw-loom No. IV, is placed *in front of the pattern harness*; the ground, whether tabby or twill, being made by the eight shafts of the latter. The binder warp is made of fine white silk, 12 single threads to 1 in. It is entered in every alternate dent of the reed, after being brought between the second and third double threads of the pattern harness. The healds have ordinary ½ in. eyes, and the headles have both top and bottom shafts.

Position of the binder harness

Only two treadles are necessary for the tabby ground, and these are placed in the centre. The binder treadles, four in number, are corded to the headles, 3 and 1 to the right, and 2 and 4 to the left of the tabby ground treadles.

The *cording*, as the system of connecting the healds and shafts of the harnesses to the treadles is called, is such an important matter that a separate chapter must be devoted to its consideration.

The cording

Chapter XVIII

THE PULLEY MOTION AND ITS CORDING

Superiority of the pulley motion for cording

IN all the draw-looms designed by the author the ground and binder harnesses are connected with the treadles by cords running over pulleys instead of the usual system of levers and marches, for it has been found that a pulley motion, when accurately arranged, is far more dependable than one of levers, and is, at the same time, more easily adjusted.

The pulley motion for draw-loom No. IV is quite a simple one, but for the full-sized looms, particulars of which will be given in Part IV, the pulley motions and cordings will be found to be rather more complicated but equally adjustable. Plates XXVIII and XXIX must be consulted for particulars of the arrangement of the pulleys and cording of No. IV draw-loom.

Pulley motion of draw-loom No. IV

1. Between letters *D D*, Fig. 2, Plate XXVIII, a row of 12 small pulleys will be seen; they are divided into two sets by a long washer, the set near the front post of the loom consists of four pulleys, and there are eight pulleys in the back set.

2. Immediately below the back set of pulleys, two larger ones are mounted, close together on an iron rod fixed between the two upright side posts of the loom on the side of the loom table, which match the upright side frame of the loom. These pulleys are kept in position by

washers exactly under the centre of the set of eight pulleys *D D*. The two large pulleys are lettered *E E*.

3. Below the eight pulleys, *DD*, on the side frame of the loom, a slat of wood is screwed and lettered *F F*; it is furnished with eight small screw eyes spaced so as to be exactly underneath the centre grooves of the eight pulleys, *D D*.

4. About midway between the eyes *F F*, and the pulleys *D D*, a row of short vertical lines, lettered *G G*, is drawn, which indicates the position in the loom of the ends of the eight shafts of the pattern harness and the four top shafts of the binder harness.

Having identified these various objects and their relative positions, the reader will see at once that eight cords attached to the ends of the pattern harness shafts *G G*, brought over in the grooves of the eight pulleys *D D*, threaded separately through the screw eyes *F F*, divided into two sets of four, as will presently be explained, can be tied to two strong treadle cords coming from the centre of the loom just below the two large pulleys *E E*, and perfectly connect the shafts of the pattern harness with a pair of treadles.

Before an explanation of the rather different cording of the binder harness is given, it will be more convenient to turn to the diagrams of the front views of the pulley motions and cording given in Plate XXXIII, Figs. 1, 2, and 3.

Fig. 1 shows the pulley motion for the pattern harness. No supports for the pulleys are shown, but the correctness

Pulley motion of pattern harness

of the position of the various parts will be at once recognized as they are lettered the same as in Plate XXVIII.

The letters *G G* indicate the ends of the pattern shafts to which strong, thin cords are attached and carried over the pulleys *D D*, on both sides of the loom. The cords are threaded through the screw eyes in regular order as they come off the pulleys; No. 1 cord being at the back and No. 8 towards the front of the loom. Below the eyes the cords from pulleys 1, 3, 5, and 7 are neatly joined together and connected by a snitch to the treadle cord the backmost of the two pulleys *E E*. The remaining pulleys, 2, 4, 6, and 8, must be gathered in like manner and joined a little lower down, so that the two knots work free of each other, to the treadle cord for the pulley *E* in front.

Cording the pattern harness

After passing under the pulleys *E E*, Plate XXXIII, the treadle cords from both sides, connected with shafts 1, 3, 5, and 7, are carried to the centre of the loom, and passing between two rollers, fixed in the position shown in the diagram at letter *B*, are attached in the usual way to the ground treadle No. 1. The treadle cords from the shafts 2, 4, 6, and 8 follow exactly the same course from the front one of the pair of pulleys *E E*, but after passing through the narrow opening between the two rollers are tied to the ground treadle No. 2.

Bearings for rollers of pulley motion

The bearings for the rollers are erected on two crossbars, the ends of which are seen at *H H*, Fig. 2, Plate XXVIII, and one of the bearings between the rollers *B B*, drawn to the same scale as the loom, are given in Fig. 3, Plate XXXIII.

THE PULLEY MOTION AND ITS CORDING

For the binder harness a pair of short rollers is fitted up at the back of the bottom bar of the simple frame, near its centre, the end of the bar is marked letter *L*, Fig. 1, Plate XXVIII.

Pulley motion of binder harness

The binder cording, Fig. 2, Plate XXXIII, is much simpler than that of the shaft harness of the pattern and ground, and only requires the pulleys *D D*, and the two small rollers *A*, in addition to the large rollers *B*. The cords, which can be quite fine ones, after being tied to the ends of the top shafts of the headles, pass up and over the pulleys *D D*, to the small rollers *A*, over them, straight down through the warp to the long rollers *B*, and so between them to the several binder treadles. The best order for tying them up is headle 1 to the first treadle on the right, and headle 2 to the first treadle from the left; headle 3 to the second treadle from the right, and headle 4 to the second treadle from the left. The advantage of connecting the headles and treadles in this order is that the treadles can be used without alteration of cording either for tabby or twill binders. For tabby binders, treadles 1 and 3 can be tied and trodden together alternately with treadles 2 and 4.

No alteration of cording required for tabby or twill binders

It must be added that in making both pairs of rollers, letters *A* and *B*, the spaces for the cords to pass between them must be as narrow as possible, and the cords to be used must be of the best highly twisted flax; also that every part of the cording must have snitch joints in convenient positions, making it easy to regulate, adjust, or mend at any moment.

Chapter XIX

TYING UP THE SIMPLE FOR A DESIGN AND WEAVING A BROCADED TISSUE ON NEW DRAW-LOOM NO. IV

Larger repeats of design possible on draw-loom No. IV

THE great advance in the construction of the draw-loom No. IV consists in the provision it makes for weaving wider repeats of design than No. III, or any of its predecessors of the table-loom series. The previous looms were, as we have seen, limited as to the size of the design, as regards width, by the great space occupied in the loom by any considerable number of headles. Except for this limitation, which, however, is no insignificant one, draw-loom No. III with its more easily constructed pattern harness, is equally serviceable for weaving small elaborate warp or weft effect patterns in cotton, linen, or silk, however fine in count of warp they may be. It may also be claimed for these earlier looms that their pattern shaft harnesses are not only just as effective for small designs, but are more original and simple in construction than any looms hitherto invented for ornamental weaving, whereas draw-loom No. IV follows exactly in the draw-loom tradition, except for the position of the simple and the arrangement of the pulley-box.

Design for draw-loom No. IV described

The design chosen for illustrating the kind of work for which draw-loom No. IV was constructed, is the subject of Plate XXIX, and a sample of the silk brocaded tissue woven from the design is reproduced in colour in Plate XXXI.

Before describing the weaving of the brocade, the

design itself must be briefly considered. It is made on ruled paper squared 12 by 12 to 1 in., which agrees exactly with the size the design will appear when woven in a warp 24 threads to 1 in., two threads being raised for each unit of design as arranged for on the simple.

The design is a comber one, and is on 64 squares of ruled paper in width by 66 squares high. It is Persian in character, insomuch as the charming convention of the rose spray is copied from a portion of an old Persian pile carpet. It well illustrates, in the present arrangement as a silk tissue, the free and graceful nature the designer can give to his work by the use of the comber repeat, in which the design can be doubled and reversed *above*, instead of *by the side of the subject*, as in the point repeat. This arrangement throws the principal feature, *the rose*, into positions which suggest an elongated diamond shape as the geometric basis of the pattern. The freedom and gracefulness of the design result from the comber repeat form, which throws the reversed curved stems of the spray into a vertical wavy line from which the leaves, flowers, and secondary features spring in varied positions.

Freedom of design due to comber repeat form

The order of the tie-up of the design of Plate XXIX for the brocaded tissue is almost the same as that for the two-coloured design of Plate XXV, described in Chapter XVI, illustrating a tie-up where two colours are provided for; in fact, they are exactly the same up to and including the seventh line of the rose and star design, after which point the gold star begins, and, consequently, at this point, a second tie-up for the star form must begin to be added

The tie-up for brocading

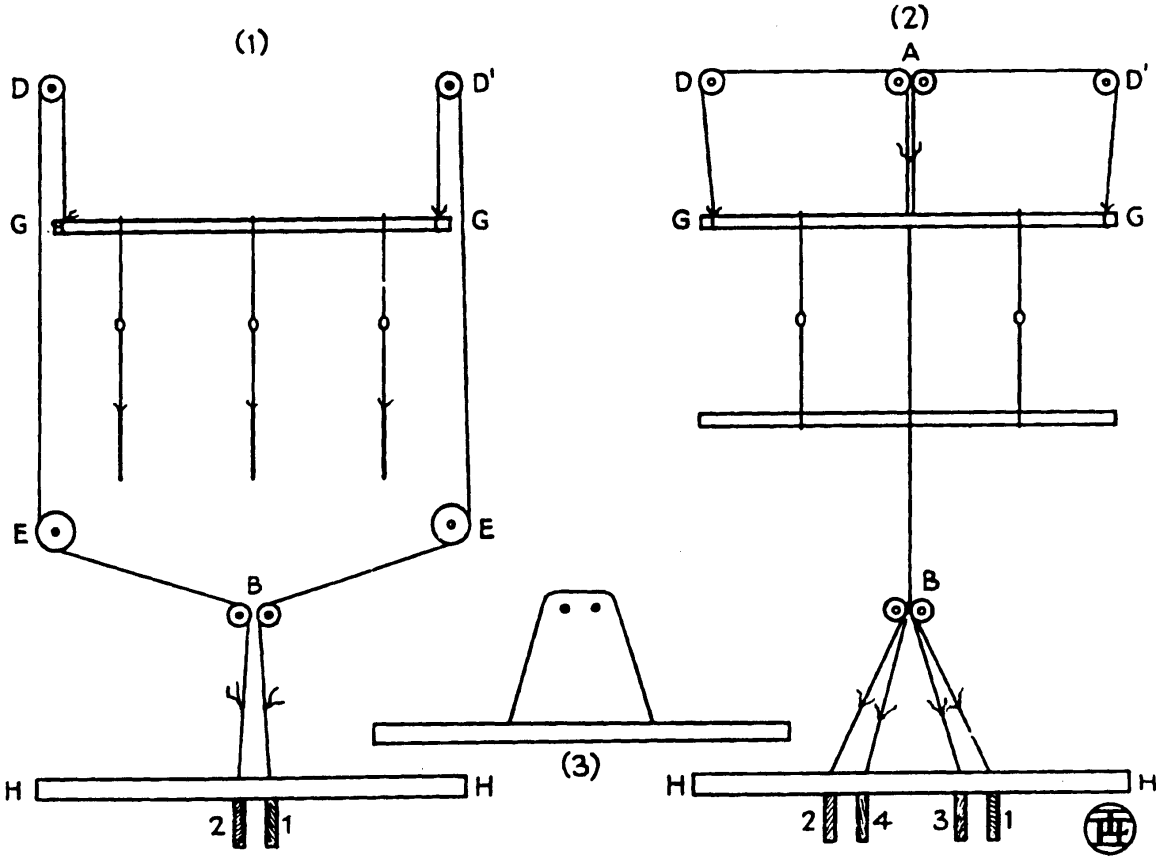


PLATE XXXIII

PULLEY MOTIONS FOR THE NEW DRAW-LOOMS

to the tie-up for the green leaves, stems, and small embellishments.

A short digression must be made here in order to explain the method adopted for varying the colouring of certain parts of the pattern of a web, without thickening the material by extra wefting. It is used when the variations consist of small spots and patches of colour standing quite clear of each other, as in the case of the flowers and stars of the design under discussion. This will be at once seen in the reproduction of the coloured tissue in Plate XXXI. This process is called *inlaying* or *brocading*. In the design the figures intended for brocading are indicated by being enclosed in dotted lines for the guidance of the " reader-in " of the simple.

Weaving webs face downward in Jacquard weaving

In elaborate commercial weaving, with a Jacquard machine, whether by hand or power, brocading is generally done face downwards in the loom, and the separate brocaded wefts are inserted by means of several small shuttles, or swivels, worked at the back of the material. This is, of course, very difficult work when done by hand, and requires great skill and judgment on the part of the weaver. It is, however, not necessary to discuss it here, as in the new draw-loom the webs are woven face upwards and *the brocading is done from below* by means of needles, as will be explained before the end of this chapter, when the process of weaving the brocade is described in detail.[1]

Brocading with needles

[1] It is interesting to note that the antique figured velvets are often embellished with small brocaded figures in gold thread or strips of gilded parchment, which must have been inserted from below with a needle in the way described: cut velvets must be made face upwards if cut by hand.

Reading-in the tie-up for brocading

Returning to the consideration of the tying up of the simple, at the point reached before the above necessary digression was made, and line No. 7 had been read-in as follows: " Take 16. Pass 2, take 9. Pass 4, take 1. Pass 1, take 1. Pass 3, take 7. Pass 2, take 9. Pass 2, take 11." The tie for first line of the brocaded star has then to be made in a separate coloured thread in order that the six yellow or gold thread units might be brocaded in their appointed place in the same seventh line. It will be noticed that the designer has surrounded both the star and the rose with a dotted line for the guidance of the *reader-in*, which indicates that *only the portion of ground warp threads within the dotted boundaries* need be lifted as the star and rose have to be *brocaded*. The reading for the brocading tie in line 7 would be: " Pass 42, take 5. Pass 3, take 1. Pass 3, take 5. Pass 9."

After the reader has carefully studied the above paragraph and compared it with the design, he will realize that only the ground between the dotted lines has to be " taken" in the ties of the brocading lines, and that all the other squares, including those of the roses and the stars, have to be passed.

Reading-in for draw-loom No. IV

Another sample pair of tics for reading-in had perhaps better be given before leaving the design and passing on to the explanation of the weaving brocade of Plate XXXI. Line 13 of the design will be a good example, as the tie will include portions of both the rose and the star brocadings. In this line the tie for the running shuttle with the green weft will be a very full one. It is: " Pass 1, take 48.

Pass 3, take 12. Pass 2, take 2," and line 13 of the brocading will be " Pass 3, take 3. Pass 6, take 1. Pass 7, take 1. Pass 6, take 3. Pass 9, take 6. Pass 2, take 7. Pass 2, take 6. Pass 6."

In conclusion, as regards the design and tie-up on the simple, it will be seen that owing to the fact that in the spaces from line 1 to line 6, and from line 34 to 39, inclusive, in which there is no brocaded ornament to be provided for, the whole tie-up is made with only 120 lashes for the brocading instead of 132, as might have been expected.

Preparation for tying up and weaving, draw-loom No. IV

The entering and preparation of draw-loom No. IV for the tying up of the two warps to the front roller as well as weaving the tabby ground of the material, so as to make a good foundation for the pattern structure; are all to be done in the same manner as described for the weft effect pattern of No. III draw-loom: moreover, they should not be affected by the slight differences made by the alterations in the position, and the difference of construction of the eyeless front harness and the moving of the binder harness from the back of the pattern harness to its front next to the reed. In fact, both these alterations render the entering and working obviously more simple.

Testing the various parts of the monture

Naturally, before beginning to weave the design, the tabby ground must be brought to great perfection, and each headle of the fine silk binder should be brought up and tested, in order to make sure that all its threads rise exactly in their places, *to the right of the double thread of warp in each alternate dent of the reed.* It must also now be decided whether the binders on the coloured wefts are

to be worked tabby or twill. In the example, Plate XXXI, the binder is a tabby one. This being the case, the binder treadles which are placed in pairs to the right and left of the ground treadles, 1 and 3 being on the right, and 2 and 4 on the left, must be coupled together in order to make the treading easy and certain.

Wefting for the brocade

For the wefting, the same white silk as that used for the binder can be wound double for the ground shuttle, and the other running shuttle, as a shuttle that runs right across the warp is called, should be wound treble, in order to well cover the white ground, the same silk dyed green being used. The silks for the brocading figures, the colours of which can be varied to any extent if desired; in the present sample are rose pink, deep orange, gold and silver. Real gold and silver threads were used in the sample, but they are rather difficult to manage, and are liable to tarnish, so that it is generally thought best to use gold and silver coloured silks except for very special works.

Where small shuttles are used for brocading

For certain reasons, which it is not necessary to discuss here, rich satin brocades and tissues are woven face downwards in the loom. When they are so woven, the brocading is inserted by means of small shuttles carrying the different wefts, several such shuttles being moved in regular order, as indicated in the design. In the sample of Plate XXXI it will be seen that most of the brocaded lines would require six shuttles in every line. These would be used after each line of green weft was thrown, and as the stuff was being woven face downwards, each tiny shuttle could be moved the little space required, and rest on the back

of the material without getting into disorder. As, however, it was found more convenient and pleasant in the new draw-looms to weave face upwards, a new method of brocading had to be devised for inserting the small spaces of colour from below the warp, and large embroidery needles were found to answer the purpose perfectly and be even less difficult to manipulate than the small brocading shuttles.

The order of weaving the brocade will best be explained by tabulating the several separate movements, assisted by the diagram of wefting, Figs. 1, 2, and 3, Plate XXXI.

At Fig. 1, Plate XXXI, a portion of the brocade is drawn in three shades of grey, representing the three different colours of the finished sample of Plate XXXII. The ornamentation is all in correct proportion, and the separate lines of the units of design are numbered at the right-hand side from No. 1 to No. 10. Between line No. 10 and No. 11 a strong line is ruled across the sketch. It will be seen that the space below the line includes foliage drawn in a dark shade, a portion of a rose in a very light shade, and a part of a star in a middle tint.

In Fig. 2 an elongated drawing of the same parts of the design will be easily recognized when carefully compared with the lower part of Fig. 1 above it. The 30 lines ruled across the diagram represent shoots of *ground weft*, and at *one* end of every such line a numeral is placed. By means of the numerals the course of the shuttle can be traced from No. 1 at the right, where it enters the shed, to No. 30 on the left, where it is ready to start on the final

shoot of No. 30 in preparation for line No. 31. The inner column of numerals and brackets, Nos. 1 to 10, at the right-hand side, show that *three shoots of weft* of various colours are compressed into the space occupied by each row of the units of design as represented at Fig. 1, lines No. 1 to No. 10, and all the other lines of the design.

All shuttles and needles must follow in regular order and direction

1. In preparation for every line of the design, a shoot of white silk must be made in the tabby ground shed, the shuttle alternately entering the shed from right to left, or from left to right, and each shoot must be well pressed down by the reed in order to keep the web solid and square; also all the entries of the green pattern running shuttle and the brocading needles of each line, however many there may be, must follow in *the same direction as the tabby ground shuttle.* This order must be absolutely kept or inextricable confusion will be the result.

Order of weaving

The ground shuttle, left resting on the right-hand side of the foundation of woven tabby ground, must be driven across in the shed opened by the right-hand ground treadle, and when the weft has been beaten down, must remain resting on the left-hand side ready for its return.

2. The rod which rests on the handles of the shed opener must be pushed to the right and rest on the hook placed on the side post so as to leave the space in front of the cords clear; the first lash of the simple can then be brought down and selected, the simple cords pulled forward by means of the lash, placed on the rod, as it is gradually pushed towards the hole in the left handle, secured, and there remain quite free from the hook on

Order of weaving brocade

which it rested. The lash, freed from the cords, can then be allowed to sink below the handles and remain there.

3. The shed for the green weft can now be made by pulling forward the handles of the shed lifter till they are held in position by the catch or catches. *The first pattern shed*

This being done, the threads of warp *under* which the green pattern weft is to run will be seen lifted on the surface of the web, and the spaces to be covered by the green weft will be unaffected.

4. The binder treadles on the *right*, which must have been tied together, as before mentioned, have to be pressed down, which will raise the first and third headles of the binder harness, and their warp thread, will be seen in all the spaces eventually to be occupied by the green weft.

5. The green shuttle with its weft can be shot from right to left, and be placed at rest on the web above the ground shuttle. *The first colour shoot*

6. The binder treadles can be released, and the catch of the shed lifter pushed up to close the shed.

One-thread of weft in accordance with the design should now appear properly bound at regular intervals right across the material.

7. The ground shuttle with its white weft must next start in the second ground shed from the left, and after being well pressed down, rest on the web as at the beginning, and be followed by the second pattern weft, from left to right. Both running shuttles will now be found in the first position on the web at the right-hand side. *Order for the second shoots of weft*

In weaving the sample, Plate XXXII, it was found that

in order to make the design work out in right proportion, three shoots of ground weft in alternation with *three shoots of green pattern weft were required to fill out each row of the design without changing the pattern shed.*[1]

On the completion of the first row of pattern units, both shuttles should be found on the left side of the web ready to begin the second row as soon as the second pattern shed is made by the lifter. Thus, in exact order, line after line, the rows of square units of design must be woven until the seventh row is reached in which the brocading of the gold and silver stars has to begin.

Where the brocading shoots begin

It must not be forgotten that, from row 7 to row 33 of the design, two pattern sheds have to be opened for each row of units, one opening for the running shuttle of green silk as before, and the other for the brocading figures which come on the same line. No. 7 is an instance in point. This has been explained previously in the present chapter under the heading " Reading-in the Design," and should now be made quite clear.

The weaving of line No. 7 of the brocade, Plate XXXII, as tabulated, if clearly understood, will be sufficient to explain the technique of the whole work as regards this matter.

The separate movements for weaving the first brocading row of the design are as follows—

The movements for brocading tabulated

1. Open the shed for the ground weft and throw shuttle from the right where it remains after the green weft of

[1] Although the *pattern shed* has not to be *changed* until the three rows of each unit are complete, the shed lifter with the cords remaining on the stick has to be pulled forward and let back in order to open and close the shed for each shoot of weft.

row 6 has been laid and is waiting to be pressed down by the first ground shoot of No. 7 row.

2. Shoot the ground weft and leave the shuttle on the left.

3. Open and fix the shed for the green weft.

4. Open binder shed by its appropriate binder treadles.

5. Throw green weft shuttle.

6. Open and fix brocading and binding shed, the same as No. 4.

7. From below the warp a brocading needle, threaded with gold thread or yellow silk, must be brought up close to the yellow star on the side nearest to the place from which the green running shuttle started.

8. Pass the needle *over* the six spaces to be covered by the yellow weft, but *under the raised binder* threads as well as the single unit of ground in the centre of the six yellow units.

9. Let the needle carefully down to hang below the web and remain there ready to be used in the next line.

10. The other stars in the same line, No. 7, must be brocaded in exactly the same manner, and the binder and brocading shed must, of course, remain open until they are finished. Each brocading figure, needless to say, must have its separate needle and weft, and all must hang clear below for use in the succeeding lines.

Pressing the brocaded line base by ground weft

11. Close the brocading shed and binder and open the shed for the following shoot of ground weft which will press all neatly together, and begin the round of wefting in the opposite direction. If all the above directions are

closely followed, the hanging needles and the running shuttles will be found in exact order and position for the next line of the design. It should, perhaps, be mentioned that the brocading needles must be brought up when required for the next line on *the upper side of the wefts of the two running shuttles.* Unless this be remembered, the weft already laid will simply be drawn out and the star left blank.

In row No. 9 of the pattern the brocading of the rose begins and the star is continued up to row 20, although the rose is continued to row 33.

Brocading with small shuttles

Should the practised weaver be used to work with the face of the material downwards and prefers to continue to do so, the brocading with small shuttles will be rather easier to do, as the brocading is done by passing the shuttles one after the other forward or backward in the tiny spaces of the brocading shed like a little fleet of boats, as they rest in a line near the edge of the woven portion of the web, whilst the running shuttles are driven swiftly from side to side. In this case, the design would have to be read for the cords of the simple: " Pass the ground and take the figure." By weaving face downwards, however, the difficulty of all the operations is very much increased, and the pleasure of the work is greatly diminished.

PART IV
SPECIFICATION

Chapter XX

SPECIFICATION NO. I FOR A FULL-SIZED SINGLE-THREAD NEW DRAW-LOOM FOR FINE LINEN DAMASK WEAVING

Simplicity of the draw-loom harness

IT will have been realized by the reader who has carefully studied the previous chapters of this work, that the general principles on which the draw-loom harness is constructed, complicated as they may at first sight appear to be, are actually extremely simple and unsophisticated; insomuch that the whole mechanism, when well constructed, furnishes the handicrafter with a perfectly sympathetic and adaptable tool for the production of more or less elaborate ornamental webs. The student will also probably have gathered that, within certain definite limitations, the diversity of plans and arrangements for variations of repeating patterns possible to the skilful designer are practically inexhaustible.

An adaptable tool

Draw-loom harness compared with that of the Jacquard

To weavers and designers well acquainted with the details of Jacquard machine weaving, whether by hand or by steam power, the plans and specifications for the full-sized draw-looms already constructed by the author and now in use, will not be unfamiliar, for the simple reason that, except for the Jacquard machine itself, the harnesses and fittings of *all modern looms for pattern weaving* are built on the same plans as they were many centuries before Jacquard's invention came into use, or steam power was adopted to actuate the loom instead of the foot-power of

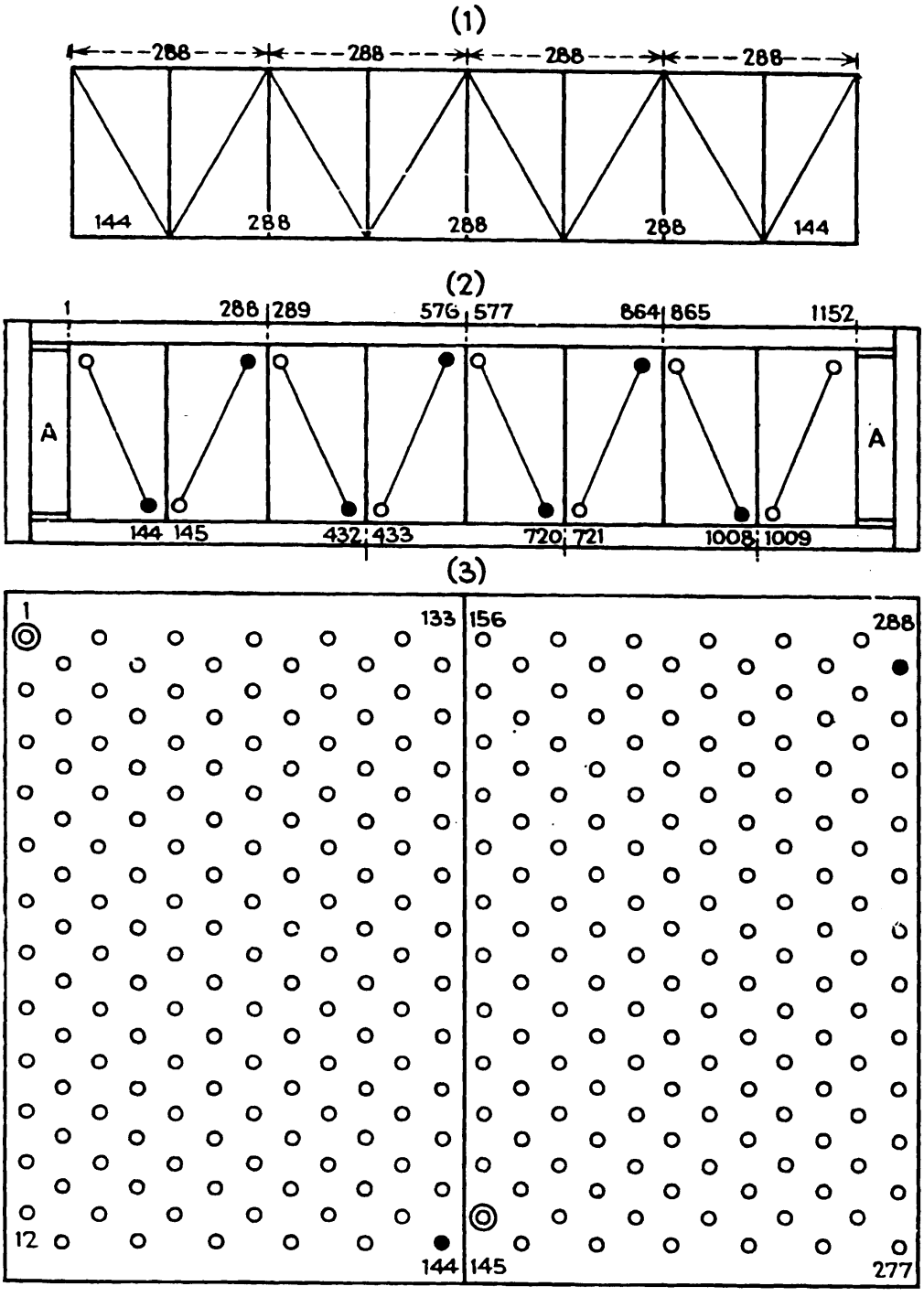


PLATE XXXIV

COMBER BOARD FOR FULL-SIZED NEW DRAW-LOOM, SPECIFICATION No. I

the weaver. This was fully explained at length in the author's first book, and only needs to be briefly mentioned here in order to point out that any combination of harnesses or repeating forms of design suitable for Jacquard weaving are appropriate and possible for use in the new draw-loom.

The first full-sized new draw-loom described

The first full-sized pattern loom to be described, although not the first to be built, is chosen here because of its great similarity to the typical loom which was the subject of Part I of this book.

The loom was made for weaving fine webs of linen 48 threads to 1 in., the reed space being 24 in. There were, therefore, 1,152 threads to be accounted for in the comber board on which the repeats had to be arranged. The pattern in this case, however, was to be a point repeating one, four complete repeats in 24 in.

The comber board frame

The comber board frame having to accommodate a set of comber slips, the combined width of which must equal that of the warp, must be about 3 in. wider at each end than the set of slips, in order to allow the necessary spaces required for the pulley cords which connect the treadles with the shafts of the harness to work freely (see Plate IV, Fig. 3). The comber frame has to measure outside from end to end, 30 in. This will at once determine the exact width of the frame of the loom itself, as the comber board has to rest upon the bars *D*,*D*, fixed between the upright side frames of the loom (see Plate II, Fig. 1).

The design of the comber board

The details and setting out of the comber board are given in Plate XXXII, Figs. 1, 2, and 3. Figs. 1 and 2 are diagrams of the repeats in the comber board, showing the

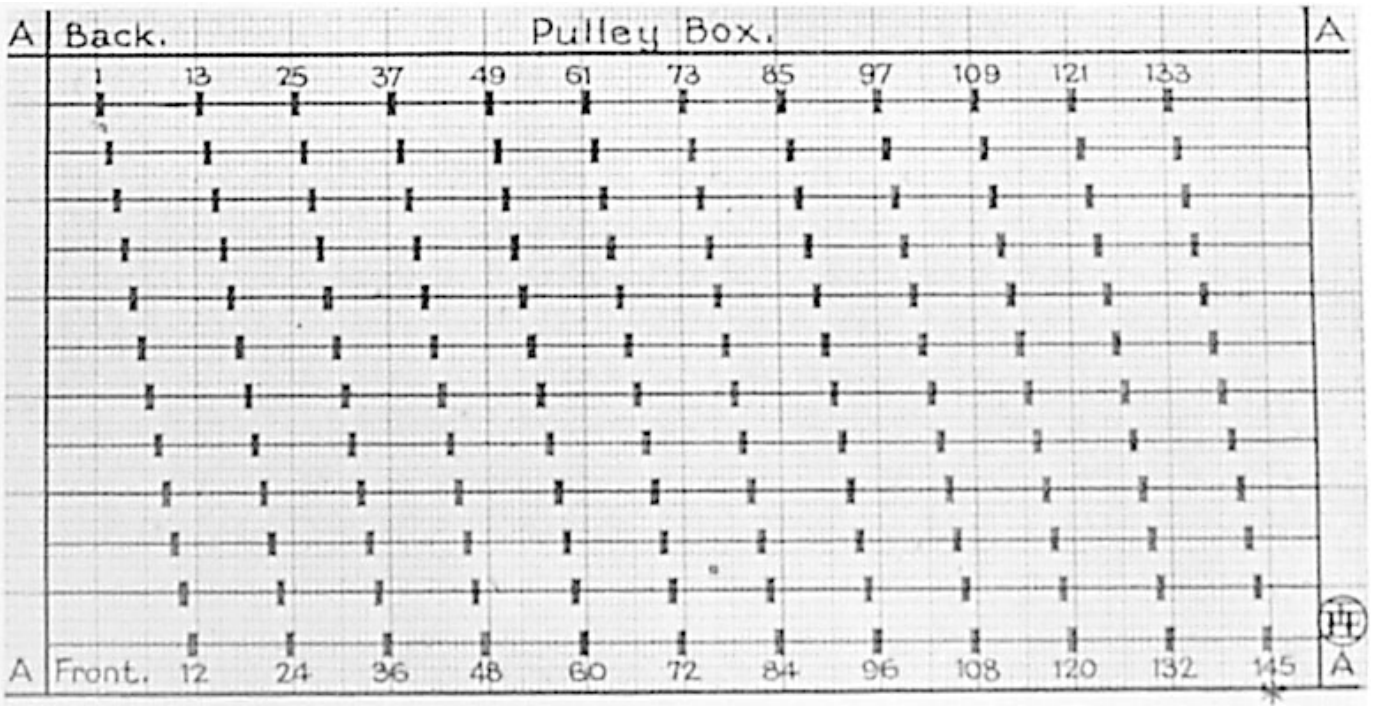


PLATE XXXVA

PULLEY ARRANGEMENT FOR SPECIFICATION No. I

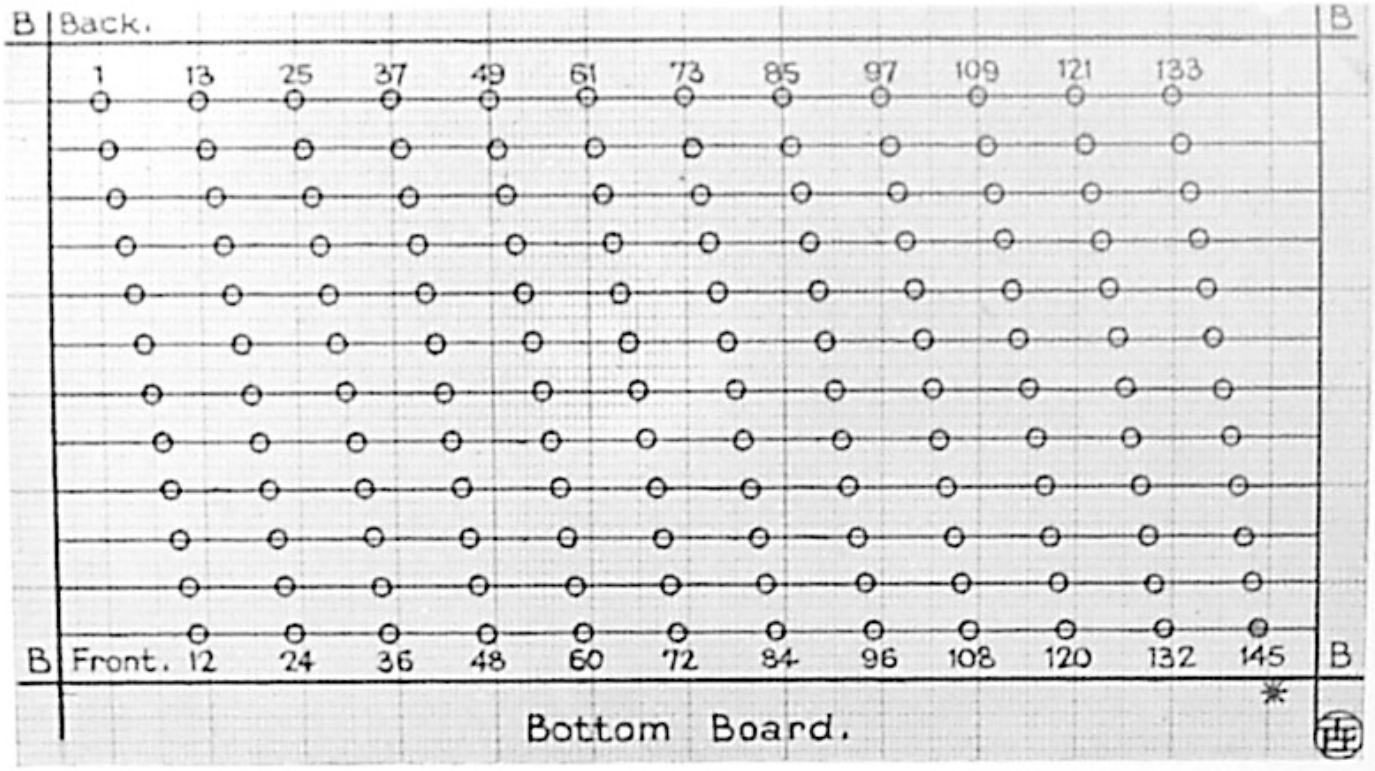


PLATE XXXVB

BOTTOM BOARD OF PULLEY BOX FOR FULL-SIZED NEW DRAW-LOOM, SPECIFICATION No. I

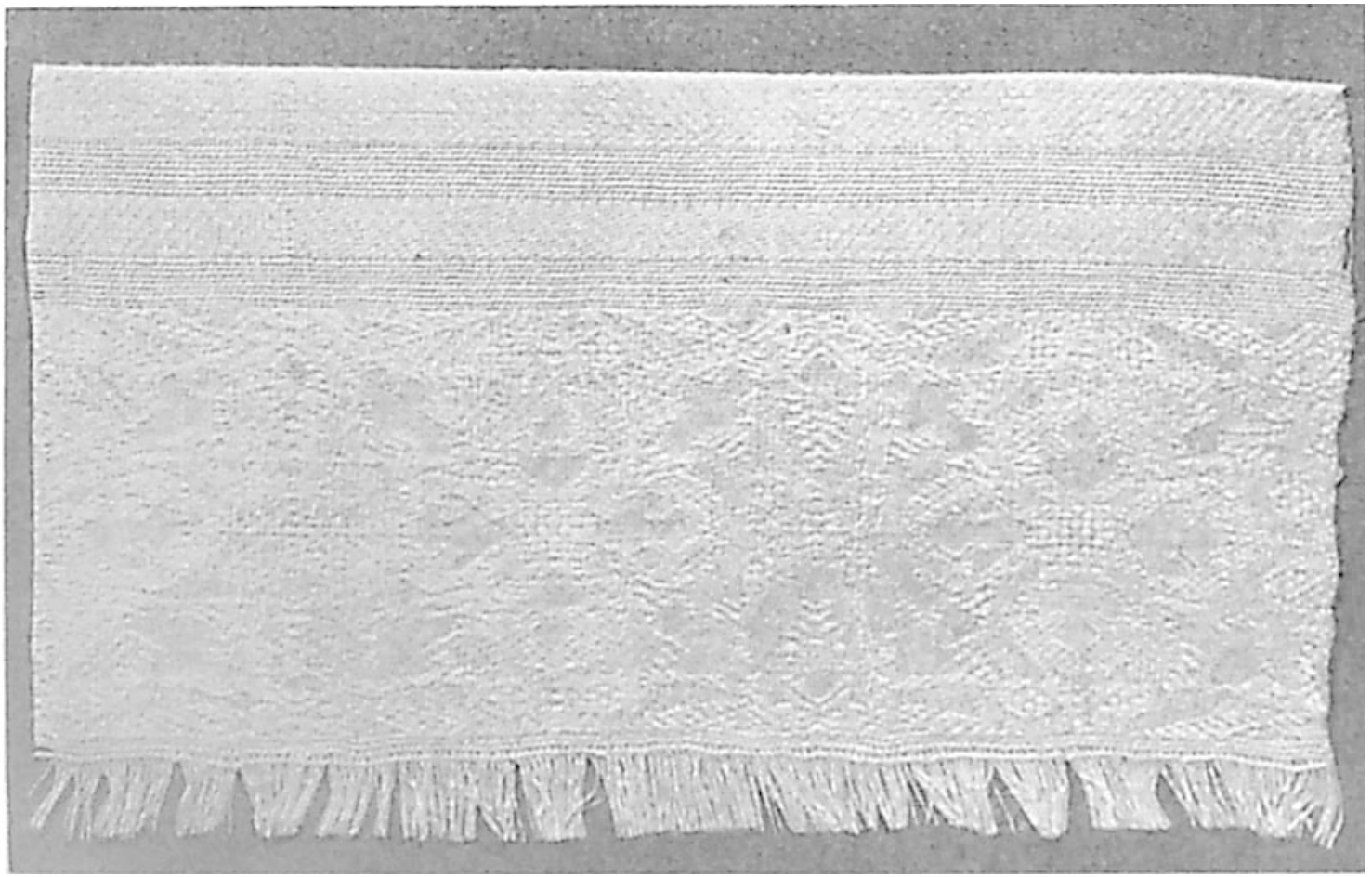


PLATE XXXVI

LINEN DAMASK WOVEN ON FULL-SIZED NEW DRAW-LOOM, SPECIFICATION NO. I

arrangement of the holes for every thread of warp; beginning with No. 1 hole at the first point at the back, and finishing with hole No. 1,152 at the last point, also at the back, whilst all the other points have two threads side by side, the same as in the diagram of the comber board, Fig. 2, Plate IV. This is generally a disadvantage to the pattern, when the material is woven, because the unit of design at each point, except the first and last, consists of two threads instead of one, as in all the other units. This difficulty is obviated by leaving an empty hole and missing thread 144 at the end of each half repeat, and beginning the next half repeat at the beginning of the next row, thread 145. Fig. 3, Plate XXXIV, will help to explain this somewhat difficult point. In this illustration, which represents the end of the comber board under consideration, each comber slip is pierced with 144 holes, No. 1 hole being at the back and hole 144 at the front. Hole No. 1 is filled in in black, which indicates that it is to be left empty, and the thread which would have been No. 144 becomes 145, the first thread of the second half of the whole repeat.

Entering arrangements

By the above arrangement seven threads of the warp of 1,152 would remain over when the entering was complete, and as there is no way of unwinding surplus thread before the warp is woven out, the best plan to avoid that inconvenience is to lay the warp 1,145 threads instead of 1,152.

As pointed out in Chapter III, the order of entering the warp for a point repeating design is changed at each point; accordingly, No. 1 thread at the back left-hand side

of the comber board is entered first and is followed forward to the front to No. 12; the next begins again at the back, Nos. 13 to 24 at the front, and so on until hole No. 143 towards the front next to the empty hole at the end of the half repeat from which thread No. 144 is missed. The entering for the second half repeat begins with thread No. 145 and proceeds from front to back, row after row, until the empty hole, No. 288, at the end of the whole repeat is reached, and the second repeat begins with thread 289 at the back. Thus, the entering of the warp changes at every point until the last repeat of all is reached, where the last thread of the warp is entered, to be coupled with the first threads of all the other full repeats, as shown in the diagram, Fig. 2, Plate XXXIV, where the order of entering the whole warp is shown by the zigzag line and numerals.

Point repeat entering

The bottom of the pulley box

As the comber board is perforated for a pattern harness of 12 shafts, and as every thread of the warp is to have its separate cord on the simple, it is necessary to pierce the bottom board of the pulley box with 12 rows of holes for the necking cords which connect every single thread of warp to each separate pulley cord. It was found necessary also to have 12 rows of 12 pulleys each in the pulley box, so that all the parts of the monture, the healds with their couplings, the comber board with its 4 point repeats, the pulley box with its pulleys and cords, and the simple with its 144 cords, should all be in exact agreement. This can all be traced out clearly on the diagrams, Figs. 1, 2, and 3, Plate XXXIV, and the diagrams *AA* and *BB* of

Plates XXXVA and XXXVB, which clearly illustrate the pulley box arrangement. *Arranging the pulleys in their box*

The healds and couplings, in the eyes of which are entered the 1,152 threads of fine linen warp, hung by means of their bannister knots on 12 shafts immediately under the rows of holes in the comber board. This not only keeps the eyes of the couplings at a perfect level, but allows of them being worked by treadles, with which they connected separately from the pattern harness above, so that plain tabby or twills of various kinds can be woven alternately with spaces of point repeating designs. Plate XXXVB shows the capacity of this fine loom in this respect.

Chapter XXI

SPECIFICATION NO. II

Description by the owner of the loom

A VERY useful draw-loom as well as one on which a great variety of beautiful silken fabrics could be woven, as shown by the reproductions in colour on Plates XXXVII and XXXVIII, was designed by the author for one of his most efficient pupils, and will, no doubt, be studied with interest, especially as the weaver for whom it was designed has written an excellent description of its construction and mounting; a great proportion of the work was done by herself and was described by her in a journal which she kept of her textile studies, called *Weaving Notes*, during the years 1925–29. The author has her permission to quote from the journal as follows—

Height of draw-loom

Width

Portability

The height of the loom is about 7 ft. 6 in. The ceiling should be not less than 1 ft. higher. Width, 27 in., not counting the batten, which can be taken off without moving the reed. This goes through an average doorway. Length, 4 ft. 3 in. This could not be much more without making it impossible to move the loom intact. Weight: can be moved by two people.

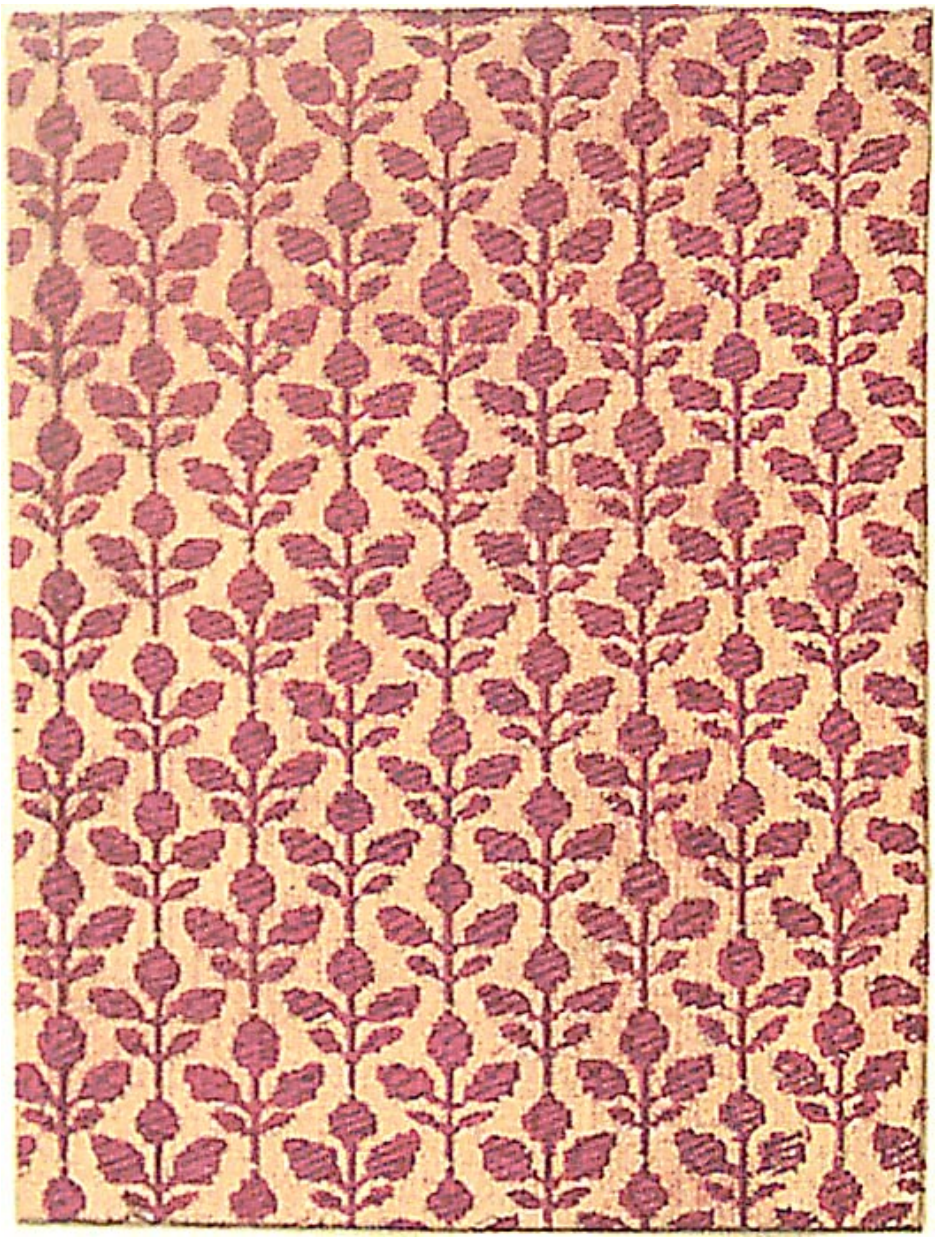
The wood

The loom was made of unstained oak varying from $\frac{3}{4}$ to $1\frac{1}{2}$ in. in thickness. Designed as a table-loom, the whole upper framework lifting off the table without disturbing anything except the treadle cords, which have to be disconnected. It was made immovable for weaving by holes in the upper framework fitting like cups on to pegs projecting from the top of the table. If the upper framework is too unwieldy for awkward stairs, the pulley box, comber board, and the rest of the monture may be detached with the warp upon them, and packed with the front

Detaching loom from table

Made fast to table

PLATE XXXVII.



A.H.

Silk Tissue woven on her Draw-loom.
Specification 2 by Alice Hindson.

Silk Brocades woven on her Draw-loom by Alice Hindson.

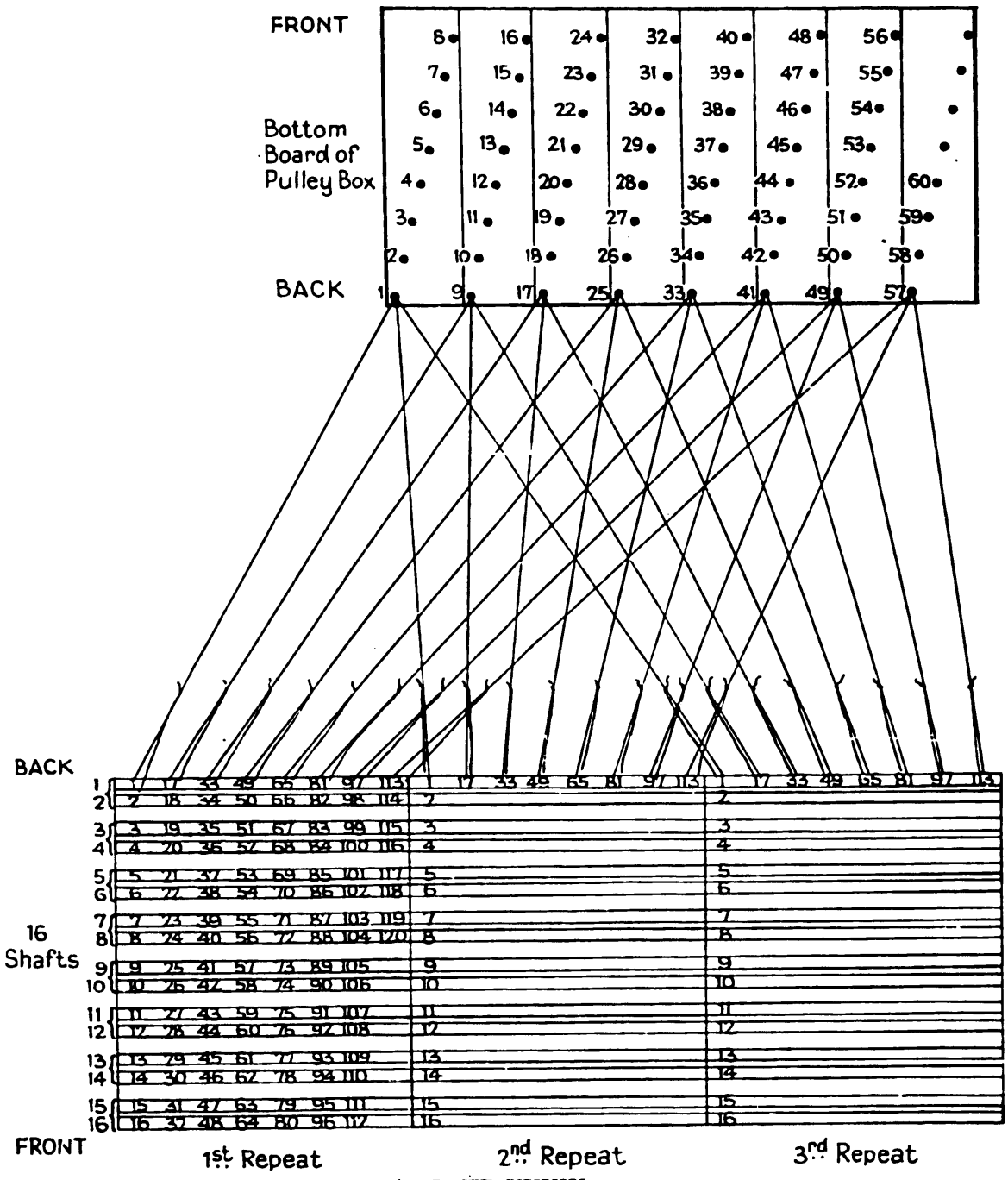


PLATE XXXIX

NECKING CORDS BETWEEN PULLEY BOX AND SHAFTS IN FULL-SIZED LOOM, SPECIFICATION No. II

How to be packed for moving

and back rollers in a box, still without disturbing the entering. If necessary, the framework supporting the pulley box and batten can be detached by undoing a few screws.

Capacity of loom

1. To weave stuff 22 in. wide with $\frac{1}{4}$ in. extra for selvages.
2. Warp 60 threads to 1 in.
3. Repeats *comber* each 2 in. in width, therefore containing 120 threads.
4. Reed 30 dents to the inch.
5. Sixteen shafts, making a ground of tabby, twill or satin.
6. Four binder shafts.
7. Two selvage shafts.
8. Swinging batten.

Tension of warps

Tension of warps—

1. Ground and pattern warp. Front roller controlled by ratchet on right side of loom. Back roller by lever and string tied to framework at front on left side.

2. Binder warp. Front roller same as above. Back roller by cord and weighted lever.

3. Selvage warps. Each selvage bobbin has a weight and counter weight so related to the tension of the warp and to each other, that they remain as nearly as possible in the same position, balancing in air.

The shedding motion

Shedding motion, rising—

1. The ground raised by depressing the treadles which are connected with the shafts by cords going over wooden pulleys. Pulleys instead of top-castle levers and marches economize space and simplify the tie-up.

The pattern shed

2. The pattern shed made by the simple cords being slipped over the harp rod, and the harp rod being drawn forward by the headles until the catches fall into position and hold the shed open.

The binders

3. The binders raised at the same time as the pattern, as the cords controlling the binder shafts lie parallel to the simple cords.

4. The selvages raised automatically with the ground and also with the binders. They have only one entering but a double tie-up; one to the ground treadle cords, and one to the binder shaft cords.

The binder shafts and healds

Binder harness on four headle shafts for binder warp 30 threads to the inch, making tabby, twill or broken twill. When the binder is weaving tabby the tissue threads float across four of the ground threads before it is bound down. When the binder is weaving twill the tissue thread floats across eight of the ground threads before it is bound down.

The floating of the binder threads

The cords which raise the headle shafts go over four pulleys on either side of the loom, then join together through four guide eyes, which direct them over pulleys at the back right-hand side of the pulley box, then over four pulleys at the right side of the pulley box at the front and down on the right side of the harp, to be secured to the bottom rod like the simple cords. If the pattern is tied up from left to right, the ties of the binder for it could be varied with very little trouble.

Building the monture

The diagram of the monture by Alice Hindson will show the design of it quite clearly, and will be perfectly understood by the reader who has studied the examples given in earlier chapters, and so her own description need not be quoted, but the description of her building is too interesting to omit.

Time spent on building monture

Spent eighteen days building the monture. The time was spent as follows—

1st day: Counting and slinging lingoes on shafts.

2nd day: Entering each lingo through one hole in the comber board and threading it on to string (or a rod) to keep it in place.

3rd day: Ditto.

4th day: Temporarily tying up shafts and cutting necking cords, 330 pieces, as the 660 threads are lifted in couples.

5th day: Readjusting everything. Exact position of comber board decided, and comber board screwed in place (up till now it had been tied firmly in position with string); discussing method of attachment of lingoes to necking and necking to simples.

6th day: Finished 1st row and did half 2nd row. Six pieces of necking are taken and snitched through a loop altogether exactly half-way: as that gives twelve ends and there are only eleven repeats, one end has to be cut off, and its fellow tied as securely as possible by a snitch. The simple cord is then threaded through No. 1 hole in the bottom board of the pulley box and secured temporarily at the back of the loom. This leaves eleven ends of necking dangling from hole No. 1. Each end is taken in turn (taking care that there is no crossing) and roughly measured to turn back on itself and make a loop about 1½ in. off the comber board above the couple of lingoes which are nipped through the snitch made by this loop.

Therefore, as explained before—

All 1st and 2nd threads of each comber repeat go up through hole No. 1 of the bottom board of the pulley box and are all snitched together to simple No. 1, and threads 17 and 18 of each comber repeat go in hole No. 9, and threads 33 and 34 into hole 17, and so on. A couple of thin but strong steel rods are threaded through the eyes of the lingoes hanging from the two shafts which are being dealt with at the same time, and secured as accurately as possible on either side of the loom after being trued with a spirit level. (I only tied my rods down to the bottom framework of the loom with cord, which meant that it was almost impossible to get the tension equal. Also, I only regulated the level of the sixteen shafts by tying them down to the framework. This was not altogether satisfactory, and later we contrived to have them resting on a shaft of wood

bound to either side of the loom, so that they were all of the same level and immovable—which was what was needed.)

7th day: Finished second row.

Discussed binder: decided on eight headle binder 60 to the inch instead of 4, with a sparser count of warp as previously planned. With eight headles and a rich count like this, the binder warp could also be woven in alternate rows with the pattern warp to make sarcenet of 120 to the inch. Question, whether this very rich binder warp might not be wasteful of silk, and the weaving more trouble than it was worth.

8th day: 3rd and 4th rows.

9th day: 5th and 6th rows. Decided against the eight headle binder and in favour of original four headle.

10th day: 7th and 8th rows.

Finishing the monture

The rest of the eighteen days were spent by the builder in altering and adjusting the various parts, tying up shafts, threading simple cords, hanging binder headles, and the thousand and one things about the complicated mechanism of a silk-weaving draw-loom which have to be attended to, and to making and entering warps for the pattern and binder.

The design of the comber board

The setting out of the comber board and the bottom board of the pulley box, as well as the pulleys in the box above it and the number of cords in the simple, will all be gathered from the diagram of Plate XXXIX. The board is pierced for 11 repeats of pattern, three of which are shown in the diagram, connected by lines which represent the necking cords, to the holes in the bottom board of the box. It will be noticed that eight holes in rows 9 to 16 remain empty at the end of each repeat. This, however, does not affect the continuity of the warp entering, as

thread No. 121, the first in the second repeat, will be found on the first shaft and be entered in the reed by the side of thread No. 120, which is the last of the first repeat.

Examples of weaving on the loom

The two specimens of silken fabrics reproduced in Plates XXXVII and XXXVIII will show the fine artistic quality of the work produced on this draw-loom.

Chapter XXII

SPECIFICATION NO. III

THE Specification No. III was made for the building of the draw-loom represented in the frontispiece of this book. The plate is reproduced from a drawing made by Alice Hindson. This loom has some special features which render it different from any of the new draw-looms previously constructed from the author's designs.

Requirements of the customer's order for the loom

One of the essential requirements in the order given for the loom was that provision should be made for the material woven on it to have a cross-border at the beginning which could be repeated at certain intervals in the web, and that borders to match it, about 1½ in. wide, should be arranged for, so as to be continued up the sides of the *all-over* repeating comber design of the fabric between them. The borders were also required to be the complementary halves of a point repeating design, while the centre comber design was to be in four repeats. The pattern warp was to raise two threads to form the design in large. The whole pattern warp of silk was to be 48 threads to the inch, and was to be 24 in. wide. It would, therefore, consist of 1,152 threads in all. This, of course, decided the width of the comber board and the number of holes with which it had to be pierced. The sketch for the comber board, pierced with its 1,152 holes, is shown at Fig. 1 at the bottom of Plate XL.

The count of the silk warp to be used

The diagram of the comber board

The frame of the board is 30 in. long from end to end,

and rests as usual on the cross-pieces *DD* of the upright side frames of the loom.

The comber slips

The set of comber slips occupy 24 in. of the frame, and are pierced with 12 rows of holes, counting from the back to the front, each complete row containing 96 holes. The total number of holes in the board is, therefore, 1,152, in accordance with the requirements of the warp, and on this number the rather complicated plan of the monture had to be worked out.

Dividing the comber board into portions for borders and filling

In portioning out the holes, the first consideration had to be given to the side borders, which were each to be 1½ in. in width. The count of the warp being 48 threads to the inch, it of course required 72 holes, occupying six rows of 12 holes each, at the right- and left-hand ends of the board to accommodate the 144 threads of both the borders. This disposal of 144 holes left 1,008 holes to be divided off into four comber repeats.

The space for the four comber repeats

The number, 1,008, divided by 4 affords 252 holes for each repeat which fills out, including the holes for the borders, the whole space of the comber board, as shown at Fig. 1, Plate XL. These several points in the setting of the comber board are all indicated by the numerals at the beginning and end of the short lines which represent the rows of holes from the back to the front of the comber board.

Entering of the two borders

It will have been noticed, if the numbering of the holes has been closely observed, that at the back of the board beginning with No. 1 hole at the left, all the numerals are odd numbers, except those of the last six holes at the end,

which are all even ones; this is not a mistake, for it is necessary because the requirement regarding the borders was that their repeat should be a *point* one which requires, as before explained, the entering of the warp to change at every *point* in order to reverse the second half of the design.

When, therefore, the fourth repeat of the comber design ends at the 1,080th thread, the 1,081st thread, an odd number, is entered next to it at the front, and the rest of the entering proceeds from front to back line by line, and finishes on the 1,152nd thread at the back.

The pulley box, its holes and pulleys

The bottom board of the pulley box is drawn at the top of Plate XL, Fig. 2. It will be seen that it has only half the number of holes for the left-hand border and one repeat of the centre design when compared with the comber board; 36 holes are allotted for the border and 126 holes for the centre comber design, as the warp threads had to be arranged to rise in twos to form one unit of the design in large.

It must be added that the number of pulleys in the box is 162, and that they are arranged on six steel rods to agree with the perforations of the bottom board of the box.

Necking cords for borders

The arrangement made for drawing up the necking cords of both borders at the same time as the cords of the centre repeating design has next to be described. It is shown in the same diagram, Plate XL, between Figs. 1 and 2, where the diagonal lines diverging from one row of holes in the bottom board of the pulley box are

Distribution of necking cords

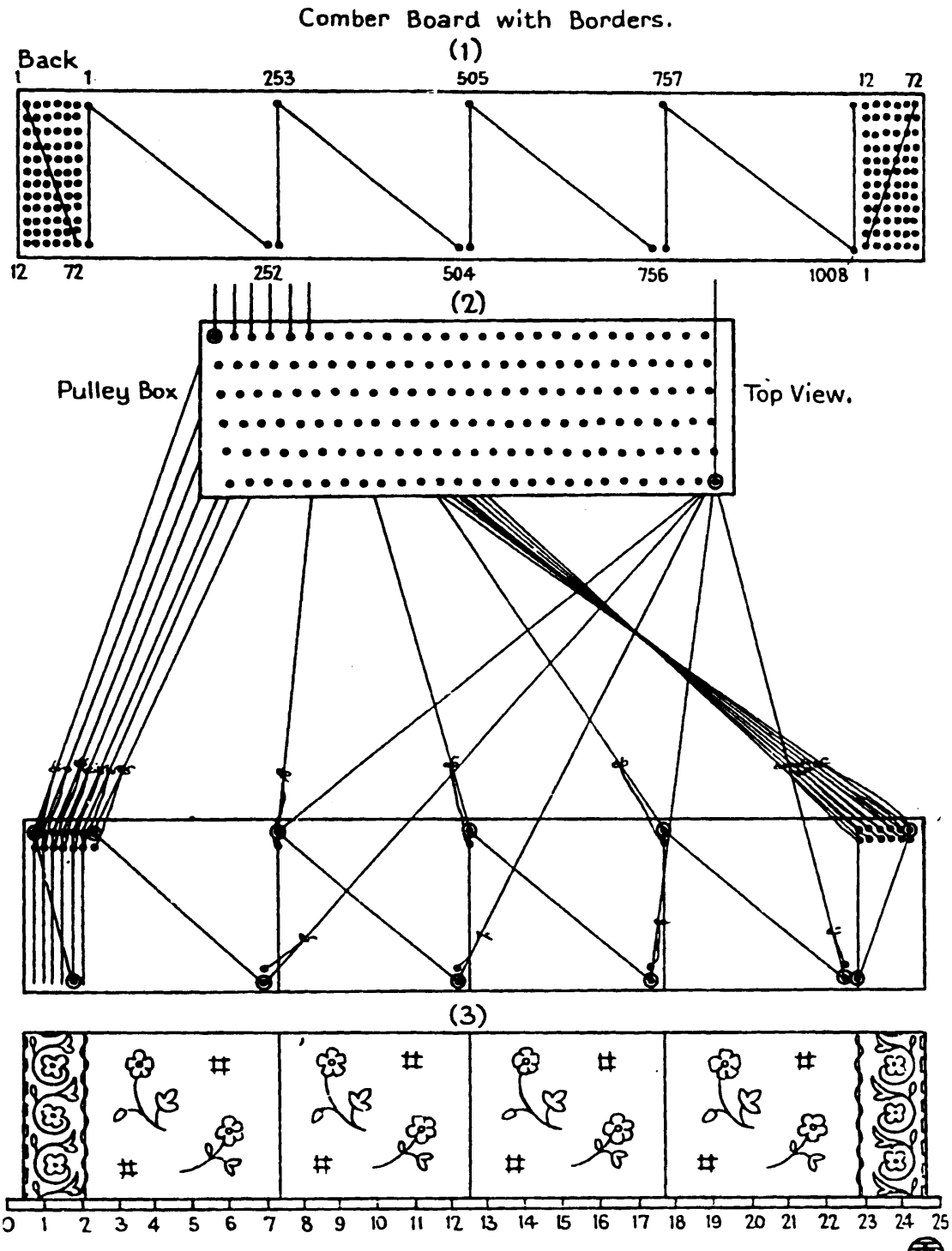


PLATE XL

FULL-SIZED NEW DRAW-LOOM, SPECIFICATION No. III, SHOWING ARRANGEMENT FOR WEAVING SIDE BORDERS

distributed between the two corresponding back rows of holes in the comber board as before explained.

It will also be noticed as regards the borders that No. 1 hole in the bottom board of the pulley box is not only coupled with holes Nos. 1 and 2 at the left-hand end of the comber board, but that by means of the second necking cord, which is joined to the first cord of the pulley box, the 1st and the 152nd hole, as well as the 1st and the 151st, on the right side of the comber board, will be actuated by the same pulley box cord No. 1.

Control of both borders from one side

It will be readily understood that if the necking cords going into the holes 3 and 4, 5 and 6, 7 and 8, 9 and 10, and 11 and 12 of the comber board are thus coupled to the several cords of the first row of six holes in the bottom board, and the necking cords of the last corresponding row of holes in the comber board, Nos. 1,152 and 1,151, 1,150 and 1,149, 1,148 and 1,147, 1,146 and 1,145, 1,144 and 1,143, 1,142 and 1,141, are all coupled to the first row of six holes in the bottom board of the pulley box, and the six rows of necking and pulley cords of the two boarders are all coupled together, the couplings of both being actuated exactly in the same way except for their being reversed.

The central portion of the monture, consisting of four comber repeats of 126 pattern units, or 252 single threads occupying that number of holes in the comber board, will be readily understood from the diagram, as will also the filling up of the whole board in the order already described; but the important matter of connecting the shafts of

the pattern harness, as well as fitting up and connecting those of the binder harness to the treadles, must be carefully and clearly explained.

The best arrangement for the treadles is for the odd numbered treadles of the tabby and binder to be placed on the right side of the pattern treadle, and for the even numbered ones to be on the left.

The tying up is as follows: The pattern shafts Nos. 1, 3, 5, 7, 9, and 11 are connected by their cords and pulleys to treadle No. 1 on the right of the central pattern treadle; while shafts Nos. 2, 4, 6, 8, 10, and 12 are tied to treadle No. 2 on the left of it. The binder harness, carrying a warp of single threads 48 to 1 in. on four shafts, is tied thus: Shaft No. 1 to treadle No. 1 at the extreme right, shaft No. 2 to treadle No. 2 at the extreme left, shaft No. 3 next to the ground treadle No. 1 on the right, and shaft No. 4 next to treadle No. 2 of the ground harness on the left.

There are, of course, many other ways of tying up the shafts of both the pattern and the binder harnesses to the treadles in order to produce other effects of ground or binders, but they must be left for the weaver to adapt to his own requirements as he becomes more and more familiar with the capacity of his loom.

Chapter XXIII

SILK DAMASK PATTERN WEAVING

The design in silk damasks

IN figured damask material, unless the pattern is so small as to be woven on a thread monture, the design is produced on a warp of fine strong pure linen or silk, crossed by weft of a similar material, carried by a single shuttle. Damask is the most perfect of all pattern weaving, because the design is woven in the very texture of the web simultaneously with the satin ground itself, no extra binders being required. For a full description of satin damask weaving, its technique and effect, the reader should consult *Hand-loom Weaving*, pages 210 to 217; also the same work should be referred to for an explanation of satin weaving, pages 179 to 185. It must, however, be explained here, that a damask web design depends, for its definition, on the possibility that this method of weaving affords for producing definite, separate spaces of warp or weft satin at will on each surface of the web. In *warp satin* the threads of the warp predominate in the proportion of 7 threads of warp to 1 of weft, and in *weft satin* the proportion is reversed, being 7 threads of weft to 1 of warp. Plate XLI, Fig. 1, letters *A* and *B*, represents a portion of the front and back of a figured satin web. At letter *A* the figure, a cross, is formed by flushing threads of *warp* tied down by occasional binders of weft, while the background is woven in flushed loops of *weft* tied down by tiny intersections of warp as at letter *B*.

The technique of damask weaving

Silk damask: effect of pattern

It makes little difference which surface of a silk damask is considered to be the front, as both are equally rich in effect and have the same general appearance and clearness of pattern. It is usual, however, to weave damasks face downwards in the loom and for the background of the design to be in warp satin. The example of Fig. 1, Plate XLI, at letter *B*, is the front of the material, and letter *A* the back.

How large damask designs are arranged for

Damasks of very small designs can be woven on a thread monture, each single thread being a unit of design, but if several threads are raised to form each unit, it is necessary to make use of a double harness, one to form the design in large and the other to weave in the satin ties.

Healds of the binding harness described

The harness by which the binding ties are produced (*the headles of which have very long eyes*) is placed in front of the pattern harness, and plays the most important part in the technique of damask weaving. It is so placed in the loom that the warp, which passes singly through its long eyes, does not rest on the bottom of the eye, but hangs free a little below the middle of it when the harness is not in action. Its action when in use is similar to that required for what is called *a rising and sinking shed.* The eyes of the healds are 2½ in. to 3 in. long, and the headles, 8 in number, are connected by a pulley motion to 8 treadles, according to a particular plan which causes each headle to rise or sink as required; and, moreover, *two separate* headles if *connected* according to the plan, *with any one treadle*, can be caused, *one to rise and the other to*

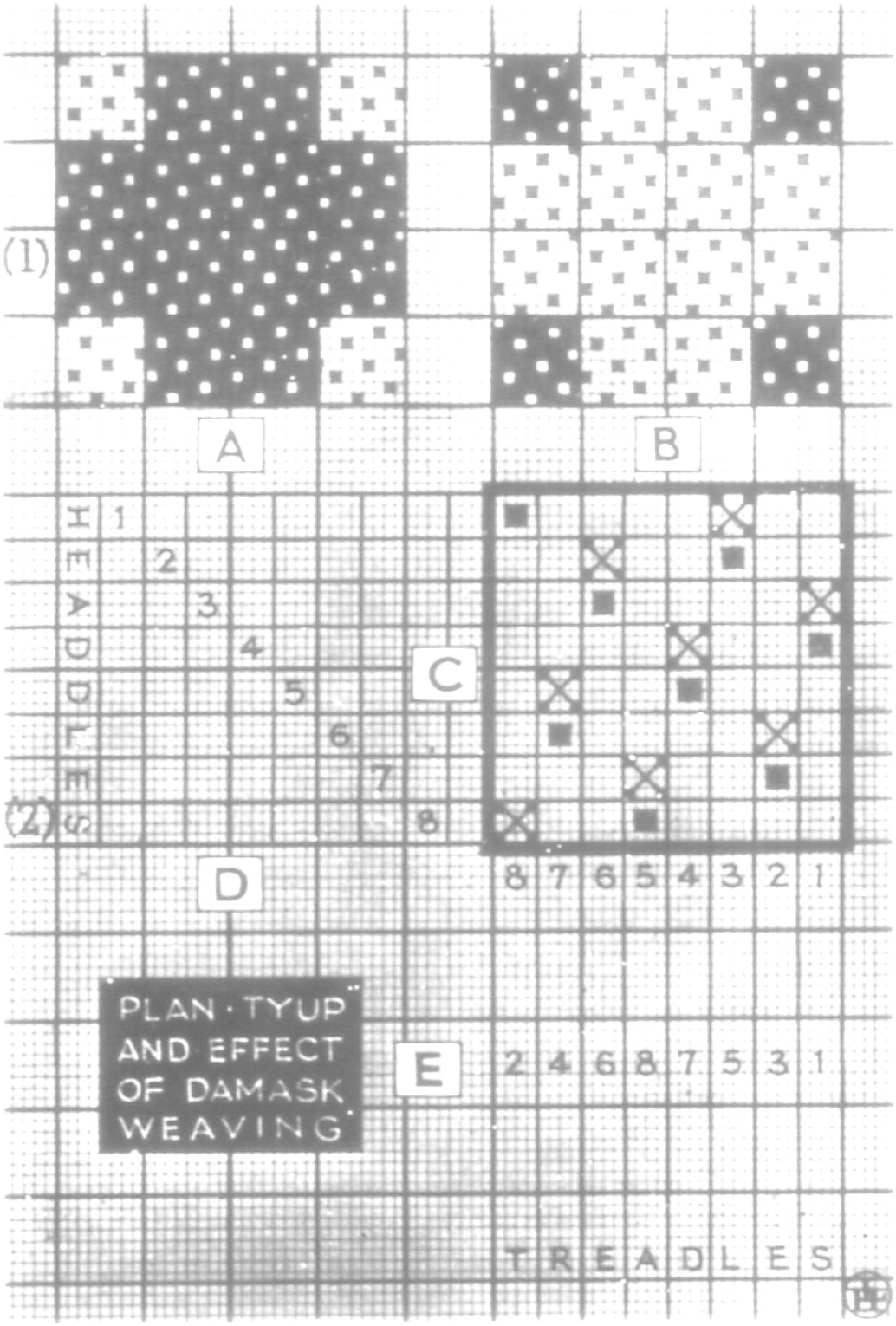


PLATE XLI

EIGHT-LEAF SATIN DAMASK HARNESS, SPECIFICATION NO. IV

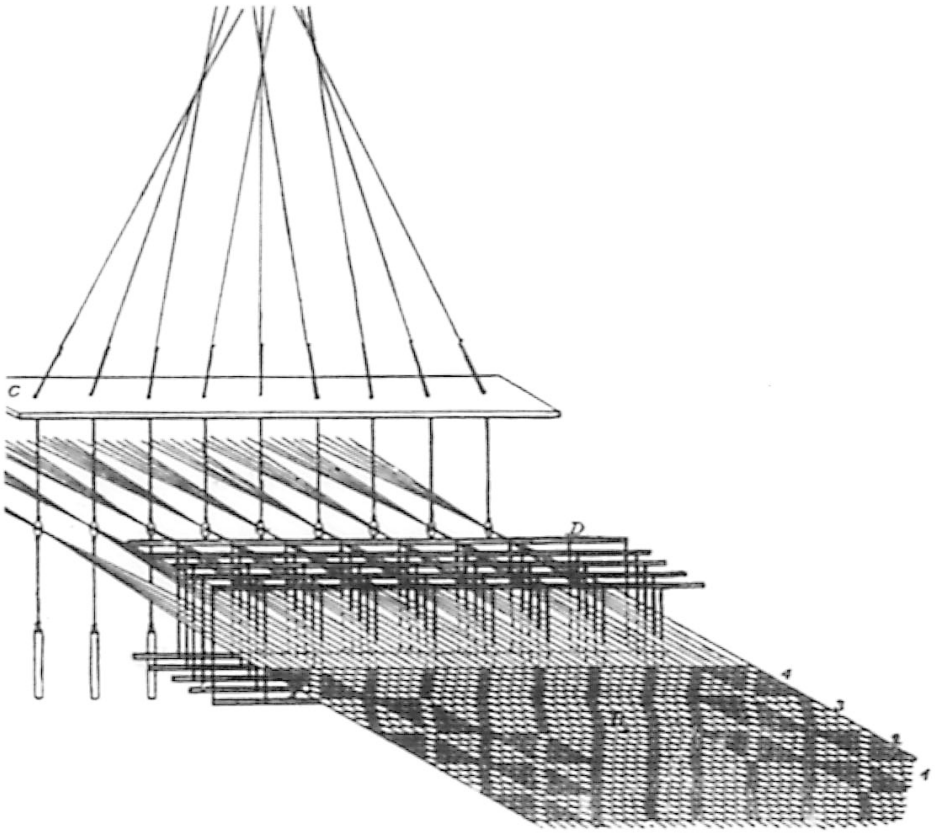


Fig 113

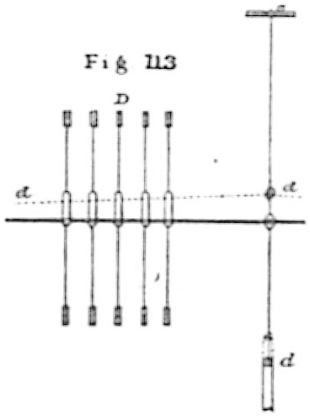


Fig 114.

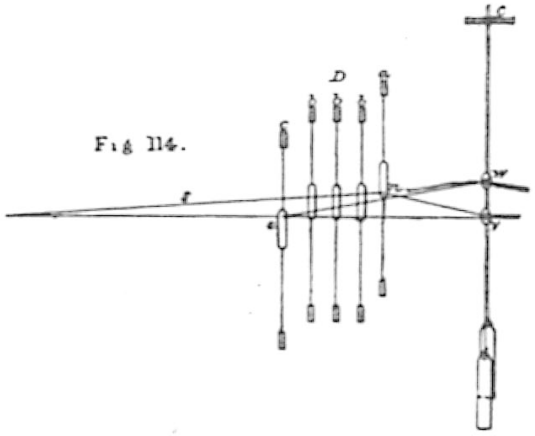


PLATE XLII

Headle Satin Harness and Monture for Damask Weaving

(From an old print)

sink at the same time. Plate XLI, Fig. 2 *D*, gives the plan of entering and the tie up of a harness of 8 headles. The crosses in the entering plan *C* indicate the tie to the treadles for raising a headle, and the squares the tie for holding another headle down. The numerals below the plan show the *order* in which the treadles are to be used, but not necessarily their *positions* or order of treading: these are arranged by the weaver to suit his own convenience. Probably he would arrange them as indicated by the numerals below the line at letter *E*; No. 2 taking the place of No. 8, No. 3 the place of No. 2, No. 4 that of No. 7, and so on, but this re-arrangement would not, of course, alter the *order in which the headles themselves would rise and sink.* The entering of the warp is shown at the left-hand side of the tie-up, letter *D*, and is that of the plain straightforward 8-headle twill.

The plan and tie-up of the headles

We must now turn to a description of the pattern harness, which, although entered with a far richer warp than any of the shaft harnesses already described, is much simpler in construction. Instead of each thread of warp having a coupling and lingo to itself, the couplings of the damask pattern harness are so constructed as to carry several threads each. Instead of having eyes of thread, or mails with one hole, the damask mail is perforated with several holes, in this case 8. One of these mails, therefore, at the centre of the coupling which is weighted with one heavy lingo, will lift 8 threads at a time.

Construction of the pattern harness

Plate XLII is a very beautiful and accurate diagram of the construction and action of a silk damask monture,

which was used by the author of a book on weaving, published a little later in the nineteenth century than Murphy's valuable book, from which we have already quoted. The lettering and numbering of the original drawings are retained in the reproduction, as will be readily understood by the reader.

Diagram of 5-headle satin monture

Figs. 113 and 114 at the lower portion of the page are perspective views of the two harnesses of the monture. No. 113 shows a side view of the harnesses at rest, and 114 shows them in action. Fig. 113 gives the long-eyed healds mounted on 5 shafts only, as the loom is arranged for weaving 5-headle satin: but that detail does not matter as satins may be woven on almost any number of headles up to 16, and the principle illustrated in the diagram is the same in them all. The 5 headles are mounted in front of 2 lingo couplings of a pattern harness, through the eyes of each of which 5 threads of warp pass to the front of the loom, the 5 threads being entered *singly* in *regular succession* through the long eyes of each headle. The 2 couplings, with their mails and lingoes, hang from two adjacent holes in the comber board, letter *C*; it may be No. 1 and No. 2 or any other odd and even numbers, and when the loom is at perfect rest, the diagram (without the dotted lines *d d* and the dots which represent the raised second coupling) might stand for either 1 coupling and 5 healds entered with 5 warp threads, or for the *whole row of couplings and the whole harness of healds with their long eyes.* With, however, a second coupling raised, as shown by the dotted lines, it is clear that the diagram

represents at least 2 couplings and 10 healds of binders. In Fig. 113, 5 threads of warp have been raised and have moved to the top of the long eyes without affecting the headles in the least, or disturbing the 5 threads of coupling No. 1, which still rest at the bottom of the long eyes.

Action of the pattern monture

In Fig. 114, letter *D*, the double action of the damask monture is clearly shown. The mail of one coupling marked *W* has been raised, carrying with it 5 threads, but one of its threads has been held down by the headle *C*, at letter *e*, which has been *tied to the same treadle that has raised headle a*. The mail of the other coupling with its 5 threads has been held down by the weight of its lingo, but one of its threads has been raised by the first headle, letter *a*, as shown by the single thread *S V*, which rests at letter *n*, on the lower knot of the long eye of the headle *a*. It will be seen that the headles *b b b*, which remain stationary, have no effect on the shed formed at *S*.

It must be remembered that in Fig. 114 the headles *a b b b c* represent two sets of 5 threads, and that the holding down of a thread at *e* takes place in one set of 5 threads raised by the mail *W*, and the lifted thread at *n* is from the set of 5 threads held down by the mail at *V*.

Before leaving the two diagrams of Figs. 113 and 114, it is perhaps necessary to call attention to the reason why only two shafts with leashes and mails are indicated in the pattern harness. The reason is that two couplings and mails are all that are necessary for the purpose of clear explanation, seeing that all the mails of a damask pattern

harness are alike, and that however many there are in the full harness, they only take two positions, viz. one portion of them is lifted to form the warp of the ground satin, and all the others are left down to allow the making of weft satin and form the design: also that the set of threads, whatever the number entered in each mail, has a complete set of healds to itself.

How the pattern is defined

So far, weaving the design " in large " is provided for by the ground harness. In the spaces of ground, on the face of the stuff, the raised warp will flush over the weft and, being a rich warp, as silk damask warps always are, it will hide the tiny ties of weft entirely. In the design spaces, on the contrary, the weft will cover up all the warp except the single threads raised for ties. The different shapes of the *design* and *ground* will cross threads and interlace *at their edges*, but if nothing else were done there would be no ties or binders either to ground or pattern. It is the office therefore of the important long-eyed headle harness described above to put in these ties, and so knit the whole fabric together, both on front and back faces, into a lustrous satin damask.

Wefting a damask web

In weaving fine silk damask, several shoots of weft are often required to make up the square units of design. While these several shoots are being made *the pattern shed must remain open*, but the front harness must be *changed by the treadles at every shoot*, as shown at letter *C*, Fig. 2, Plate XLI, in order to bind the fabric together into a perfect satin web.

Chapter XXIV

SPECIFICATION NO. IV FOR A SILK DAMASK WEAVING DRAW-LOOM

The silk damask loom different from all others

SPECIFICATION No. IV is for a loom to weave figured damask material of fine organzine silk which is, as will have been gathered from the description of its technique given in the last chapter, perfectly different, both in the method of its weaving and the nature and finished effect of its texture, from any of the webs hitherto described in this book.

Special care required for handling silk

The chief difficulty which has to be overcome by the silk damask weaver consists in handling the extremely fine and delicate thread of the fibre obtained from the cocoon of the silk-producing moth. When prepared for the weaver it is much finer than the finest human hair. The original fibre in its natural state is so minute in section that thirty or more continuous filaments have to be doubled and spun, or *thrown*[1] together, by carefully organized twisting, to form each single thread of the several thousands contained in the warp of the lustrous, sumptuous web.

Silk throwing

The monture for damask weaving is much less complicated than either of the full-sized looms, Nos. 2 or 3, last specified, as it only requires 1 warp. The pattern harness, too, has no shafts or bannister knots, and although

[1] *Throwing* is the name given to the process of doubling and twisting the raw silk fibre into usable yarn.

Simplicity of damask monture

there are a much greater number of threads to the inch in the warp, there are only a comparatively few couplings and lingoes in the comber board, whatever the size of the design.

As described in the last chapter, the chief peculiarities of the damask monture consist (1) in the many-chambered mails of the couplings by which 8 threads of warp are lifted together for each unit of design, and (2) the importance of the binder harness, in the healds of which every minute thread of the rich silk warp is entered separately.

Simplicity of framework

The framework of the loom requires to be as simple and open as possible, and so arranged that the weaver shall have no difficulty in getting to any part of the monture or to the rich and delicate warp as it slowly passes through the loom, from the warp roller at the back, to the cloth beam at the front. This being borne in mind, the simple framework of the old Spitalfields weaver's loom was adopted for this draw-loom, which makes no claim to beauty, but is strong, square, and convenient for the difficult work.

Dimensions of damask loom

The frame of the loom from front to back is 7 ft., and the width between the posts 2 ft. 6 in.; this is sufficiently wide for weaving a 24-in. or even 25-in. material without a fly shuttle.

The height of the frame without the *top-castle* is 6 ft., and the bottom board of the pulley box, which rests on the topcastle, must be at least 2 ft. above the *capes* or top sides of the loom frame, so that the whole structure, including the pulley box, is at least 9 ft. high altogether.

The rollers

The rollers between the posts are 2 ft. 6 in. by 6 in. in diameter. They are reduced to 4 in. at the bearings of the post through which at one end they project about ¼ in., and at the other end about 3 in. These projections are cut square in order to fit the square holes in the movable handles.

The comber board

The comber board is designed for a comber repeating pattern of 5 repeats in 24 in., and has 120 holes for each repeat = 600 holes in all. Plate XLIII, Fig. 1, shows the comber board with its perforations as above, and over it (Fig. 2) the bottom board of the pulley box is also shown as far as its first row of 20 holes. The necking cords from the first hole in the bottom board will be seen diverging from the hole to the 1st, the 2nd, 3rd, 4th and 5th repeats of the comber board. Also the line *A* represents a necking cord connecting the last hole in the repeat No. 120 with the last hole of the 6th row of the pulley box, which is out of sight but, of course, will agree with the comber board, the hole being No. 120.

The necking cords

The baton

The baton, with its block, reed holder and shuttle race, is a swinging one: it hangs from the top of the loom frame, resting on the capes of the loom.

The monture and the warp

The monture is built for a fine organzine silk damask warp of 200 threads to the inch, and in 24 in. numbers 4,800 threads. As before stated, these fine threads have to be raised in sets of 8 by couplings having glass mails with 8 separate divisions, one hole for each thread. See Plate XLIII, Fig. 3.

The mails

The satin harness with long eyes has 4,800 healds

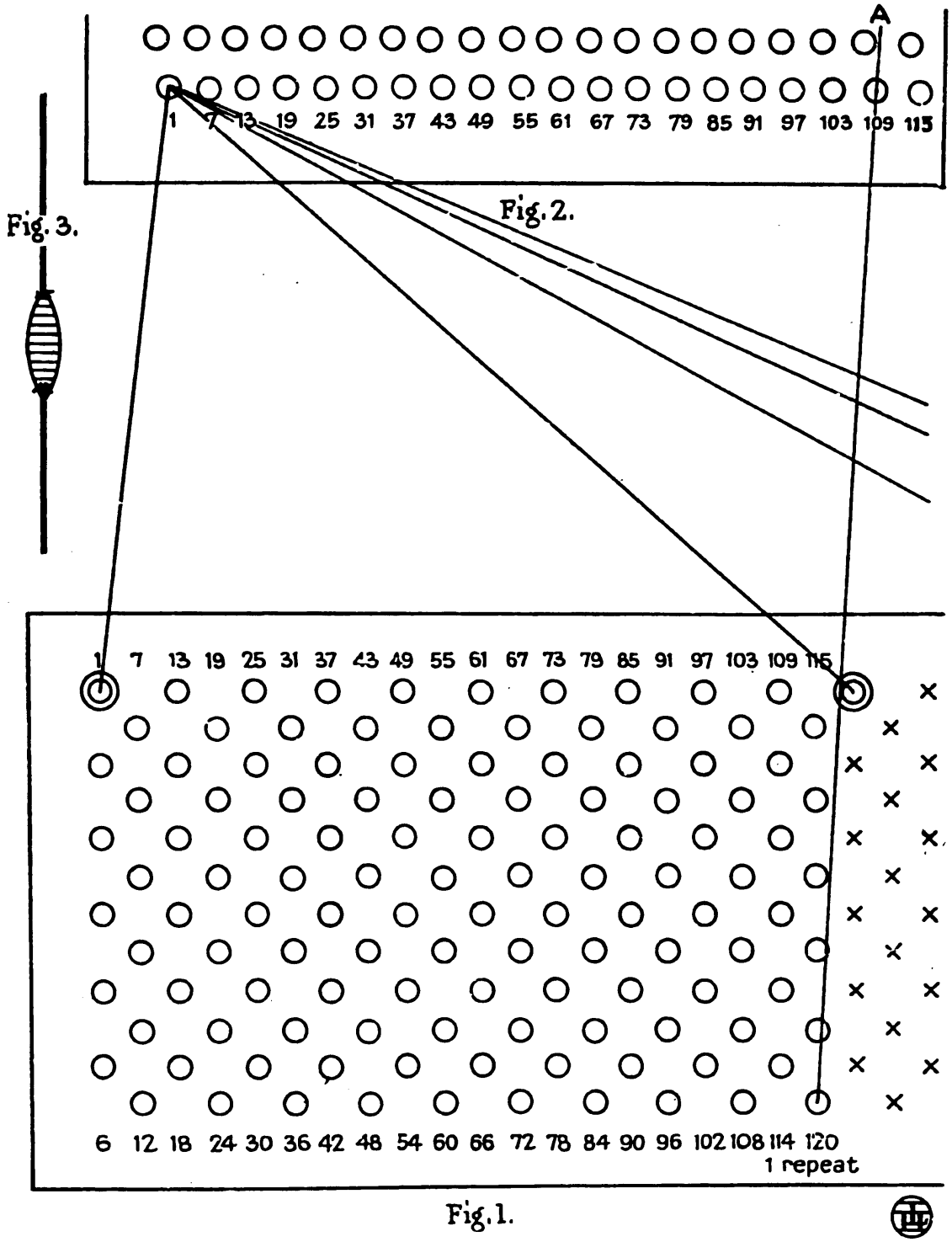


Fig. 1.

PLATE XLIII

COMBER BOARD, NECKING CORD, AND BOTTOM BOARD OF PULLEY BOX FOR DAMASK HARNESS, SPECIFICATION NO. IV

arranged on eight pairs of shafts to accommodate each single thread of warp. *The long-eyed harness*

The simple of the loom consists of 120 cords, the shed-lifting arrangement being precisely the same as that of Specification No. 3. It has a centre treadle for opening the pattern shed, and the treadles for the satin harness, 8 in number, are placed four on each side of it, as shown in the plan and tie-up in Plate XLI, Fig. 2, letter *E*. *The shed-lifter* *The treadles*

Tension must be given to the warp by means of a friction brake or weight-box. It consists of a wooden box about 4 or 6 in. wide, by 8 in. deep, and long enough to hang easily between the sides of the loom frame, below the back roller, to which it is suspended by two thick ropes in the following manner. The ropes must be very thick, not less than ¾ in. in diameter, and be very solid and smooth. They are attached to the box by a knot made at one end of each rope after it has been passed through a hole in the end of the box. The ropes are cut long enough to reach, when the top of the box hangs halfway from the roller to the ground, three turns round the roller and about 6 in. from the ground on the opposite side of the roller from the box. To this long end a thin cord is tied, having a small weight attached to it. When the loom is ready for working, the box is loaded with heavy iron or lead weights, and hangs balanced by the warp and the small weight hanging on the opposite side of the roller quite near the ground. A full description of the working of the friction brake is given in *Hand-loom Weaving*, page 91. *Tension of warp in damask weaving of special importance*

Conclusion

WE have now reached the point when this book must come to an end, although the author feels confident that a still further advance in the development of the draw-loom is possible and can and will be made. If such be the case it must be done without destroying the essential simplicity of the construction and characteristics of the traditional pattern loom, or making less interesting and skilful, though perhaps more speedy and profitable, the work of the hand-loom weaver as an artist and craftsman.

As regards the series of small shaft draw-looms, Nos. I, II and III, as described in Part III of this book, for weaving designs of small dimensions, such as may be woven on any number of shafts up to 30, a contrivance for drawing the cords of the simple in a rather more speedy manner is in course of construction, and it is hoped that the invention will soon be perfected. This will allow of any number of designs being prepared and preserved so as to be easily changed at will; but for larger patterns, for which a comber board with many perforations and a simple of many cords have to be used, such as draw-loom No. IV, in Part III, and the full-sized draw-looms specified in Part IV, the extension of the new appliance can only be hoped for, but will no doubt be eventually devised by another inventor if not by the author.

Glossary[1]

Batten, the frame of a reed.
Beam, a roller.
Beaming, winding on a warp.
Beaming drum, the essential part of beaming machine.
Beaming posts, supports for a beam.
Binder, the tie for floating weft.
Binder harness, headles for lifting binders.
Bobbin, a reel.
Bobbin-carrier, a reel-holder for warping.
Bobbin frame, part of a warping mill.
Box batten, batten with fly-shuttle boxes.
Breast roll, front beam of a loom.
Brocade, a brocaded web; originally silk wefted with gold or silver thread.
Brocading, weaving detached ornaments in a web.
Brocatelle, tissue with satin ties in figure.
Broché, web to imitate brocading.
Cane, a new warp.
Cane roll or *roller*, the back roller of a loom.
Cane sticks, sticks for fastening the warp in the beam.
Carding, preparing fibre for spinning.
Cards or *cardings*, fibres prepared for spinning.
Cloth beam, the breast roller.
Comber-board, a board perforated to hold the leashes of a monture.
Comber repeat, repetition of a design which does not turn over.
Comber slip, a portion of the perforated part of the comber-board.
Compound harness, two or more harnesses working together.
Compound monture, monture with two or more sets of leashes.
Cords, the simple on which the pattern is tied up in a draw-loom.
Counter-march, a short lower lever in a loom.
Couper, the top levers of a loom.
Cross, the crossing threads of a warp.
Cross, porrey, the cross retained while weaving.
Cross, portee, the cross used for spreading the warp for beaming.
Cross sticks, smooth rods for preserving the cross.

[1] This glossary does not pretend to comprise all the technical terms used in weaving. These are of infinite variety, and often have totally different meanings in districts separated but a very short distance one from another.

Damask, a system of weaving said to be introduced from Damascus.
Dent, one space in a reed.
Design, a pattern; one inch square of ruled paper.
Diaper, a system of weaving small patterns.
Distaff, appliance used in spinning.
Doubling, winding two or more threads together.
Draught, drawing on ruled paper.
Drawboy, a boy employed to draw the cords of a simple.
Drawboy's fork, implement for drawing the cords in a draw-loom.
Drawboy machine, machine for drawboy's work.
Entering, threading warp in leashes or reed.
Entering hook, thin hook for entering warp.
Eye, centre loop of a leash.
Fancy web, see *Tissue*.
Figured velvet, cut velvet with pattern.
Figure harness, the monture or pattern headles.
Float, a loop of weft passing over two or more threads.
Fly-shuttle, a shuttle driven by a picking stick.
Friction brake, appliance for regulating weight.
Gatherer, a part of the heck-block.
Gating, adjusting a loom.
Ground, the plain part of a web.
Ground harness, headles which form the ground of a web.
Guiding cords, supports for the pattern loops on the simple.
Half-reef knot, a single knot: see Fig. VII, Plate VI.
Hand-shuttle, a shuttle for throwing by hand.
Hand-stick, a short stick on which warps are wound.
Harness, a collection of headles.
Headle or *heddle*, a number of leashes on a shaft.
Headle frame, a frame for knitting headles upon.
Headle gauge, a tool for making leashes.
Inlaying, see *Brocading*.
Jack-in-the-box, invention which reduces the number of treadles required in a loom.
Jacquard machine, a machine perfected by M. Jacquard to supersede the drawboy in pattern-weaving.
Lam, see *Headle*.
Leaf, see *Headle*.
Lease, see *Cross*.
Leashes, loops of a headle.
Lingo, the weight of a leash.
Long march, the long levers below a loom.

GLOSSARY

Loom, any arrangement for supporting a warp and keeping it in order for weaving.
Mail, the glass or metal eye of a leash.
Monture, the mounting of a loom for pattern-weaving.
Necking cords, cords joining pulley cords and leashes in a monture.
Pecker, part of the drawboy machine.
Pickers, tweezers.
Picking-stick, the handle of the fly-shuttle motion.
Pile, the cut portion of a velvet.
Plan and tie-up, a sketch showing entry of harness and tie-up of treadles.
Plug, a tube on which weft is wound for the fly-shuttle.
Point repeat, a design repeating in opposite directions.
Pole, the pile warp of velvet.
Porrey, the warp between headles and cross-rods.
Portee, a collection of threads warped together for convenience of spreading on beam.
Pulley, a grooved wheel.
Pulley box, the upper part of a draw-loom superseded by the Jacquard machine.
Pulley cords, cords in a pulley box.
Quill, a tube on which weft is wound for a hand-shuttle.
Race, the beading on the race-block of hand-batten.
Race-block, the lower part of the reed frame of a batten.
Race-board, that on which the shuttle runs.
Raddle, implement for evenly spreading warp.
Ratchet and wheel, a toothed wheel and catch.
Reed, a comb-like implement for keeping warps even and beating weft together.
Reed hook, hook for entering reed.
Reef knot, a double knot, see Fig. VII, Plate VI.
Retting, steeping flax in water in preparation for carding.
Reverse satin, a satin with weft predominating.
Rising shed, a shed in which part of the warp rises, the rest being stationary.
Rocking shaft, part of the drawboy machine.
Ruled paper, paper for draughting designs.
Satin, a web with infrequent intersections.
Satinette, a short tied satin.
Selvage, the edge of a web.
Selvage bobbin, reel for mounting separate selvages in a loom.
Shaft, a flat lath for holding headles: see headle.
Shed, the opening in the warp for the shuttle.
Shed-stick, a round or flat stick for keeping the cross.

Shedding motion, a contrivance for opening the warp.
Shoot or *shute*, weft; also throwing the shuttle.
Short march, see *Counter-march.*
Shuttle, a tool for carrying weft.
Shuttle-box, part of a fly-shuttle batten.
Simple, the pattern cords of a draw-loom.
Sinking shed, shed made by drawing threads down.
Skein, a loosely wound length of thread.
Skutching, cleaning retted flax.
Slot, an elongated perforation.
Snitch, a noose secured by a single knot, see *c*, Fig. X, Plate VI.
Spacing, arranging threads or leashes in groups on headles.
Spinning, twisting fibre to make thread.
Spinster, a female spinner.
Tabby or *taffeta*, plain weaving.
Tail cords, the upper cords of a draw-loom.
Take-up, the gradual winding of cloth on to breast roller.
Tapestry, tabby weaving, in mosaic, with loose weft.
Tartan, a web striped in warp and weft.
Temple, implement for keeping out the edges of a web.
Terry velvet, see *Velvet.*
Thread monture, a monture for weaving patterns with single threads of warp.
Tie, a binder on loose weft.
Tie up, connecting parts of a loom together for forming patterns automatically.
Tissue, a web having one or more binder warps.
Tobine, ornaments formed by one or more headles rising and sinking together.
Topcastle, the upper frame of a loom, on which the pulley box or Jacquard machine rests.
Trevette, a knife for cutting velvet pile.
Tumbler, a top iever of a loom.
Turning on, beaming.
Twill, a web with a diagonal tie.
Union damask, damask woven of linen and wool.
Vateau, implement for spreading the warp on cane roller.
Velvet, cut, a woven fabric with cut pile.
Velvet, figured, see *Figured velvet.*
Velvet knife, see *Trevette.*
Velvet rod, a grooved rod for the pile.
Velvet, terry, velvet with uncut pile.

Warp, longitudinal threads of a web.
Warping, preparing a warp.
Warping board, for making small warps.
Warping mill, for warping large warps.
Web, a piece of finished weaving.
Weft, the crossing thread of a warp.
Whorl, a spindle weight.
Woof, weft.
Yarn, thread of any kind.

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