JACQUARD MECHANISMS

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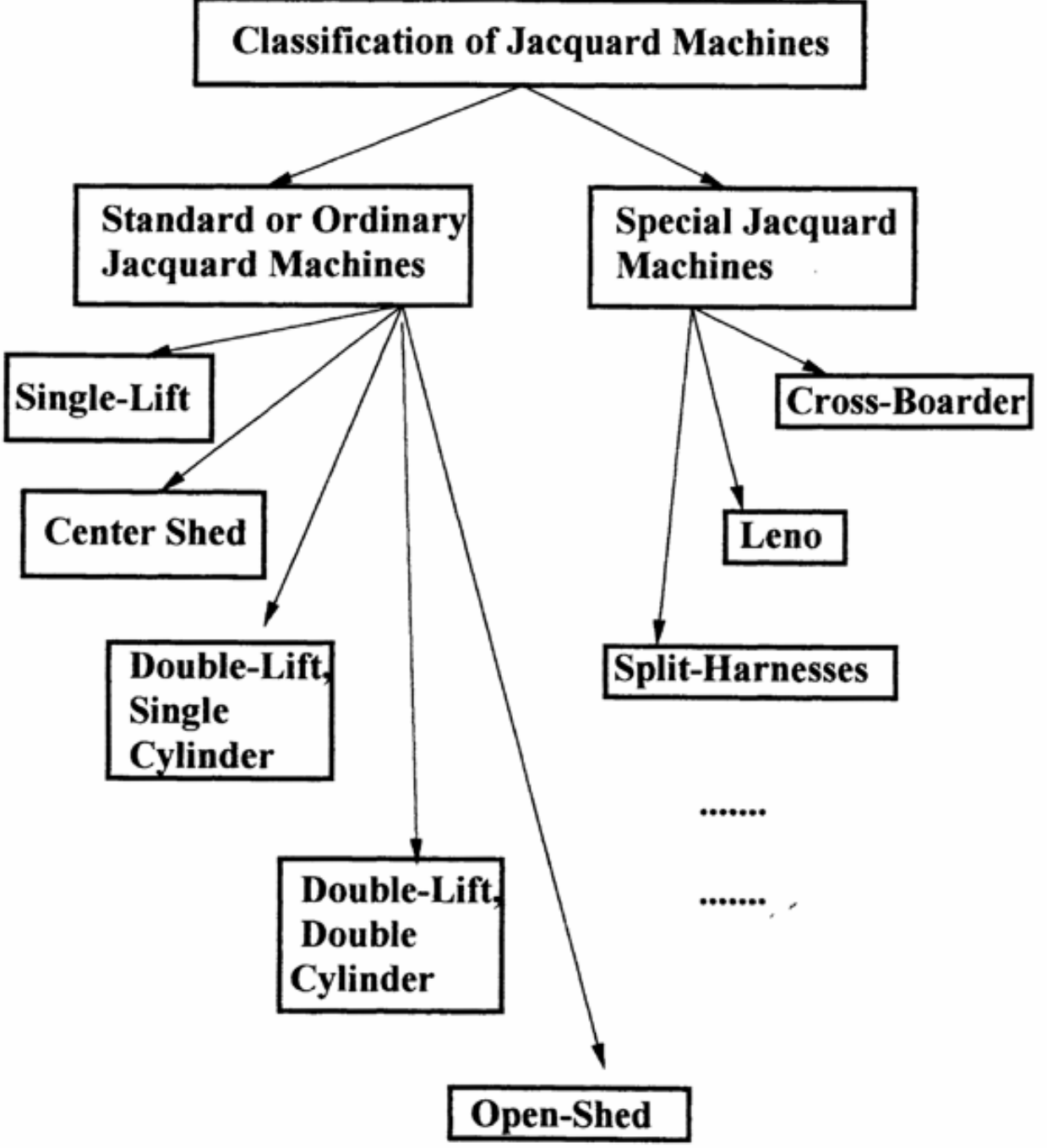
Jacquard Machines

- Jacquard shedding mechanisms are capable of producing large and intricate weave designs that are beyond the scope of dobby shedding mechanisms.
- In jacquard weaving, it is possible to control every warp yarn individually.
- Many specialized types of jacquard machine have been developed for weaving particular kinds of fabric, such as terry towels, damasks, and carpets.
- Most of the rest are general purpose types that are comparatively easy to classify.

Classification of Jacquard machines

- **Conventional jacquard machines**
  - **English pitch (coarse pitch)**
    - Mechanical
    - Single lift /double lift
    - Coarse Vienna pitch: 6.82 mm x 6.82 mm or 5.77mm x 5.11 mm
  - **French or Continental pitch (fine pitch)**
    - Mechanical or electronic
    - Single lift /double lift
    - Vincenzi / Verdol
    - French Laccase pitch: 4.00 mm x 4.00 mm; Verdol pitch: 3.00 mm x 3.00 mm
- **Unconventional jacquard machines**
  - Staubli's UNIVAL 100 Jacquard
  - Grosse's UNISHED Jacquard

- The term 'pitch' refers to the distance between the needle centers.


Classification of Jacquard Machines
Standard or Ordinary Jacquard Machines
Special Jacquard Machines
Single-Lift
Center Shed
Double-Lift, Single Cylinder
Double-Lift, Double Cylinder
Open-Shed
Cross-Boarder
Leno
Split-Harnesses
.....
.....

Size of Jacquard

- Size of jacquard
  - Design capacity of the jacquard for the control of the ends
  - Number of independent end lifts that can obtained
  - Virtually unlimited for the no. of picks in the weave repeat
- A 600-needle jacquard (12 x 50)
  - 12 is known as short row, 50 is known as long row.
  - It has twelve horizontal rows of needles placed one above the other with 50 needles in each row, plus a few extra needles.
  - Instead of no. of needles, the no. of hooks can be given to define the size of jacquard, say, 600-hook jacquard.
  - Hook is the main lifting element of the jacquard shedding.

Standard or Coarse Gauge
Sizes of Jacquard Machines
(British Standard)

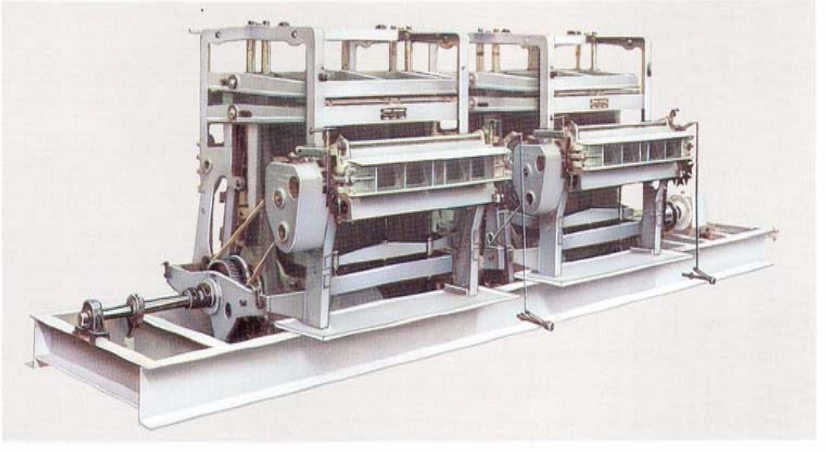
Size (Capacity, or Power)	Number of Hooks/Long Row	Number of Hooks/Short Row	Total Number of Hooks
100	26	4	104
200	26	8	208
300	38	8	304
400	51	8	408
500	51	10	510
600	51	12	612
900	77	12	924

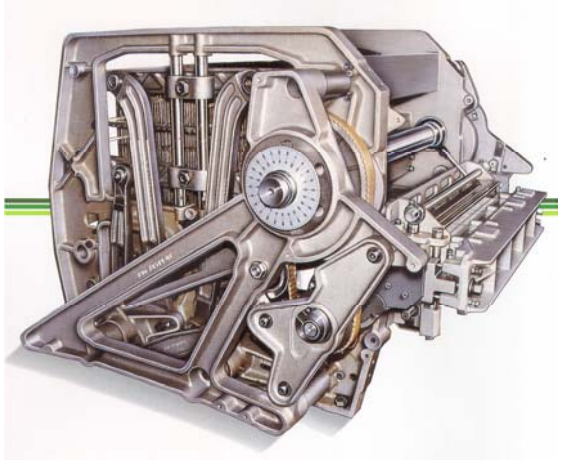
Fine Gauge
Sizes of Jacquard Machines
(Continental)

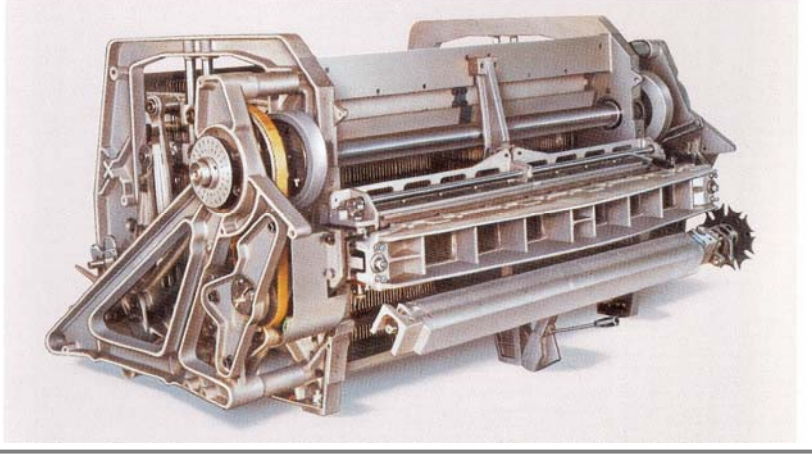
Size (Capacity, or Power)	Number of Hooks/Short Row	Number of Hooks/Long Row	Total Number of Hooks
448	16	28	448
896	16	56	896
1,344	16	84	1,344
1,792	16	112	1,792

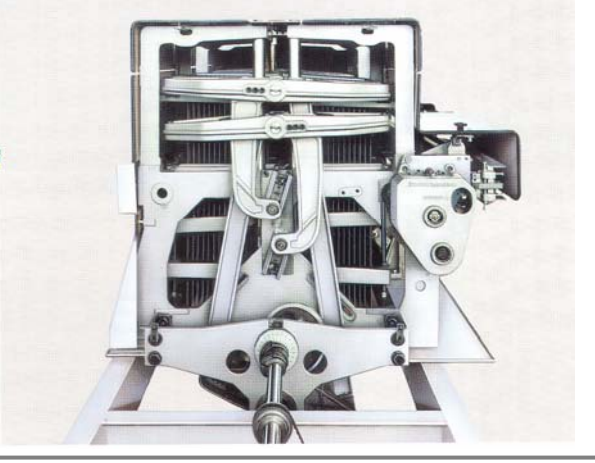
Very frequently, two or more jacquard heads are placed side by side to obtain the required number of hooks for large weave design size.

Jacquard heads with different sizes







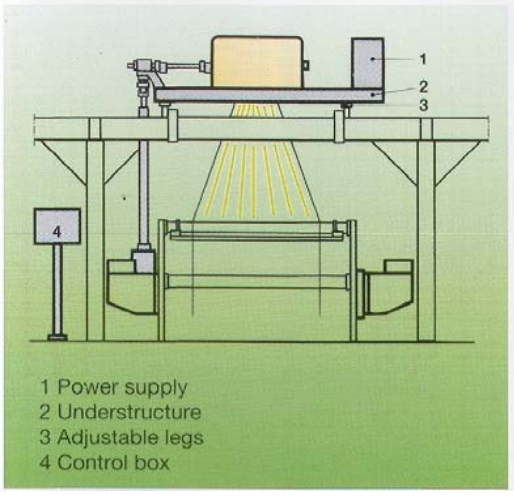


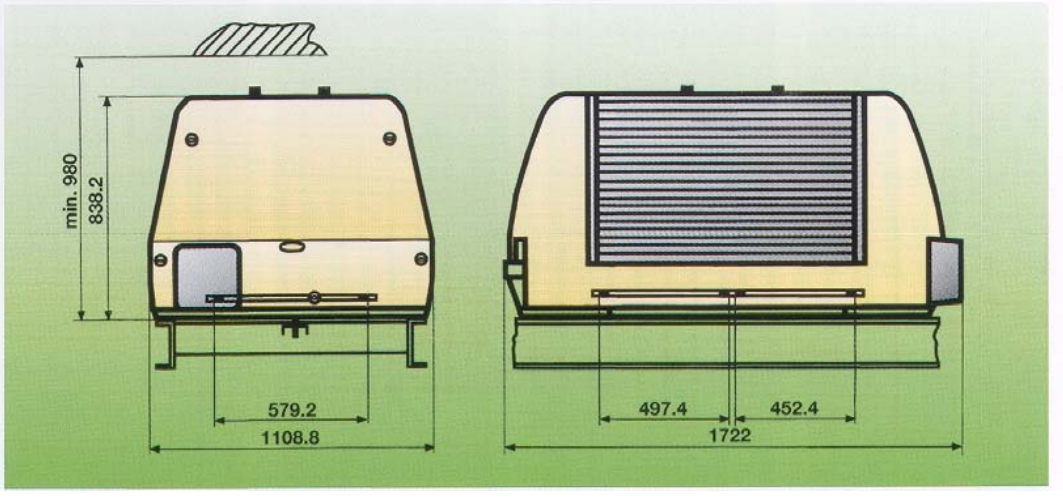
Jacquard Mechanisms

- **Three principal motion in the jacquard shedding.**
- **Drive:**
  - the mechanism that links the engine to the weaving machine
  - Knives (set of knives)
- **Selection:**
  - needles, springs, card cylinder, and endless paper pattern
- **Lifting:**
  - Hooks, neck-cords, harness cords, mails, and weights (spring or elastomer)

Jacquard Mechanisms

- A Jacquard machine may be divided into three main parts:
  - Jacquard head /engine
    - Knives, hooks, needles, springs, and card cylinder, endless paper pattern
  - Harnesses
    - neck-cords, harness cords, mails, and weights (spring or elastomer)
  - The mechanism that links the engine to the weaving machine





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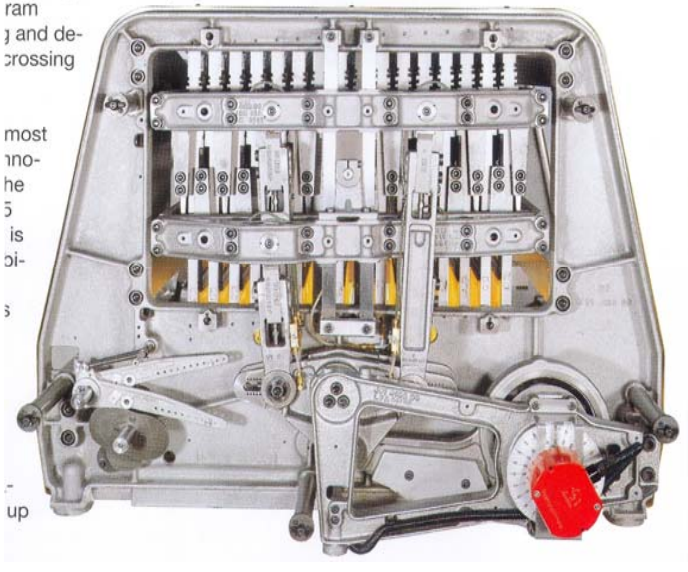
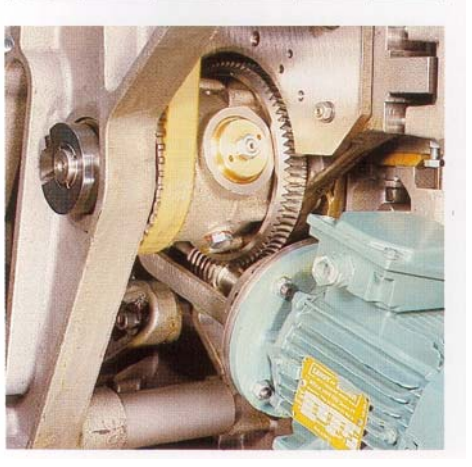
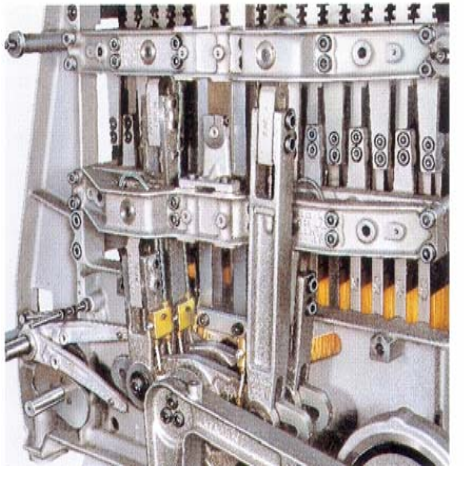






Jacquard Mechanisms

- The mechanism consists of levers that connect the main shaft to the knives. It is the connection which controls the up and down movements of the knives.
- The knives in turn move up and down hooks to form the shed according to the weave design.

Mechanical Jacquard : Single lift- Single cylinder

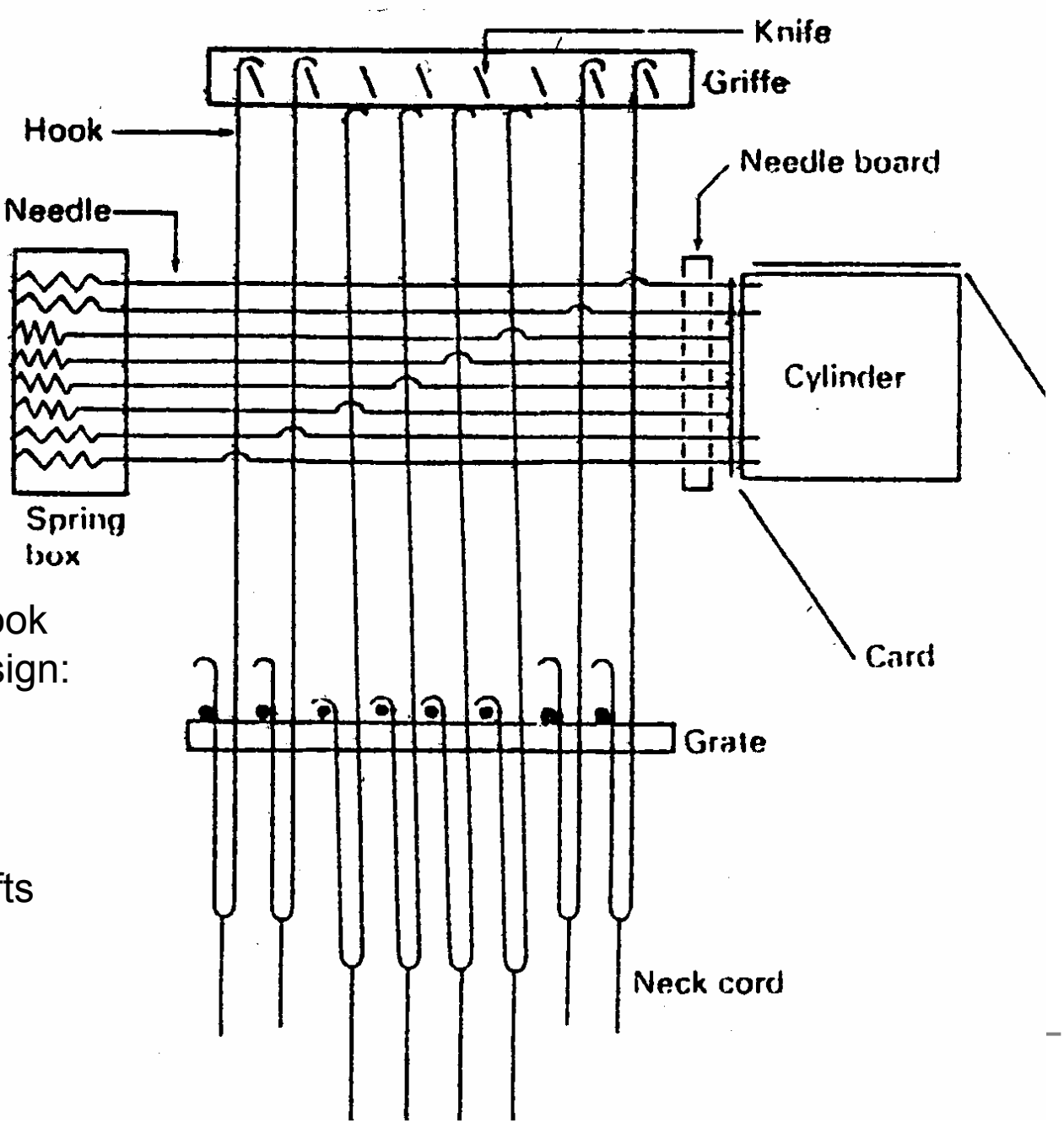
400= 8 x 50

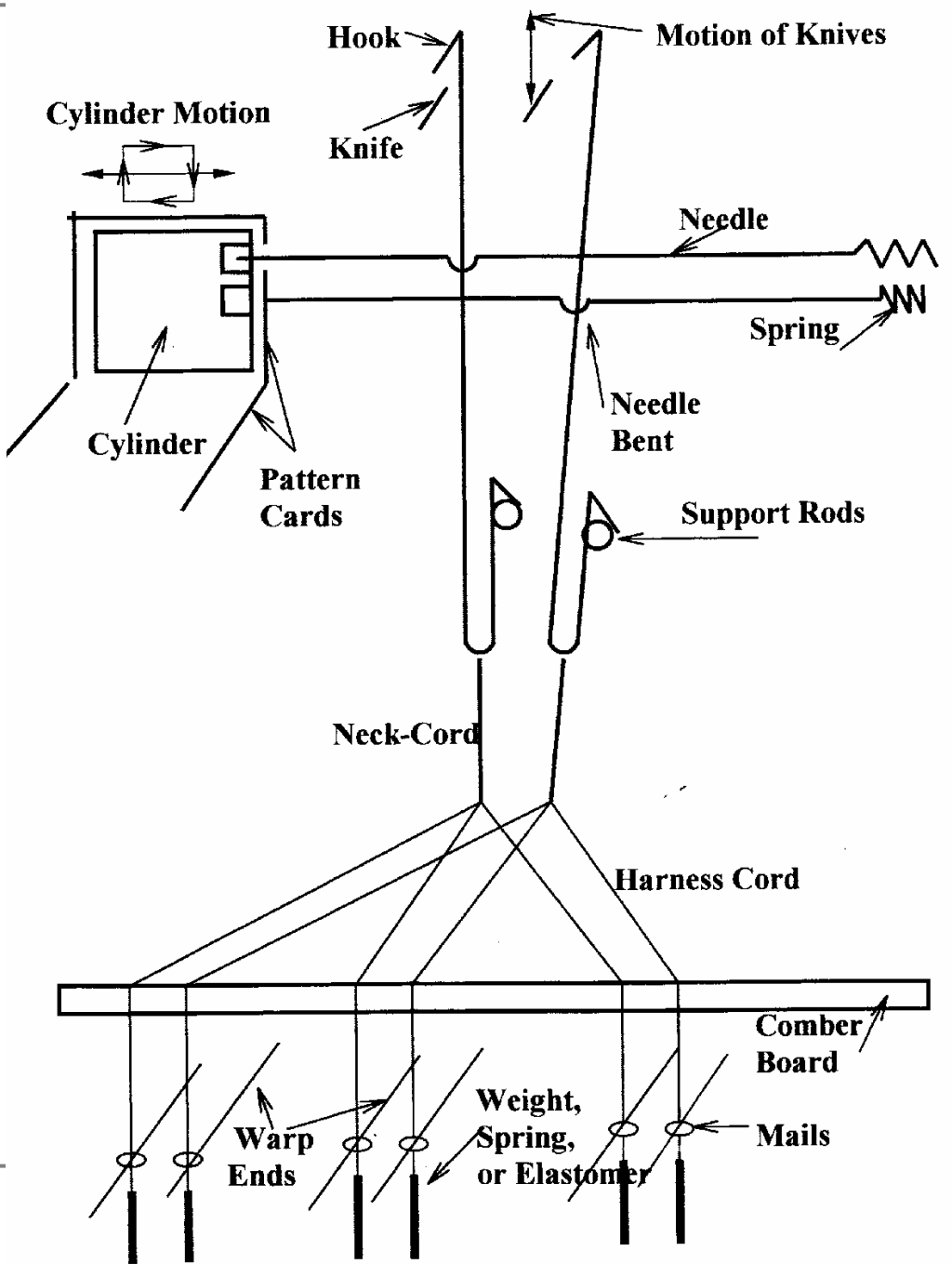
One needle and one hook for every end in the design:

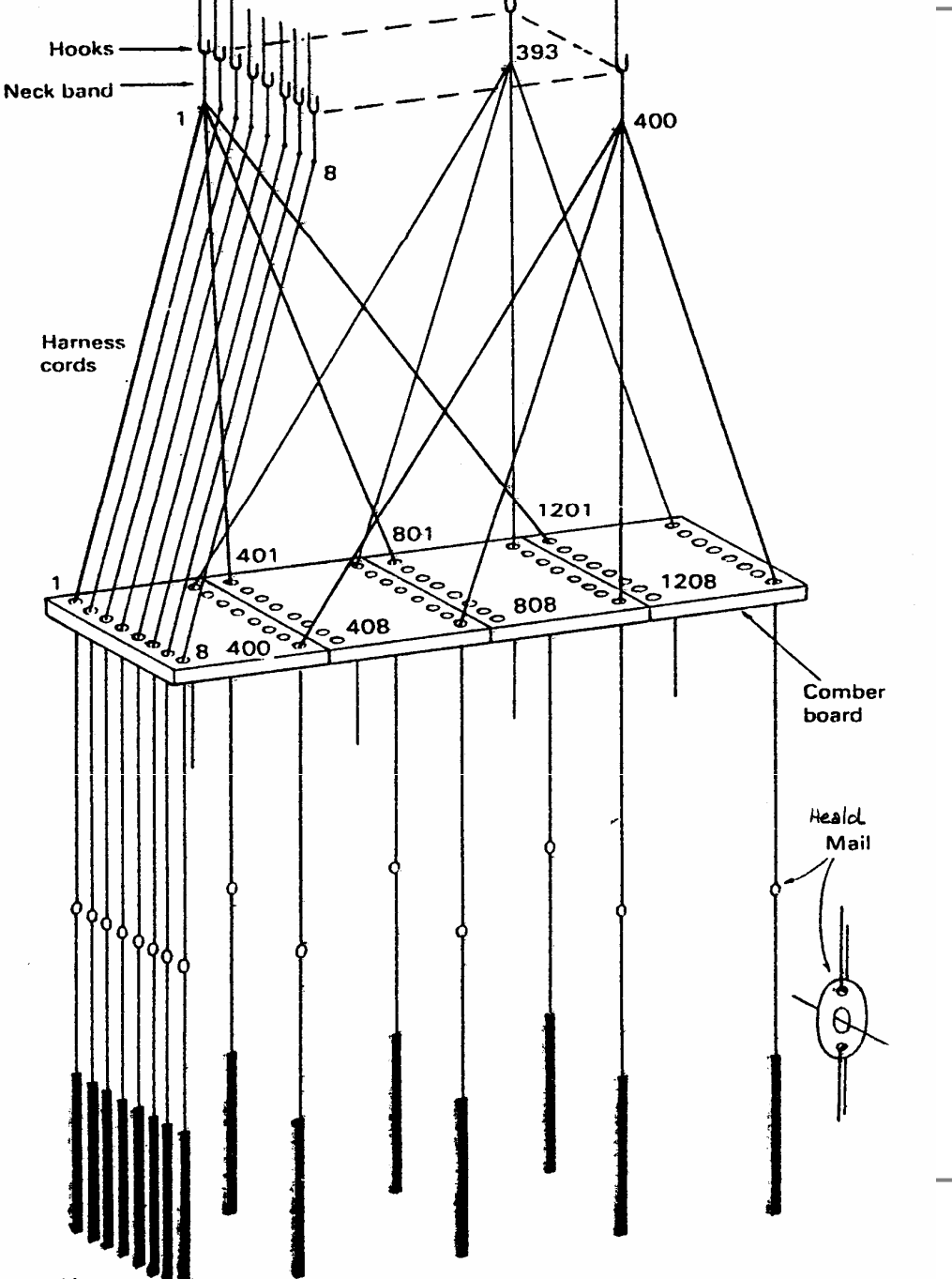
400 needles,

400 hooks,

400 independent end lifts




Hook
Motion of Knives
Cylinder Motion
Knife
Needle
Spring
Needle
Bent
Cylinder
Pattern
Cards
Support Rods
Neck-Cord
Harness Cord
Comber
Board
Weight,
Spring,
or Elastomer
Warp
Ends
Mails


Hooks
Neck band
1
8
393
400
Harness cords
1201
801
401
1
1208
808
408
8
400
Comber board
Heald Mail

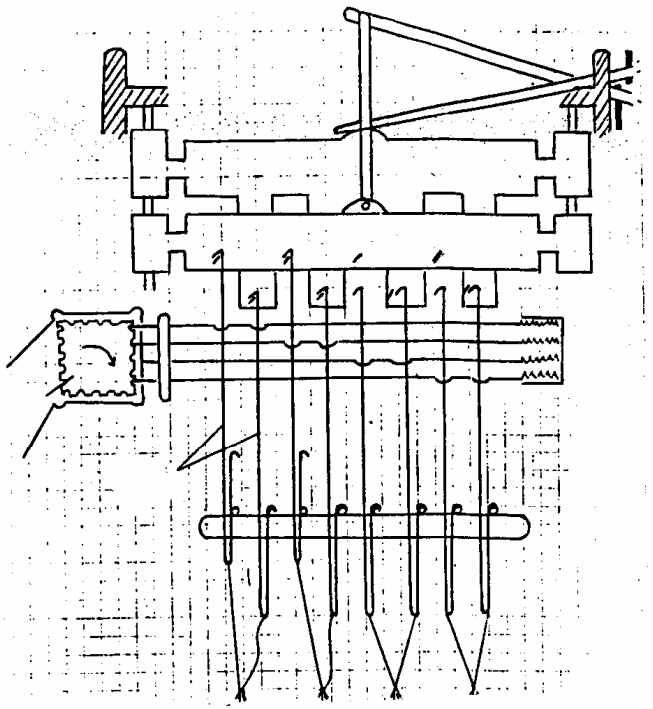
Single-Lift Jacquard (S.L., S.C.)

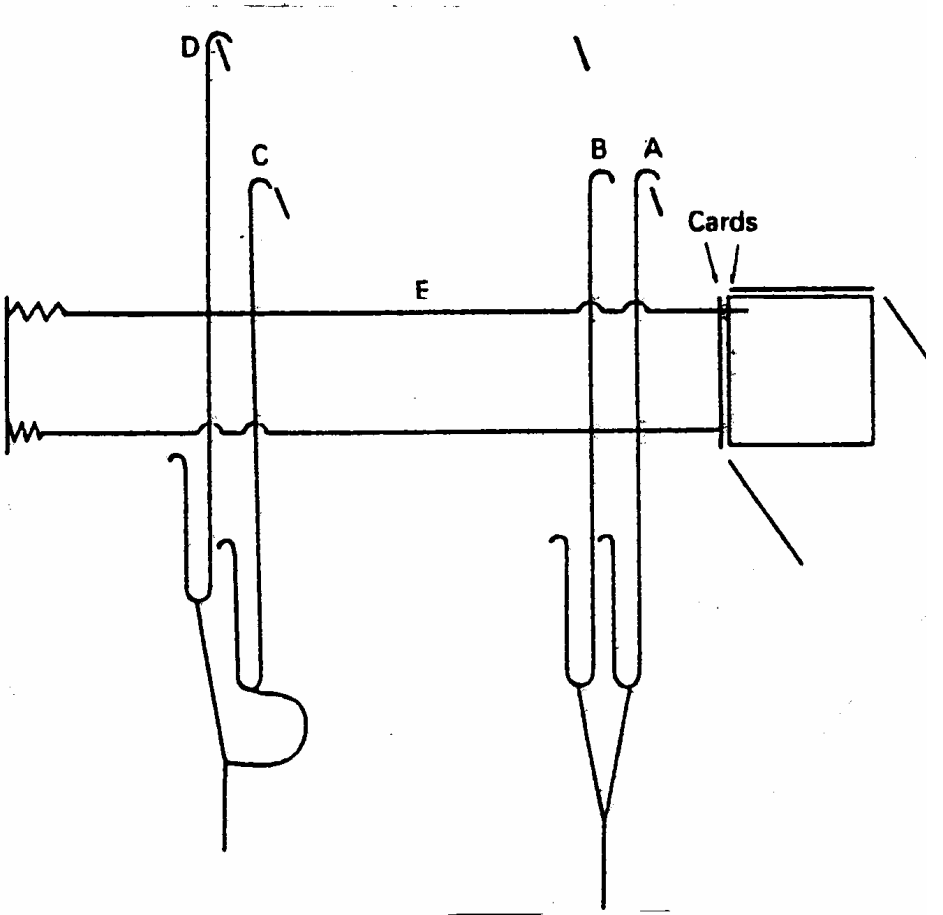
- In single lift jacquard, the shed is formed by raising the hooks by the knives (i.e. the bottom shed is stationary).
- It forms a bottom-closed shed.
- There is therefore much wasted movement, together with a tendency for the whole harness to swing. The cylinder must reciprocate and turn, and the griffe must rise and fall every pick.
- This requires more time to form the shed. These considerations drastically limit the speed at which the loom can be run.
- Additionally, the lifted warp ends are highly strained and this may cause end breakage.

Double lift - single cylinder

Two sets of knives, each mounted in a griffe; the rate of reciprocation is halved. Two griffes move up and down in opposition over a two-pick cycle

One needle and two hooks, for every end in the design





Harness cord is lifted by one of the two hooks

Double-Lift Single-Cylinder (D.L.,S.C.)

- Here each needle controls two consecutive hooks (pair).
- The pair of hooks is connected to one neck-cord.
- One hook (odd numbered) controls the neck-cord in the odd picks and the other hook (even numbered) controls the neck-cord in the even picks.
- There are two sets of knives. The first controls the odd hooks and the second controls the even hooks. The two sets of knives are operated in the alternate order, one set is rising while the other descending.
- DLSC the cylinder is turned quarter revolution every pick.

Double-Lift Single-Cylinder

- Advantages of DLSC J.'s over SL J.'s:
  - DLSC operates in semi open shed principle.
  - The hooks move less since each set is working every two picks.
  - There is less tendency for the harness to swing.
  - The loom speed is higher in case of double lift than single-lift.

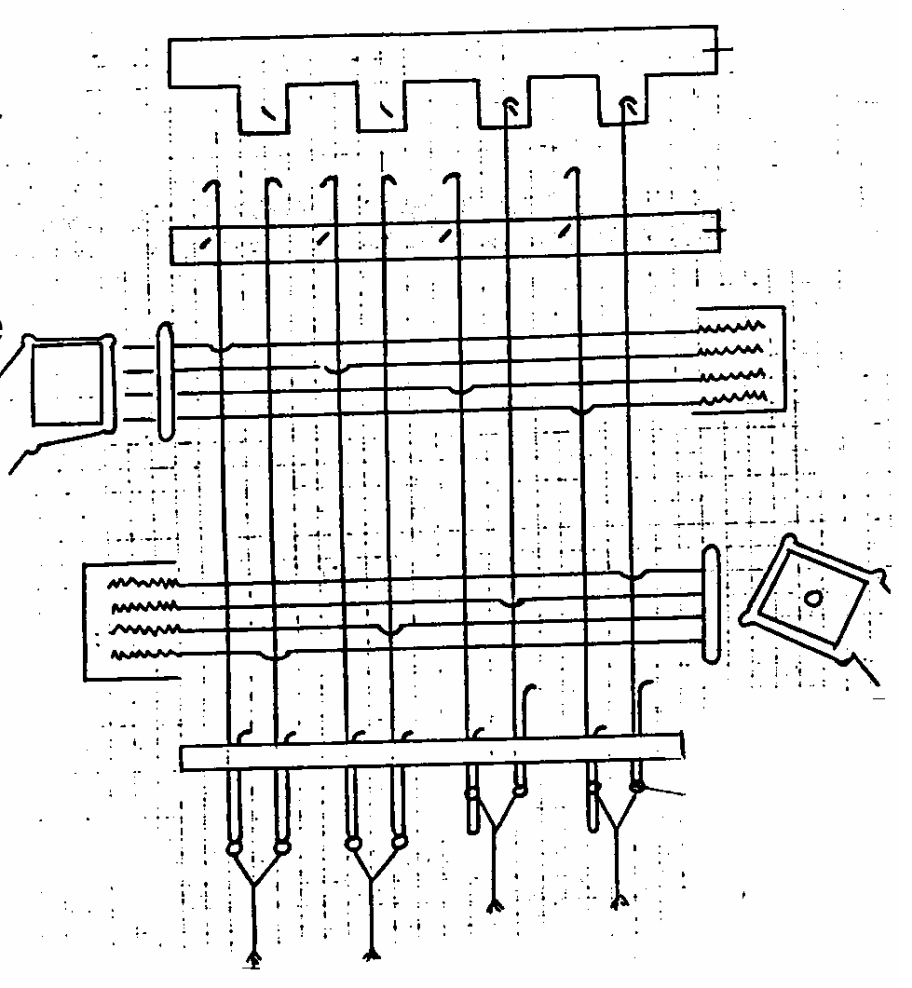
Double lift - double cylinder

Two sets of knives

Two needles and two hooks, for every end in the design

Two card cylinders operate on alternate picks; one carrying the odd-numbered and the other the even numbered cards

Griffe and cylinder speeds are halved.

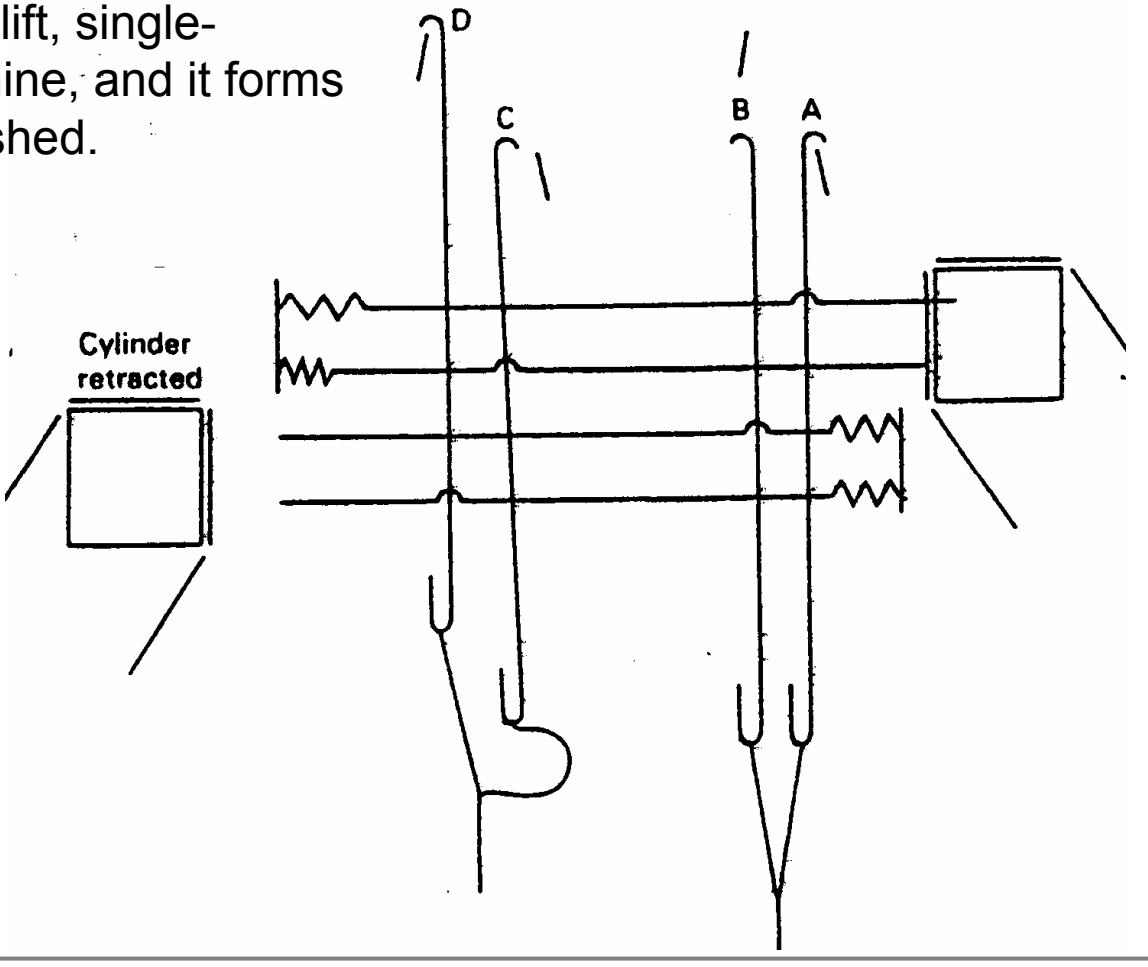


Double-Lift, Double-Cylinder

- In case of DLSC the cylinder is turned quarter revolution every pick, however in case of DLDC the cylinder is turned quarter revolution every two picks. This is because one cylinder handles the odd picks (odd pattern cards) and the other cylinder handles the even picks (even pattern cards).
- As a result, DLDC can work at faster speeds than compared to DLSC.

Double-Lift, Double-Cylinder

Its action is the same as that of the double-lift, single-cylinder machine, and it forms a semi open shed.



Double-Lift, Double-Cylinder

- The jacquard machine with semi open shed has serious disadvantage:
- The link transfer between the hooks occurs at the highest speed of these hooks; this results in a jerky performance of the harness cords which may result in 'lashing'.
- Both the harness cords and the warp ends, move unnecessarily half-way down on their lifting paths although they may be again required at the top position during the next pick.

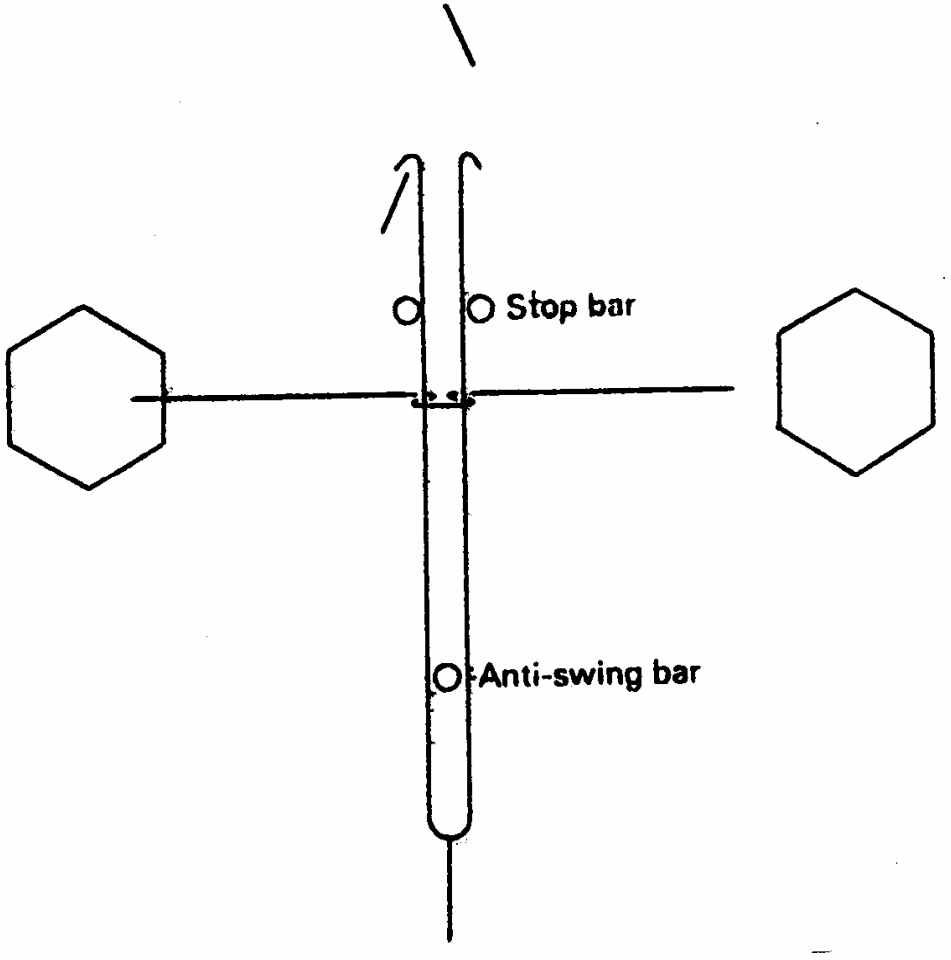
French-type jacquard machines

- Two types of fine-pitch jacquard, both originated in France:
- Vincenzi machine
  - pattern cards and a direct method of selection
  - standard sizes are 880 or 1320
- Verdol machine
  - endless paper pattern and an indirect method of selection
  - standard sizes are 892 or 1344 ends

French-type jacquard machines

- A 1320 Vincenzi machine is no larger than a 600 coarse-pitch machine, and a 1344 Verdol is smaller.
- Because of their compactness, fine-pitch machines of both types have been widely used for designs having a large number of ends in the repeat.
- In the past, the Vincenzi tended to be preferred to the Verdol in Britain, chiefly because a clean atmosphere with uniform temperature and humidity is necessary for Verdol machines.
- With the increasing use of air-conditioning plants, these conditions have become available, and the Verdol machine was gained in popularity.

Vincenzi Jacquard



In Vincenzi and Verdol machines two hooks are replaced by a double hook (hook unit),

The upper ends of a double hook always tend to spring apart because of spring- loading in the U-loop of the hook unit.

This eliminates the need for coil springs to return the needles to their original positions.

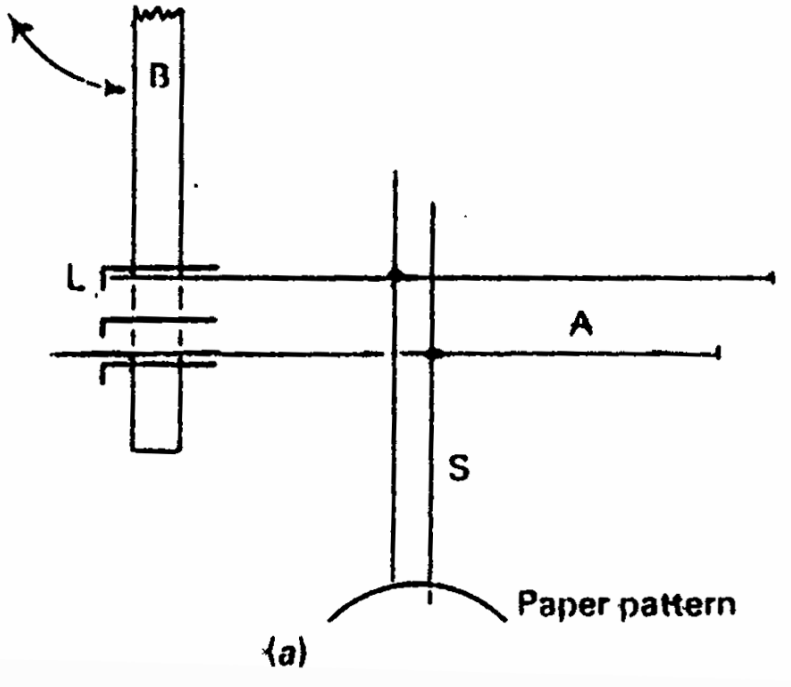
To avoid excessive needle pressure on the card, stop bars are incorporated.

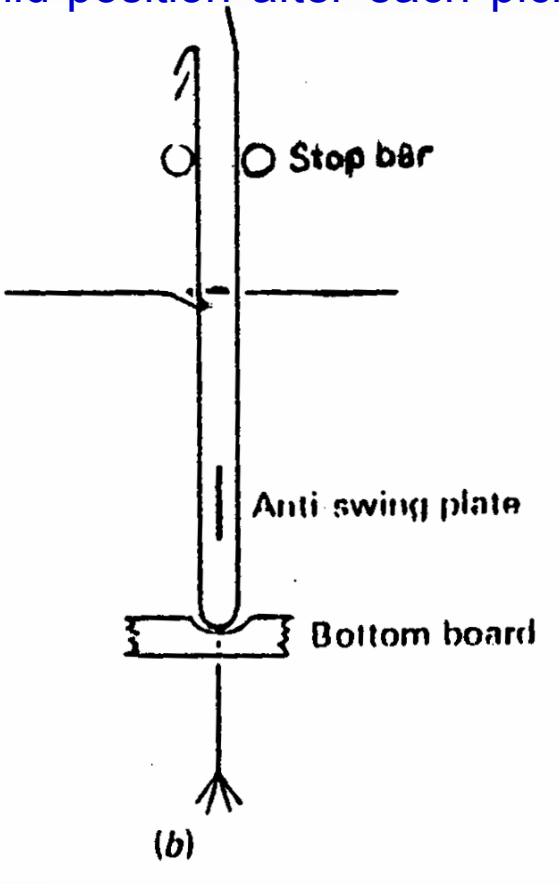
The lower ends of the hook units are kept vertical by steadying or anti-swing bars.

Verdol Jacquard (single-lift)

The selected hooks raise the ends from their center-shed position, and the bottom board lowers the unselected hooks to the bottom-shed position.

Since all the hooks must be returned to the mid-position after each pick, a center-closed shed is produced.

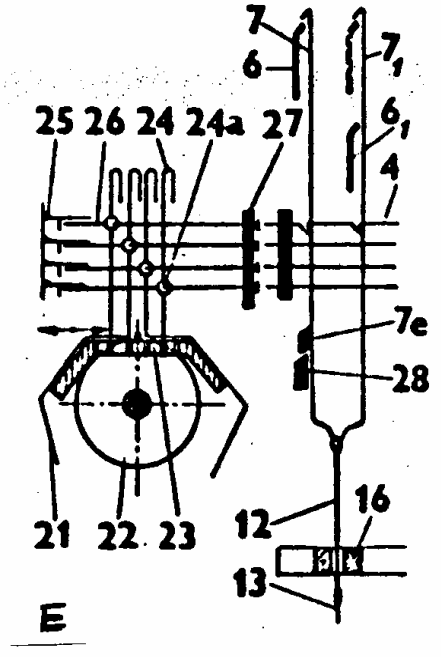


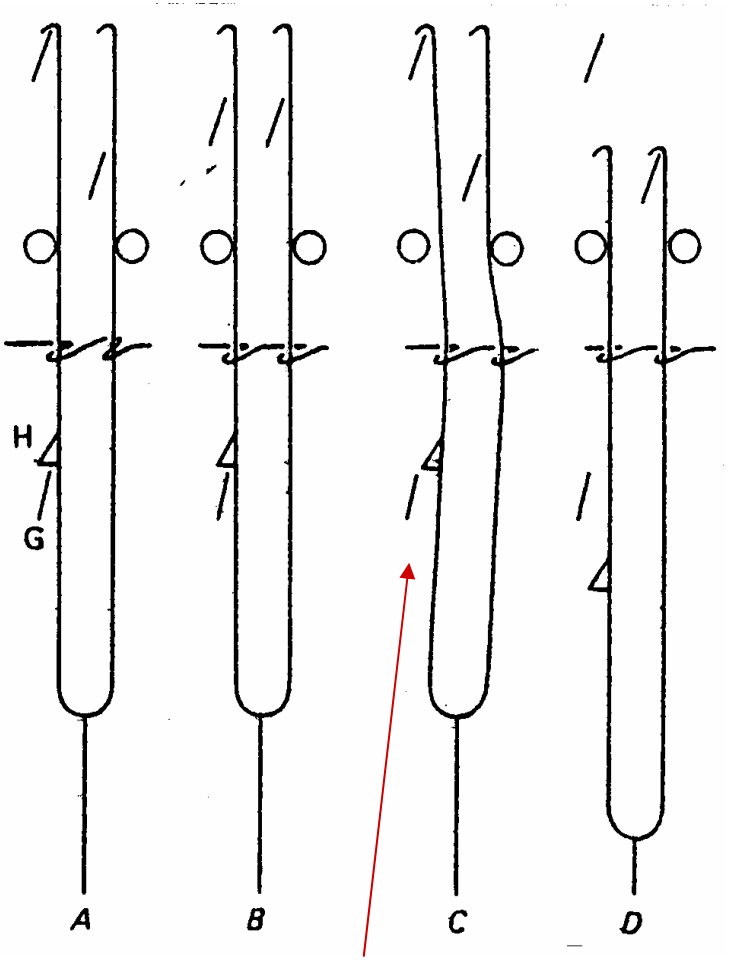


Center Shed Jacquard

- The center shed Jacquard is very similar to the single-lift with one exception.
- The bottom shed moves down while the upper shed is moving up so that the required shed size is achieved by raising the upper shed half the distance and lowering the bottom shed the other half.
- The warp yarns are strained dramatically less in this case when compared to the single-lift Jacquard.

Verdol Jacquard (double-lift)

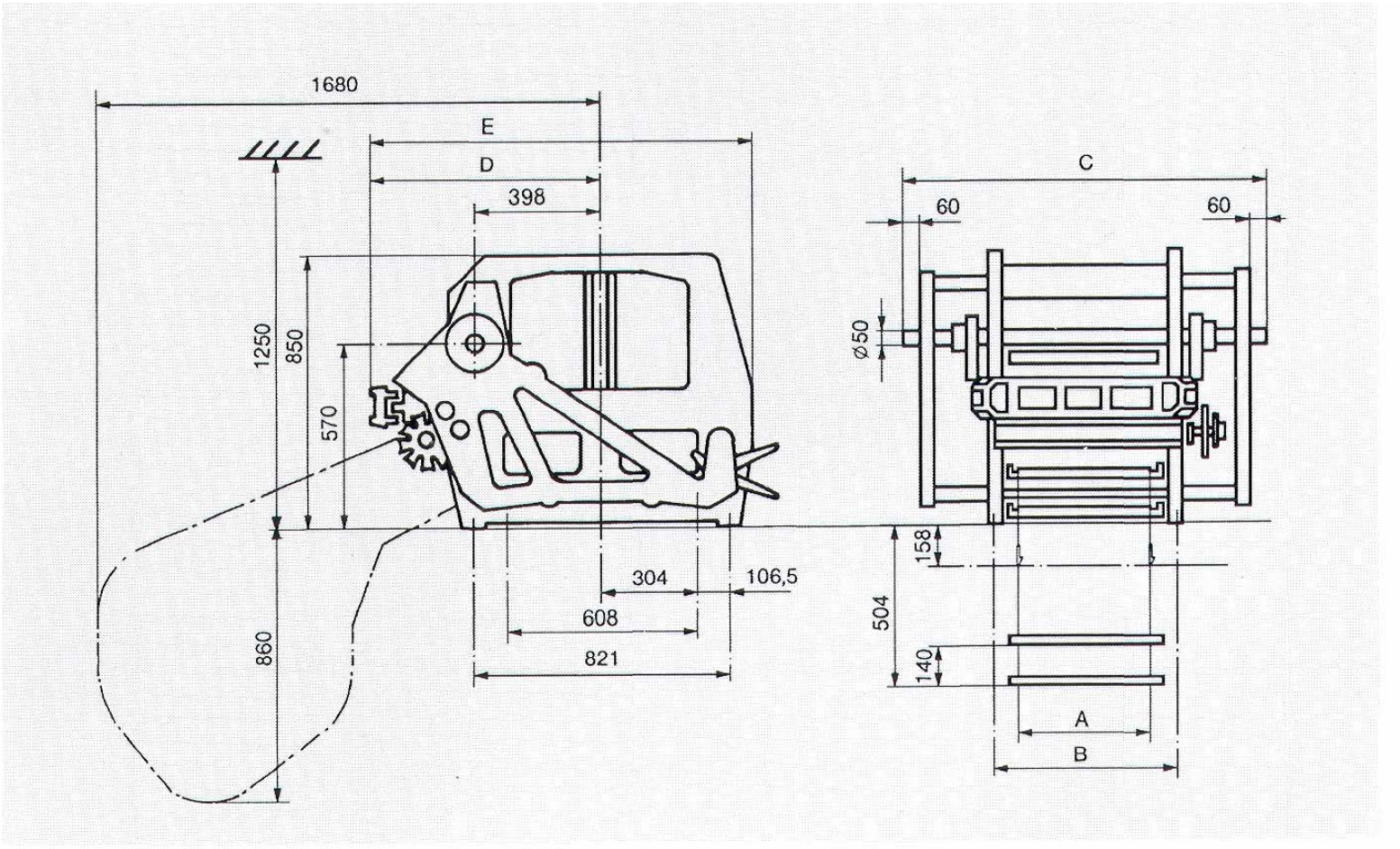




The supplementary hook H is now locked over the fixed griffe G

Uncut card displaces the needle-and-hook unit iimmediately, H will be pushed off G. As the jacquard griffe falls, the hook unit will be lowered to the bottom position.

Mechanical Jacquard head



Building the jacquard harness system

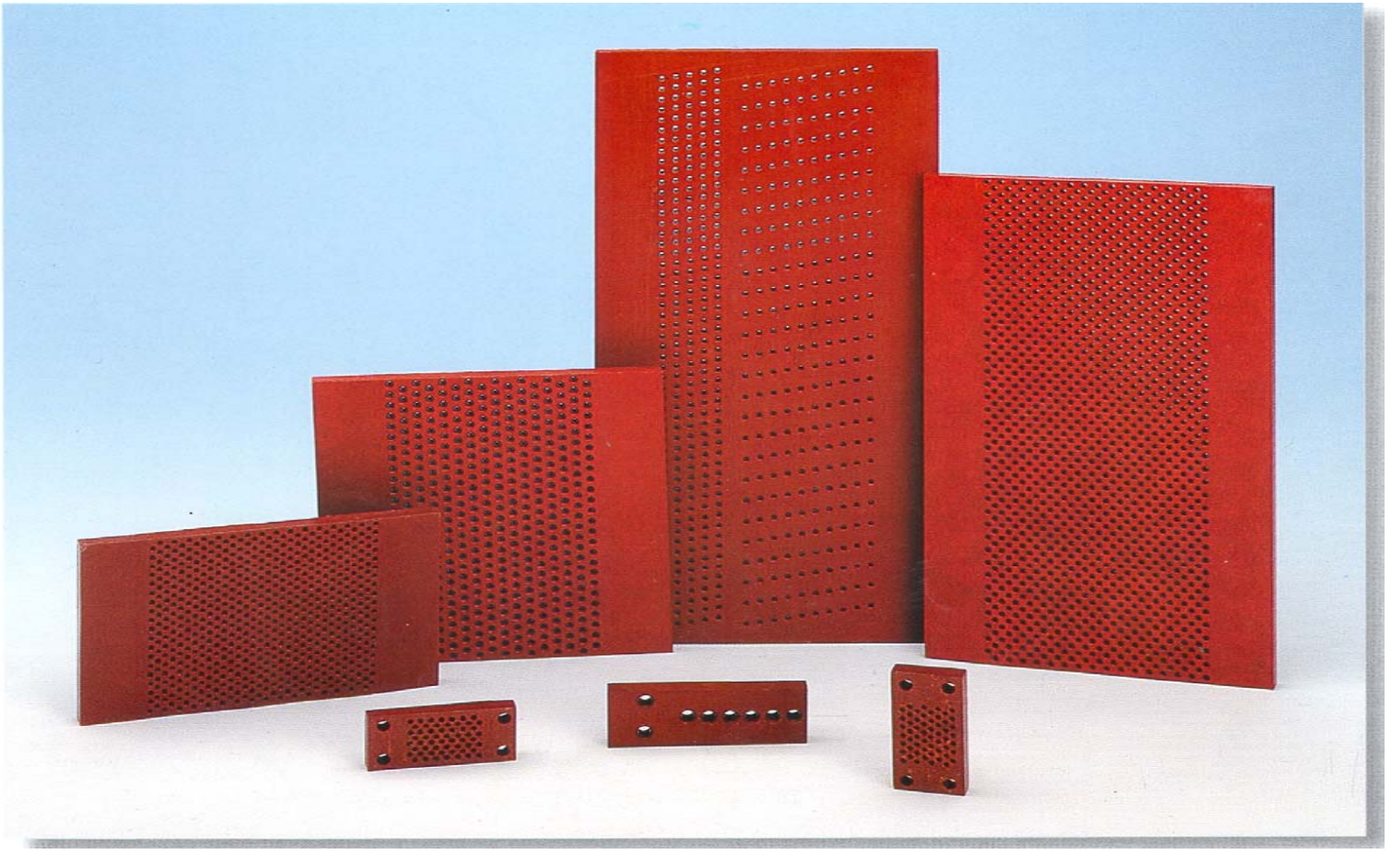
Shed formation is ideally adapted to all individual weaving circumstances. The tried and to be woven.

Harness guiding

The jacquard harness

- The **jacquard harness is the system of cords, healds, and lingoes** that transmit the movement of the hooks to the individual warp threads.
- At some distance, usually about 1-2 meter, below the bottoms of the hooks there is a horizontal comber board.
- The comber board is a piece of hardwood, or more usually sections of hardwood assembled in a frame.
- Each section of the comber board has drilled in it. The number and order of holes are similar to those of the hooks in jacquard head.

COMBER BOARDS



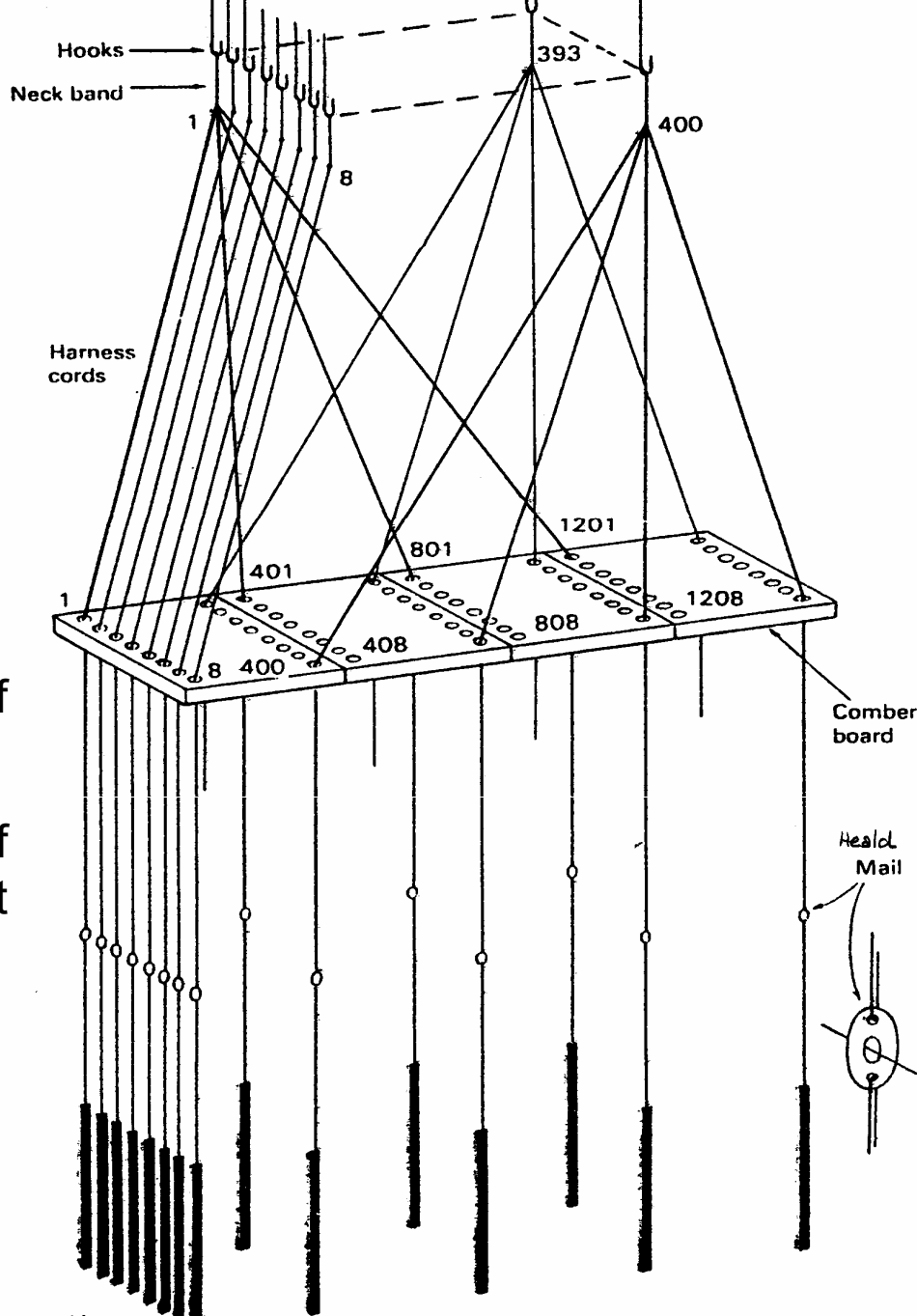
Building the jacquard harness system

- The jacquard machine is assumed to have 400 hooks:

Eight rows of fifty hooks

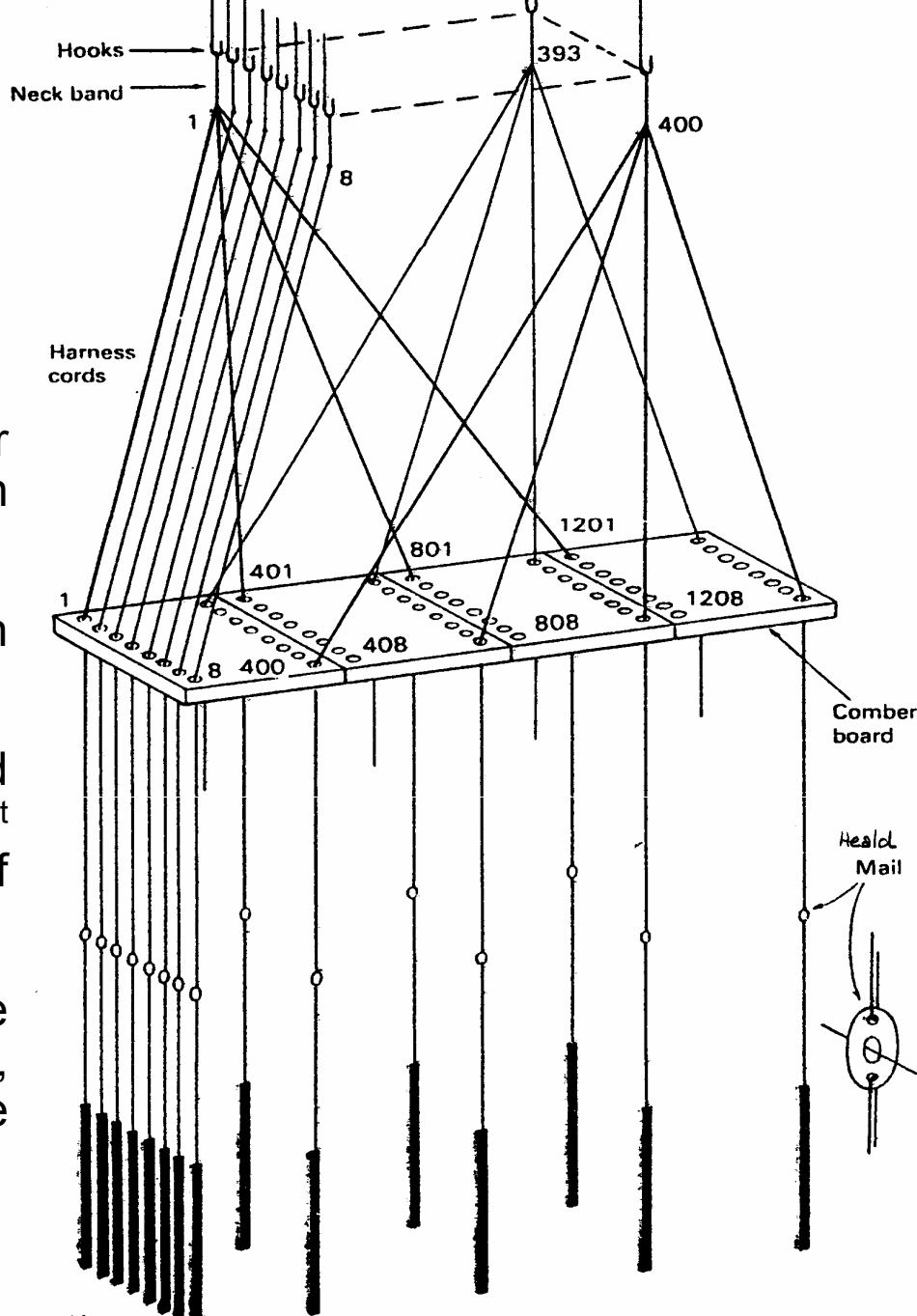
400= 8 x 50

- We suppose there are four repeats of 400 ends, making totally 1600 ends
- The holes are arranged in rows of eight corresponding to the rows of eight hooks in the machine.



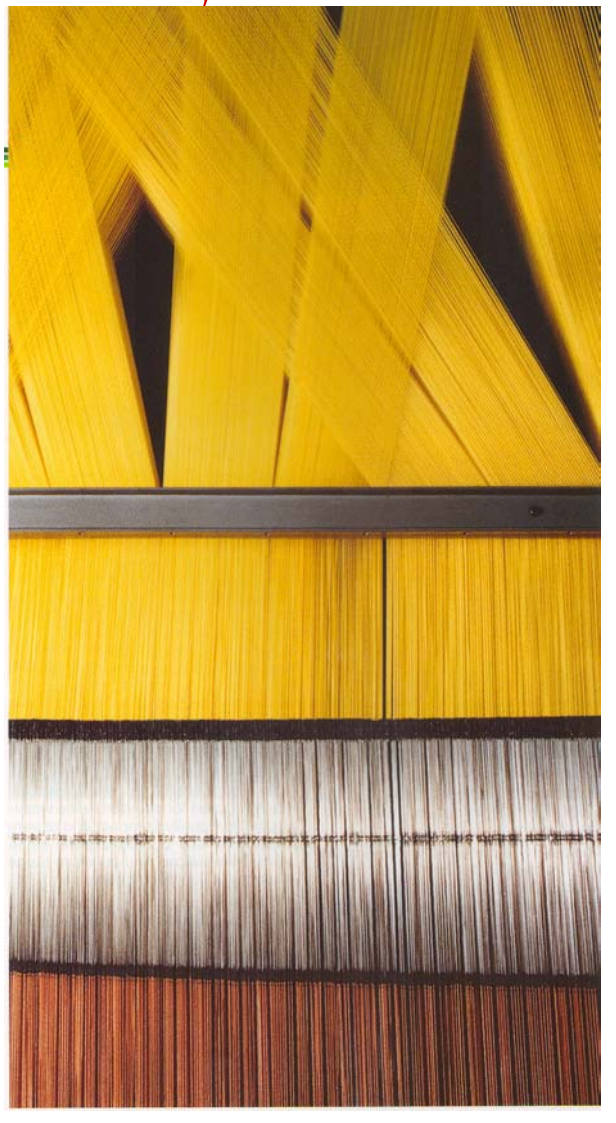
Building the jacquard harness system

- Each of the 400 hooks carries four cords, which are led through appropriate holes in the comber-board.
- The first hook controls the first end in each repeat.
- From the first hook, cords are led through the 1st, 401st, 801st, and 1201st holes, at the back left-hand corner of each repeat in the comber-board.
- From the 8th hook at the front of the machine, cords are led through the 8th , 408th, 808th, and 1208th holes at the front of the comber-board.



Building the jacquard harness system

- The lower end of each cord is attached to a heald which is attached to lingo, a thin metal rod of mass about 25 g.
- If the cloth is to have 4500 warp ends, there will be 4500 harness cord and heddles, one to control or lift each warp.
- It is quite evident that a great deal of effort and work are required to arrange a harness system containing 4500 cords.
- The new harness cords have antistatic and antisoiling properties .

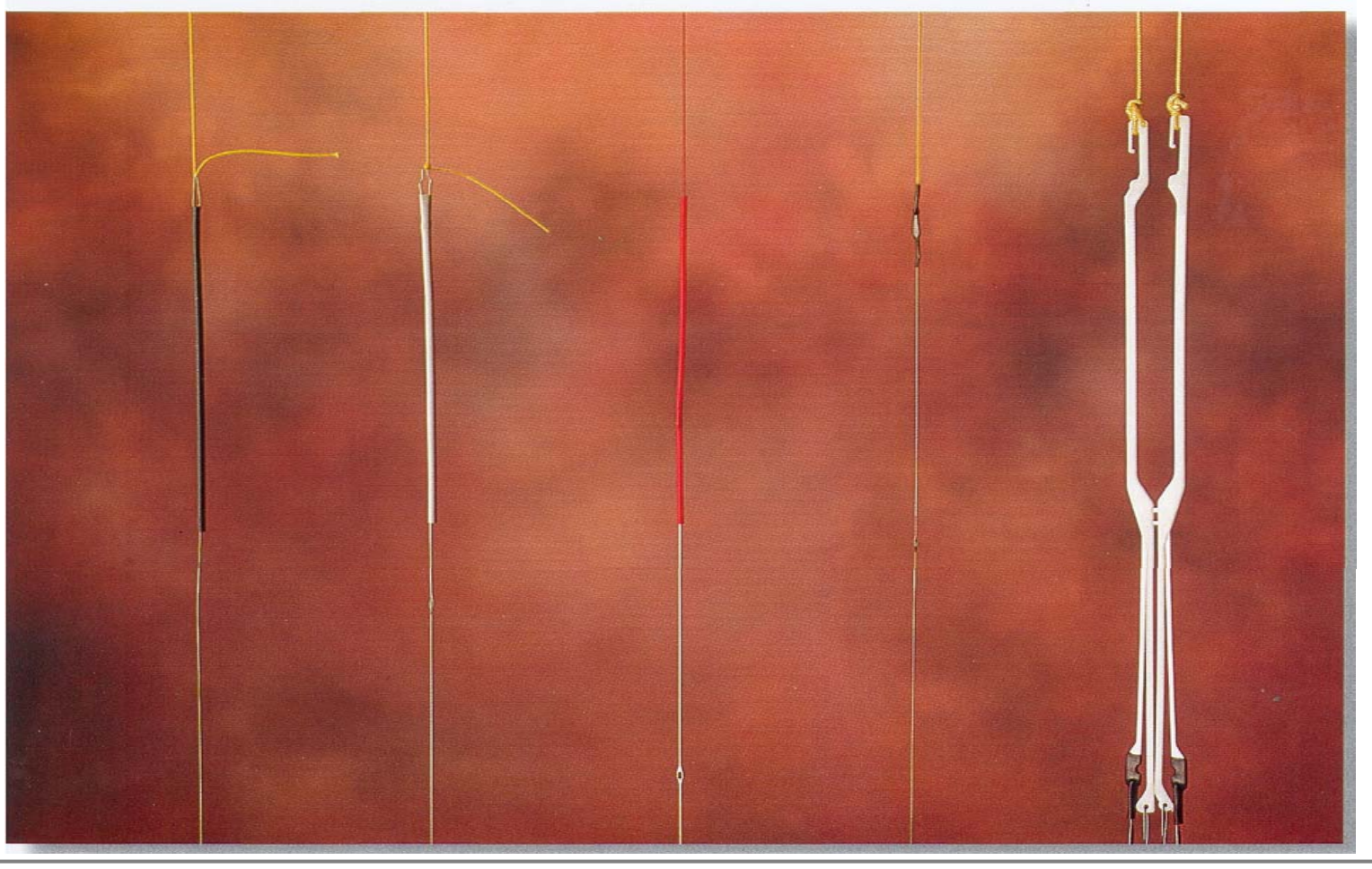


Harness system

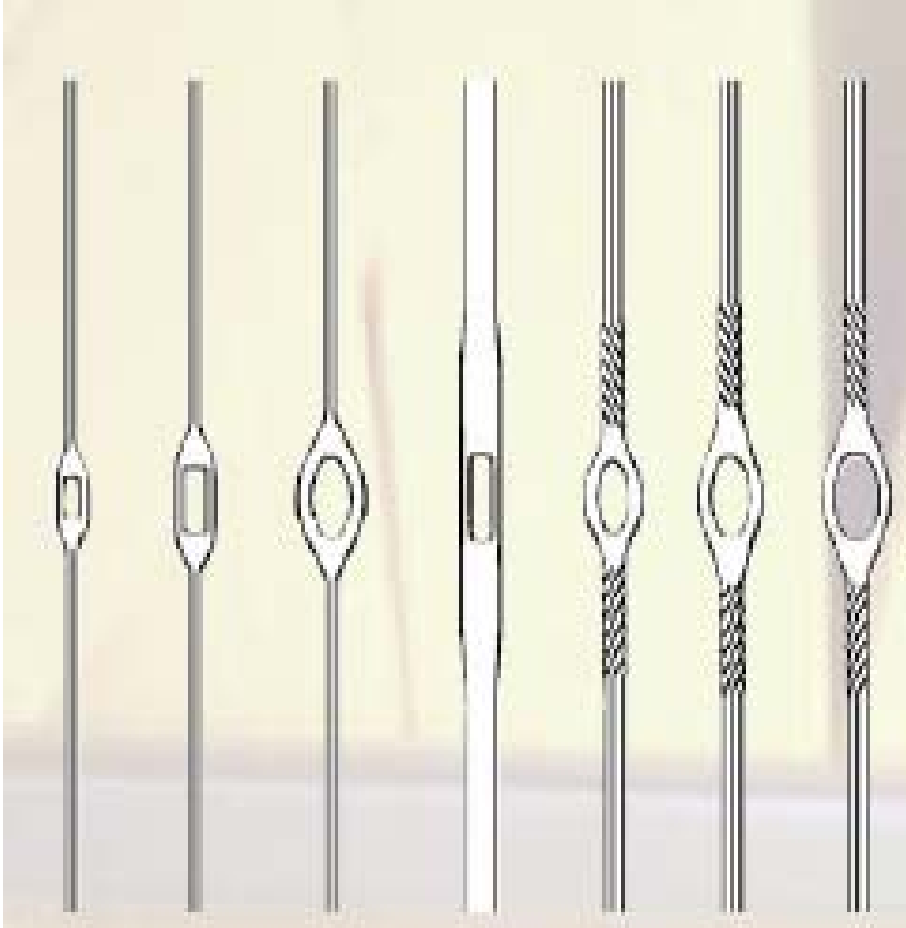
- The harness is designed as the perfect interface between the Jacquard machine and the warp yarns of the Jacquard fabric .
- It can consist of 2000 to 38000 cords over a weaving width of 1 to 4 meters .
- The harnesses may be adapted for Jacquard machines with 72 to 14336 hooks and assemblies .
- A single harness cord may be attached on the same hook tie for widthwise repeated weaves (up to 20) for weaving the same design over the width of the fabric .

Harness cords

Harness cords are attached to the heddles, each with an eye through which a warp yarn is threaded.



Heddles



HEDDLES

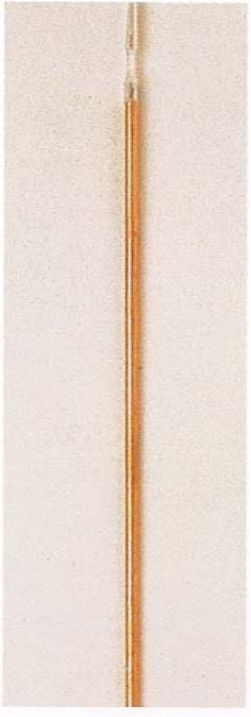
Heddles are selected according to the warp setting and the yarn count of the warp ends.

Building the jacquard harness system

- The function of the weight /lingo is to overcome the vertical component of warp tension and so keep its end down when it is not being lifted by the machine.
- More recently, individual elastic rubbers have been introduced for a greater effectiveness and a quicker return of the raised hook, so that jacquard shedding is possible at higher speeds.

Downpull elements for harnesses

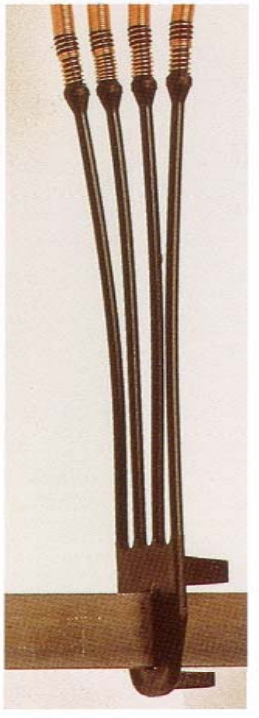
- There are basically three different downpull elements: Weights (lingoes),lycras (elastics), springs with varying downpull forces.
- Downpull elements are fastened either on the machine or directly on the floor.



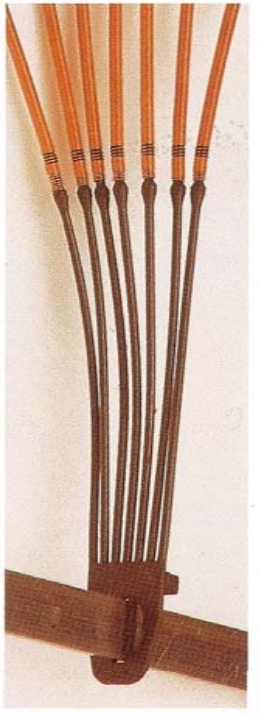
Lingoes with flexible connection to heddle

Elastomer elements, doubly covered lycras

Springs with individual fastening



Springs with fastenings grouped in 4 for warp density up to 40 ends per cm



Springs with fastenings grouped in 7 for warp density up to 130 ends per cm

Plastic bubble attachement between spring and heddle

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within the

Elastomer elements, doubly covered lycras

Springs with individual harpoon fastening

Springs with individual fastening

Springs with fastenings grouped in 4 for warp density up to 40 ends per cm

Springs with fastenings grouped in 7 for warp density up to 130 ends per cm

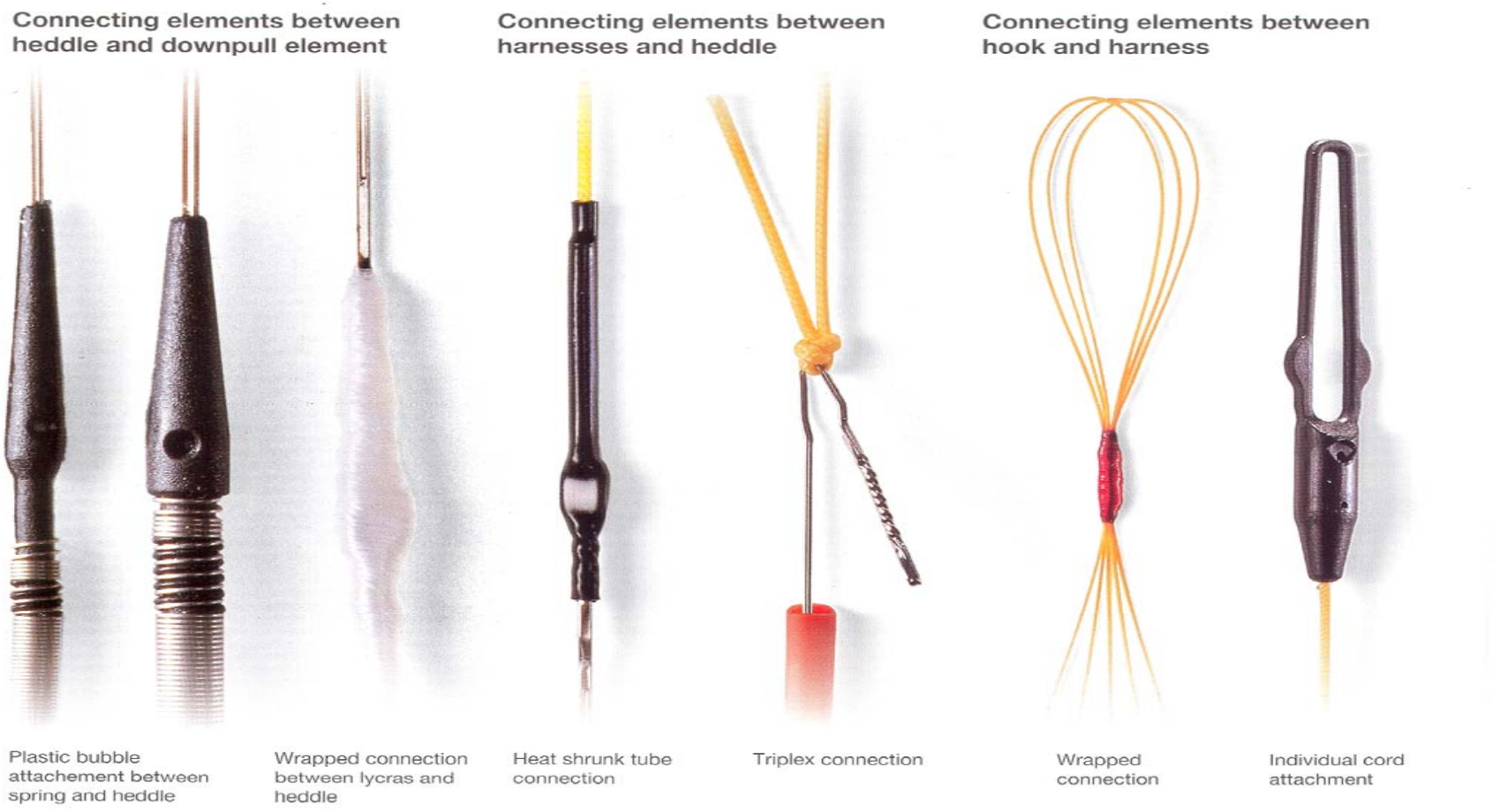
Downpull elements for harnesses

Pulldown forces are varying according to numerous parameters: density, load, speed.

Type of pulldown element	Pulldown force/weight
Lingoes	26 g mattress duck, 34 g furnishing fabric, 40 g blankets
Lycras	30 g silks, 50 g narrow fabrics, 50 g furnishing fabric
Springs	20-30 g silks, 50-75 g heavy upholstery fabrics, 80 g terry cloth, 180 g blankets

They are arranged with special types of cords and heddles

Connecting elements



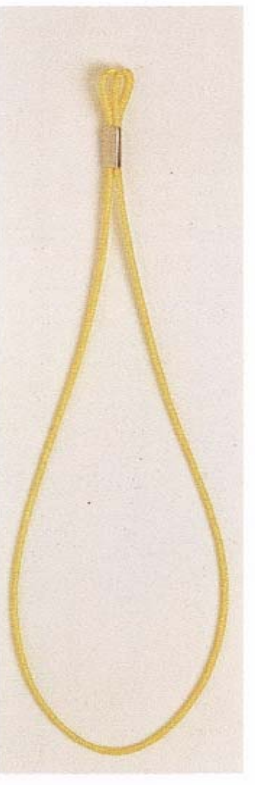
Connecting elements

Wrapped connection between lycras and heddle

Heat shrunk tube connection

Triplex connection

Wrapped connection with even number of cords



Polyester gusset

Wrapped connection with uneven number of cords

All comber boards are individually manufactured according to the instructions of each customer

COMBER BOARDS

The comber boards are custom manufactured and perforated in accordance with weaving specifications. For example, the drawing in depth is defined according to the number of rows of harness tying and drawing in, the warp setting, the harness cord type and the harness cord / heddle connection. The optimised perforations enable harness operation and weaving to be optimized.

Examples:

TERRY APPLICATION

Perforation in two parts: loops and background.

MATRESS TICKING APPLICATION

Inclined holes.

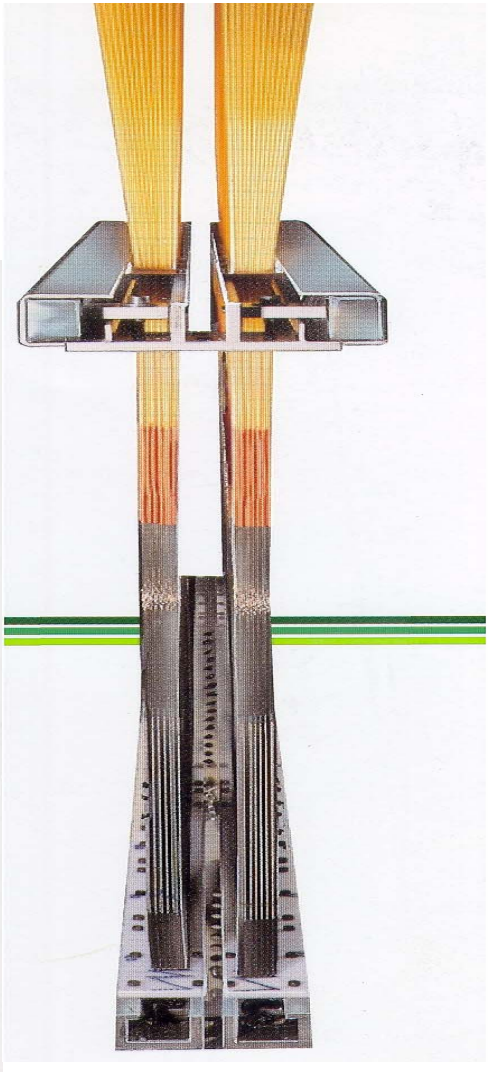
CARPET APPLICATION

MULTIPLE-ROUTE HARNESSES REPEAT

SILK APPLICATION

Density up to 140 yarns/cm.

Harness arrangement on the comber board for terry weaving



HARNESS LEASE

- This manual separation of the harness cord wires in increasing order or sequence is made in our workshops with special care and dexterity . It is highly appreciated during harness installation as it is a signifi cant time saver when placing the installation in service .
- **DRAWING IN THE WARP INTO THE HEDDLE OR COMB**

Harness preparation

Gantry Structure in Conventional Jacquard

Gantry Structure in Conventional Jacquard

- All conventional jacquard machines, either mechanical or electronic, use a frame called gantry to construct the harness system below the jacquard head.
- Problems can arise when jacquards are used on wide looms because the lifting of a hook will give the necessary lift to the heald directly beneath it, but there will be a loss of lift at the sides of the jacquard.
- The height of each individual warp end in the open shed varies depending on the inclination angle of its harness cord to the vertical axis.

Lifting Loss in Conventional Jacquard

- The vertical distance from the bottom end of the central hook to the comber-board is 150 cm
- = the length of the harness cord controlling an end operated by the same hook
- The shed height = 7.5 cm
- The hook will be raised by this amount and will give the required lift at the center of the machine.
- At 90 cm distance from the center of the machine, the length of harness cord, x:

$$x = \sqrt{150^2 + 90^2} = 174.9 \text{ cm}$$

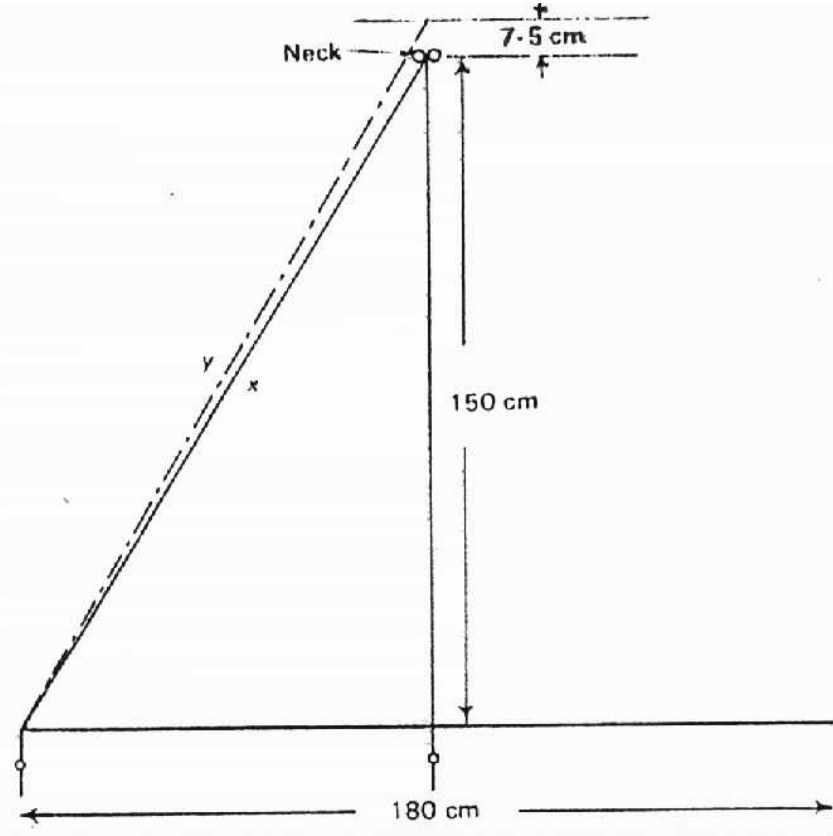


Fig. 4.44 Jacquard lift

Lifting Loss in Conventional Jacquard

- The amount of lift at the side will be equal to y-x :

$$y = \sqrt{157.5^2 + 90^2} = 181.4 \text{ cm}$$

Thus the lift at the side would be 181.4 –174.9= 6.5 cm or a loss of 13.3% in shed height.

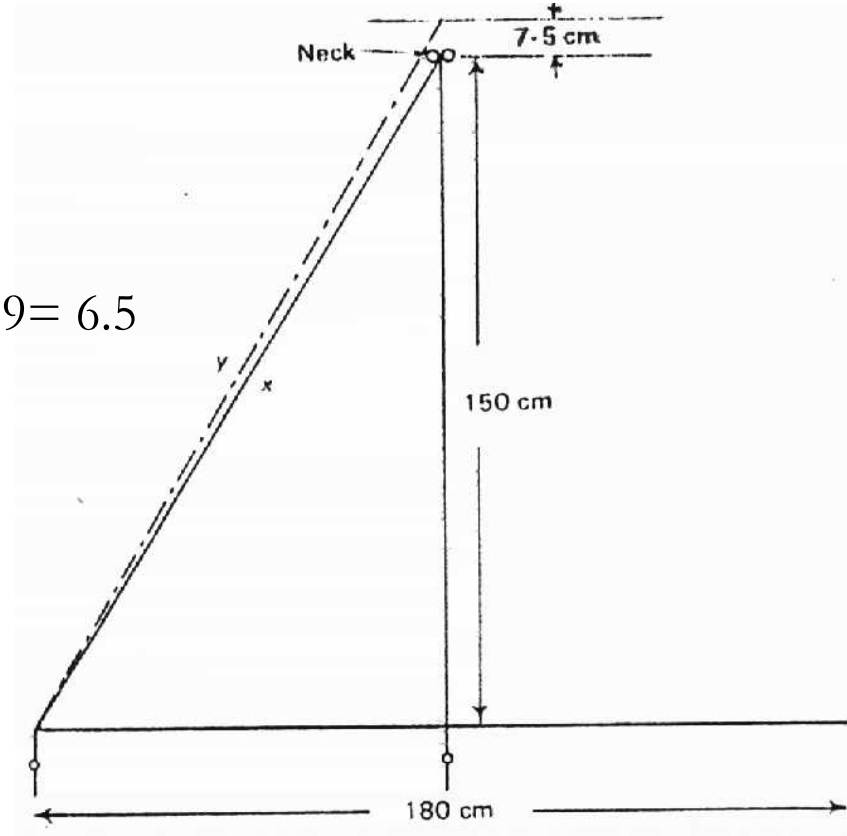


Fig. 4.44 Jacquard lift

Lifting Loss in Conventional Jacquard

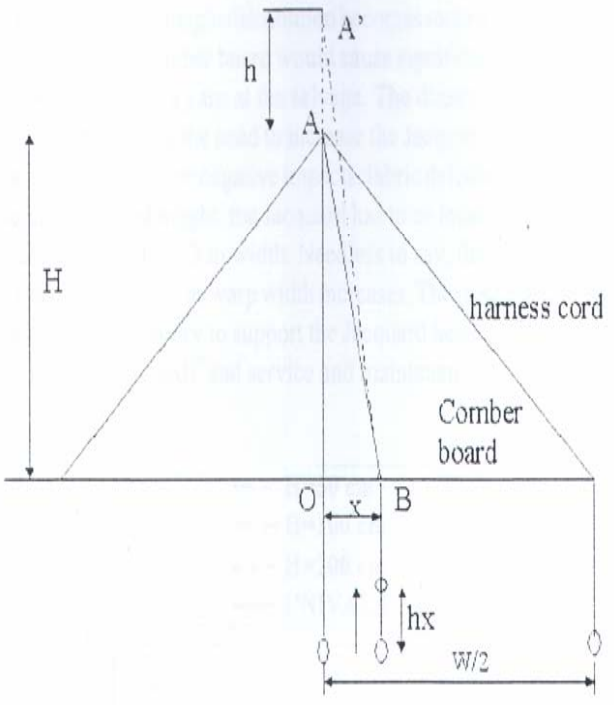
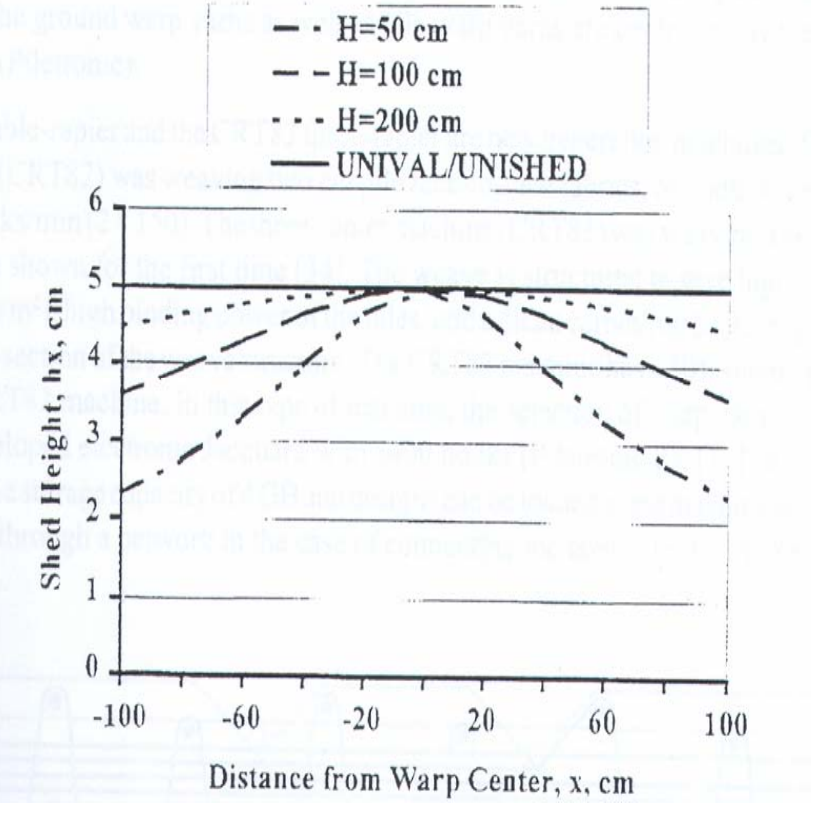


Fig. 9 Geometry of harness tie in a conventional Jacquard system

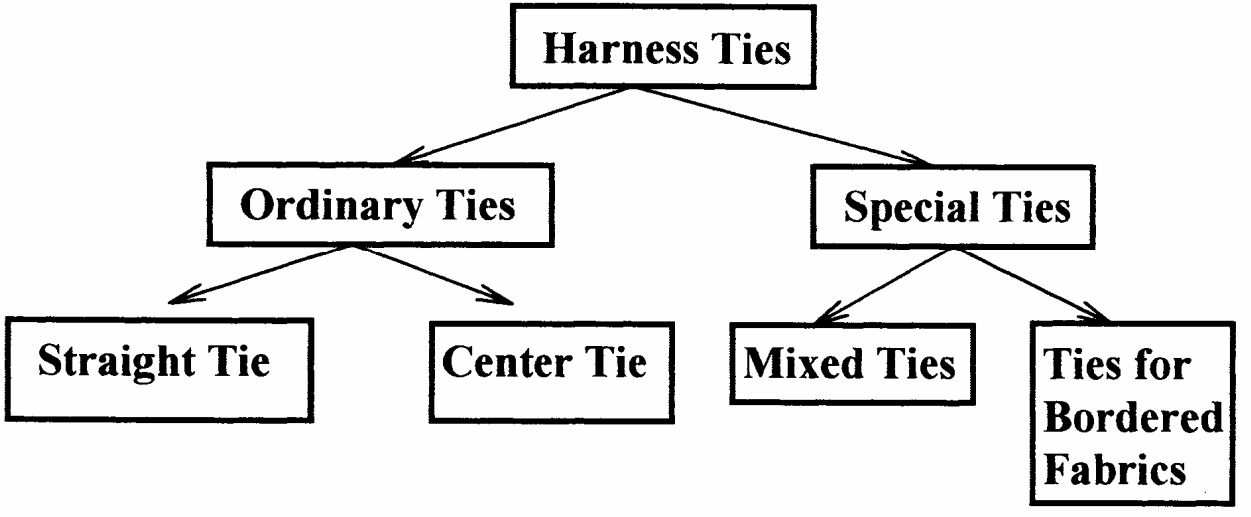


- As H becomes higher the shed height distribution becomes more even.
- Jacquard has to be located at least 2 m from the comber board when weaving a fabric of 2 m width.
- Differential in warp tension, larger shed heights, fabric defects, low speeds.

Harness ties

Types of Harness Ties

A tie in Jacquard weaving describes how the harness cords are threaded through the holes of the comber board. Harness tie in Jacquard weaving is similar to DID in cam and dobby weaving. The following shows the classifications of the different types of harness ties.



Harness ties

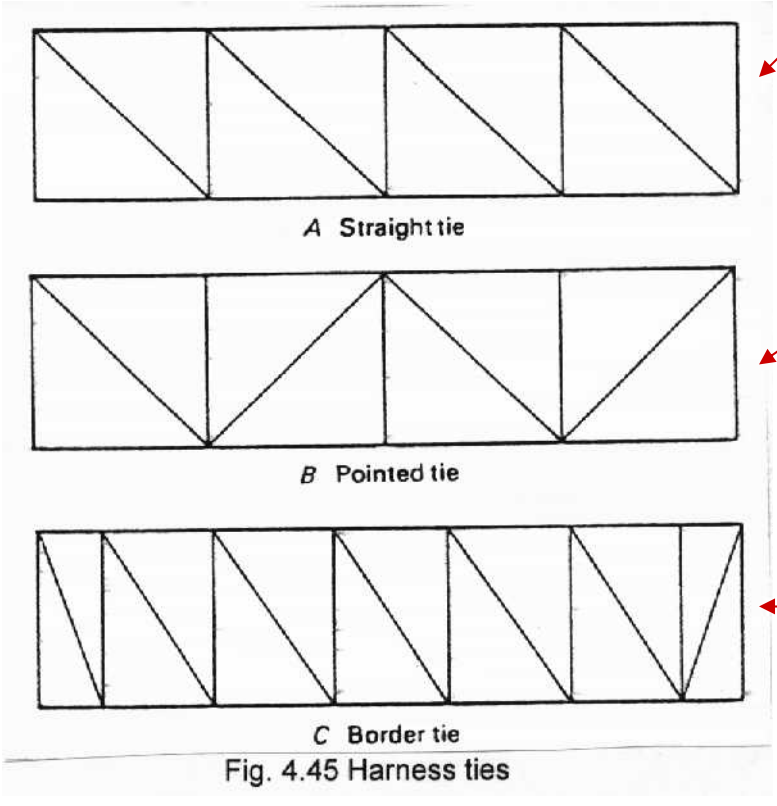


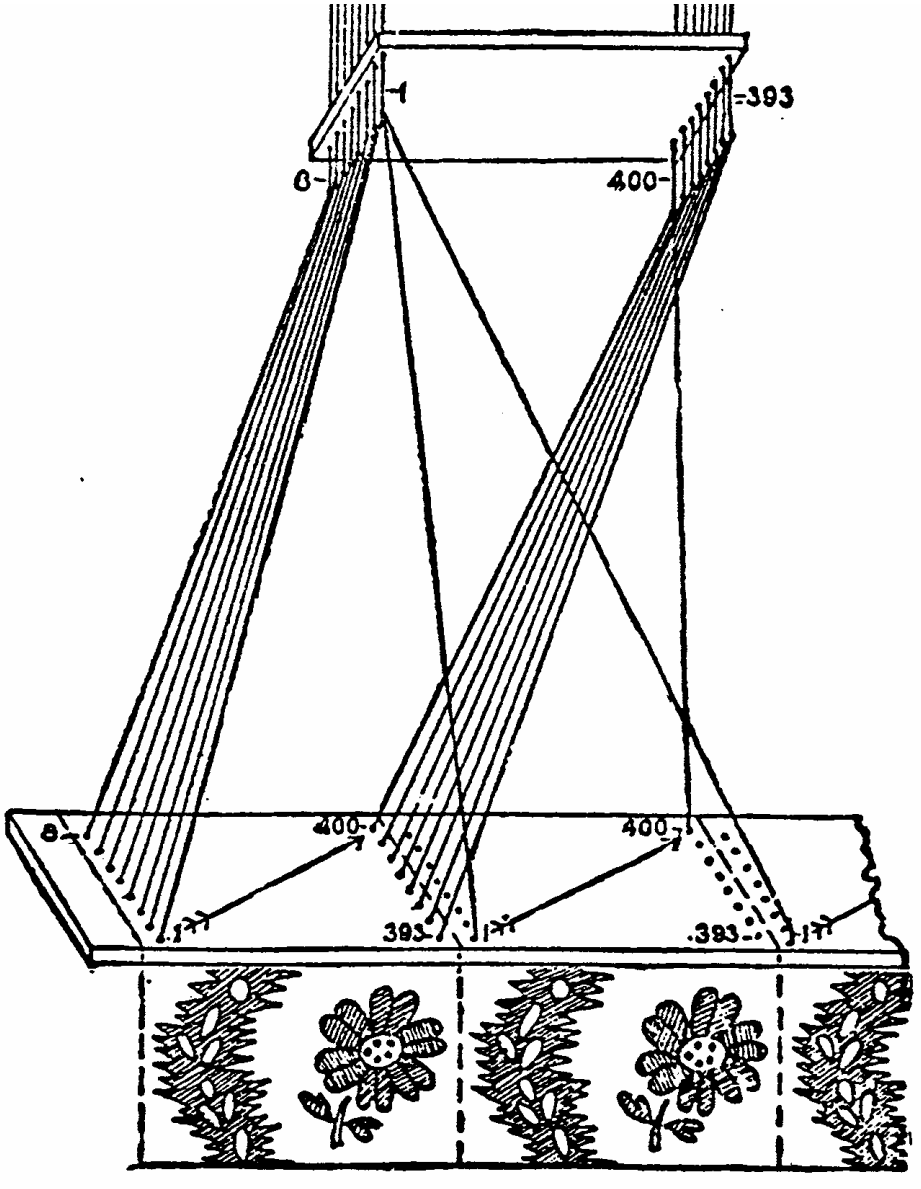
Fig. 4.45 Harness ties

- A straight repeating tie, with four repeats in the width
- A pointed tie: the second repeat is a mirror image of the first, giving the impression of doubling size of repeat, but the design must be symmetrical about its center line
- A border tie: Some of the hooks (say, one -third of the total) can be used to weave borders that are mirror images of each other. The rest of the hooks can then be used in several straight repeats.

Straight Norwich Tie

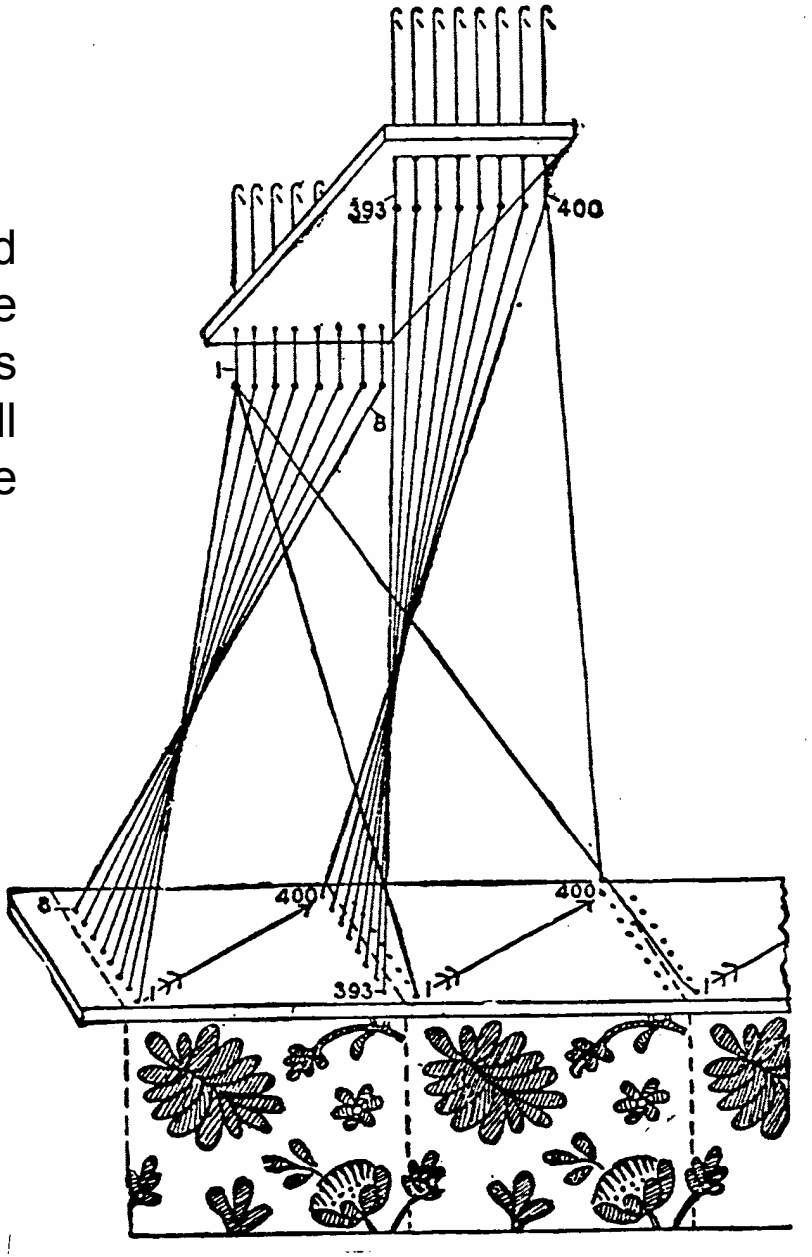
Norwich Tie : Long rows of hooks (or needles) are parallel to the comber-board and at right angles to the warp.

- A neat arrangement of the harness cords
- Design cards will be at the front or at the back and tend to obstruct light in the working areas at the front and back of the loom.



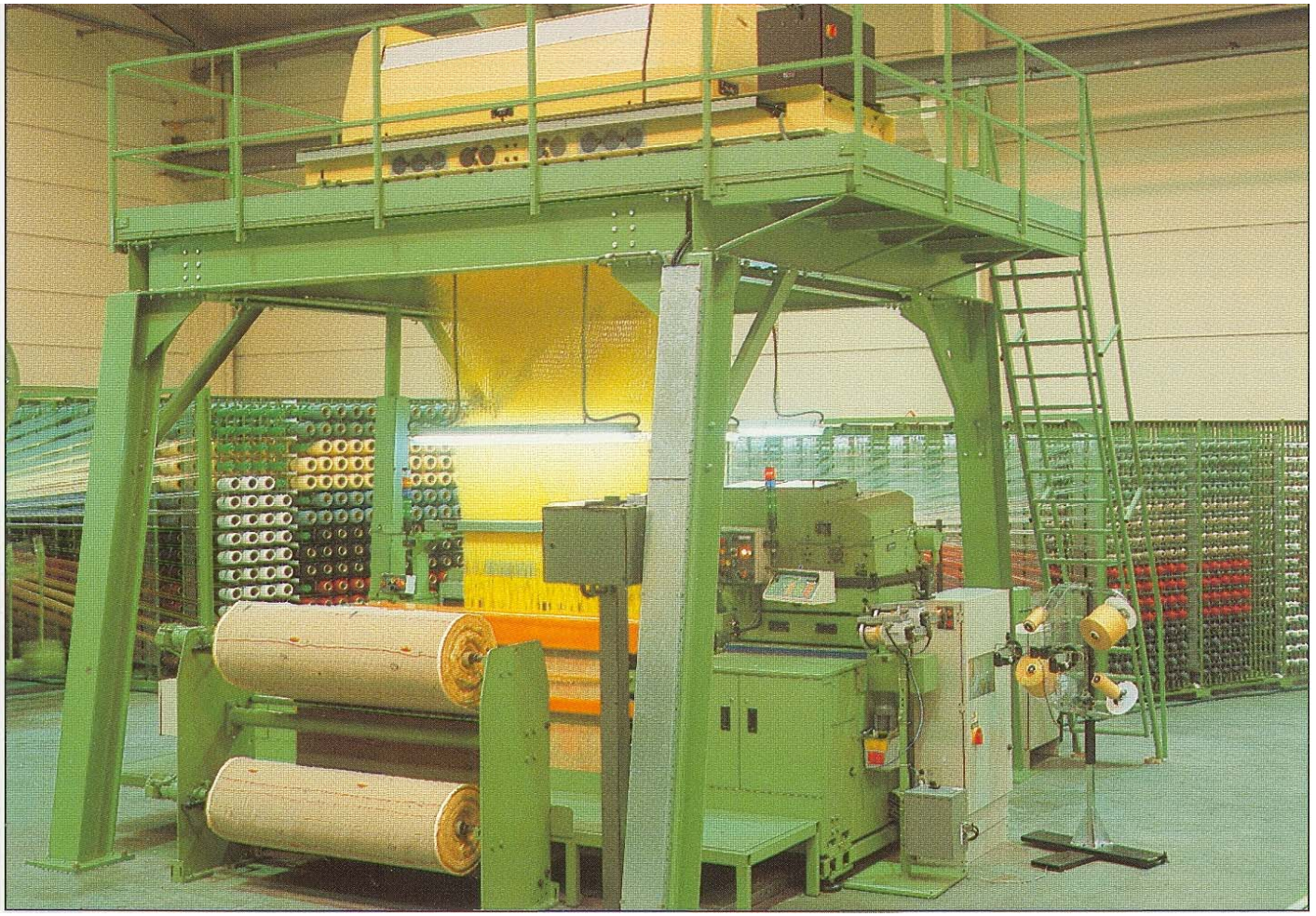
London, Crossed, or Quarter-Twist Tie

- If the jacquard is turned through a right angle, the cards will then fall at the sides of the loom, where they will not obstruct light, but the harness will now be twisted.

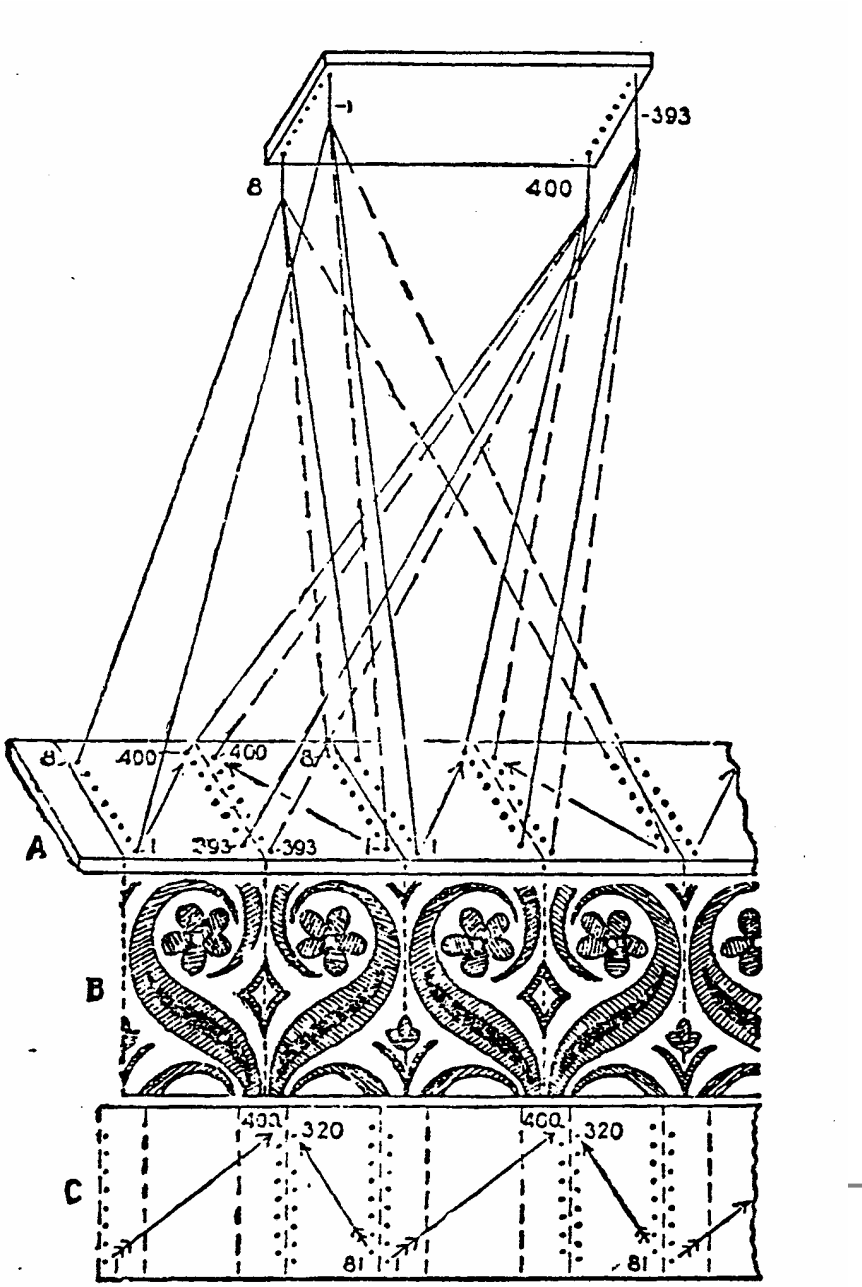


Illumination for the jaquard systems

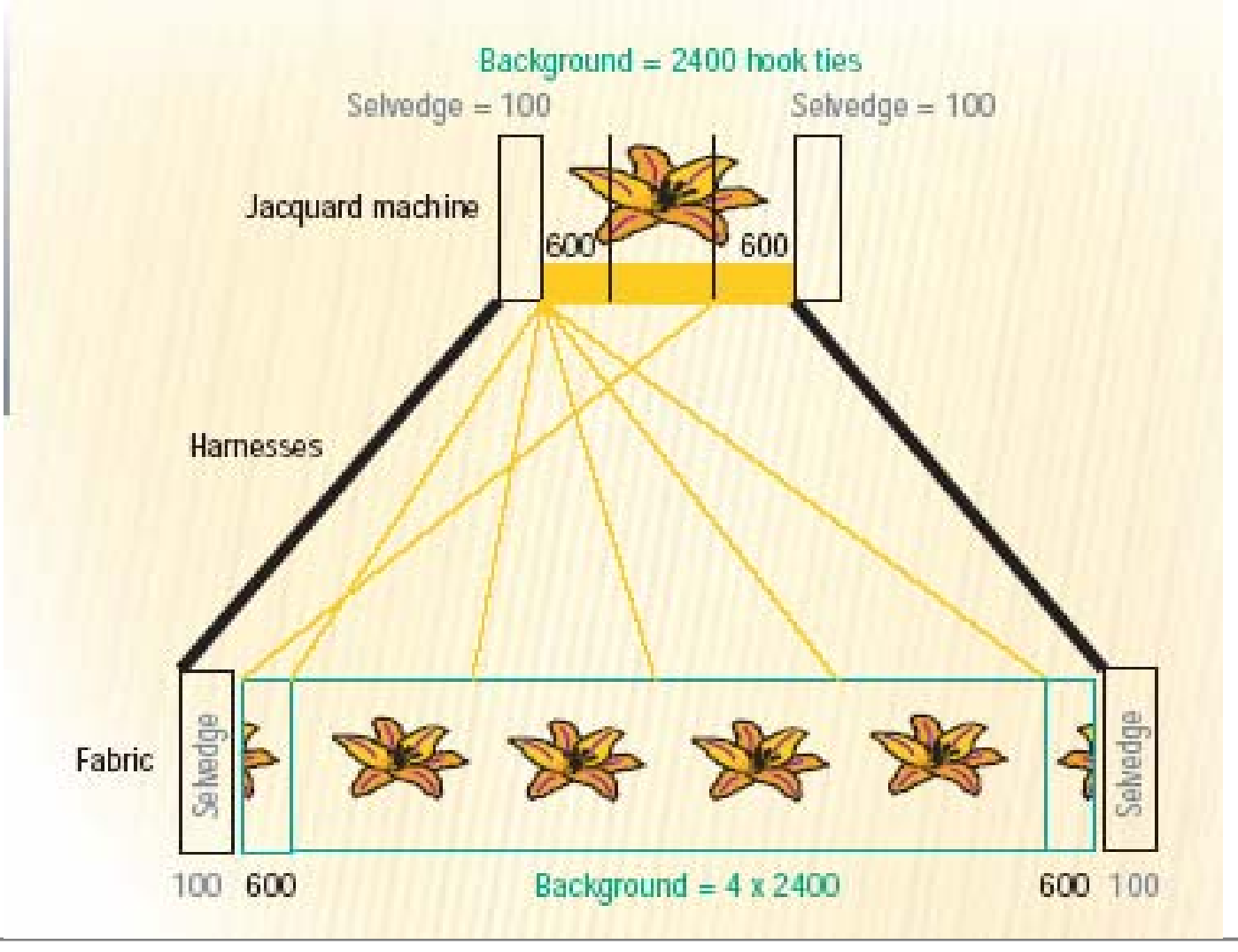
- Both types of tie have their advocates, but, with modern fluorescent lighting, it is easy to secure adequate illumination with the more straightforward Norwich tie, which therefore tends to be preferred.



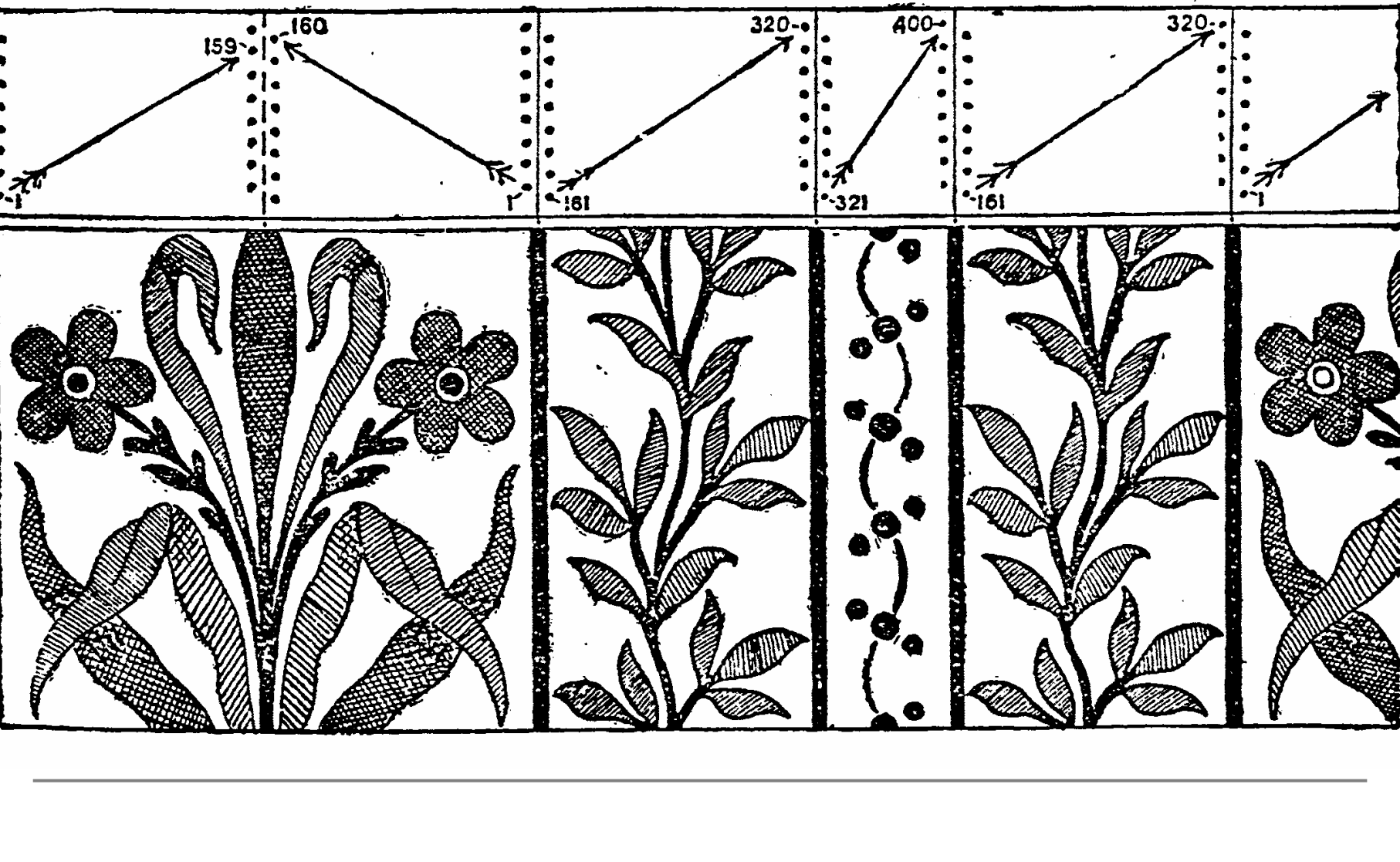
Center or Point Tie



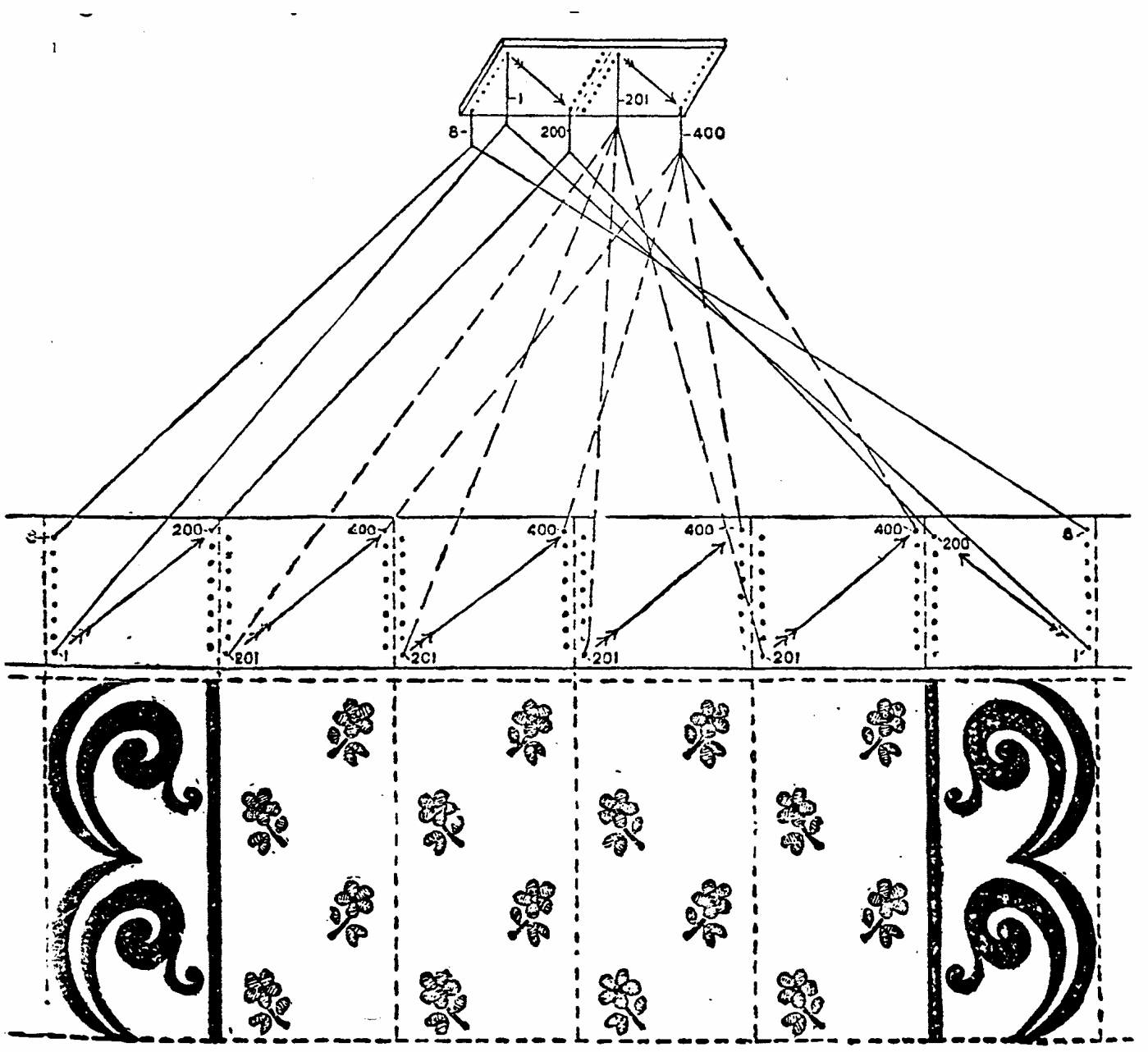
Harness ties



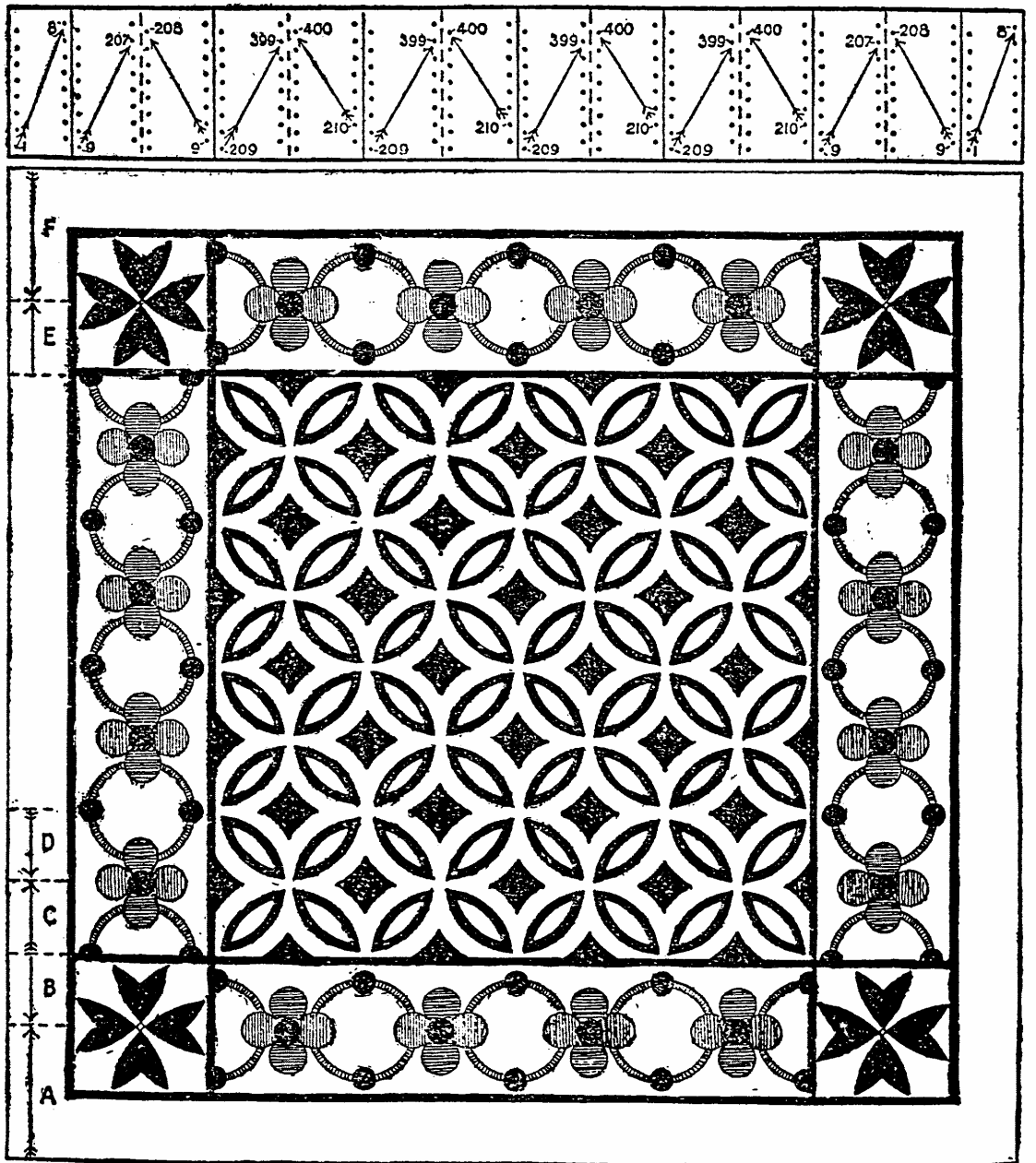
Mixed Tie



Border Fabric Tie



Border Fabric Tie

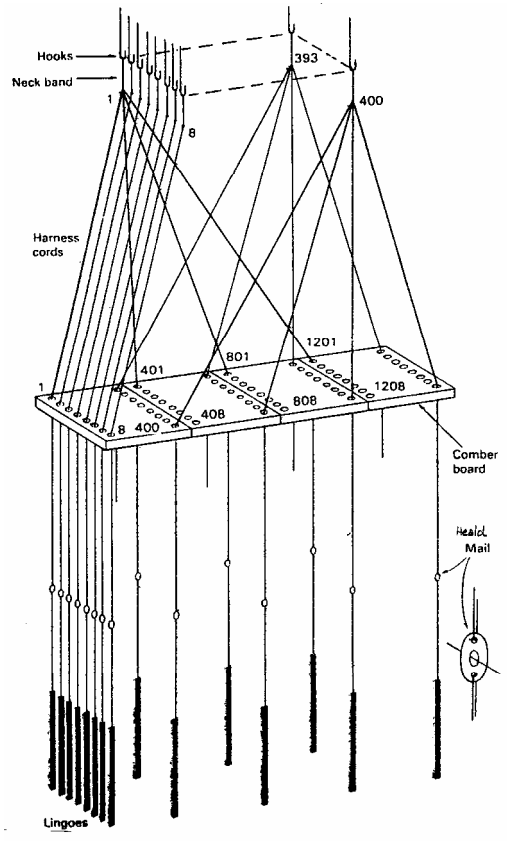


Casting-out

- In cam and dobby shedding, the number of ends/cm can be varied at will.
- With jacquard shedding, the maximum number of ends/cm is determined by the harness system.
- There is no possibility of weaving a fabric with more ends/cm than the harness has.
- It is possible, however, to weave fabrics with fewer ends/cm by casting-out.
- Selected hooks, needles, harness cords, mails remain idle.

Casting-out

- Suppose that the harness is designed for weaving a fabric with 32 ends/cm.
- The size of the repeat will be 400/32 = 12.5 cm (the width of the section on the comber board).
- If we wish to weave a fabric with only 24 ends/cm, we may do this by leaving every fourth row of heald eyes empty.
- We shall then have 300 ends in a repeat of 12.5 cm.
- In casting-out, it is desirable to omit whole rows of hooks if possible in order to simplify designing and card-cutting.
- There can be no hard and fast rules about casting-out.



Casting-Out (or Casting-Off)

Casting-out is the process of weaving designs of number of ends/design repeat less than the number of hooks in the Jacquard head. In this situation the extra mails, hooks, and needles remain idle. The warp should occupy the same width if the comber board is rigid type.

The cast out hooks can be selected in long row(s) or short row(s) and should be regularly distributed rather than selected from one area.

Example of Cast Out

A Jacquard head with the following:

Total Number of Hooks = 304
Type of Tie = Straight

Show the cast out plans for the following repeat sizes:

a) 272 ends/repeat b) 256 ends/repeat c) 240 ends/repeat

Case a

The hooks are arranged in 8 hooks/short row and 38 hooks/long row.

Number of Cast Out Hooks = 304 - 272 = 32 Hooks

Number of Cast Out Rows = 32/8 = 4 Short Rows

Cast Out Plan: Rows # 1, 19, 20, and 38

Case b

Number of Cast Out Rows = (304 - 256) / 8 = 6 Short Rows

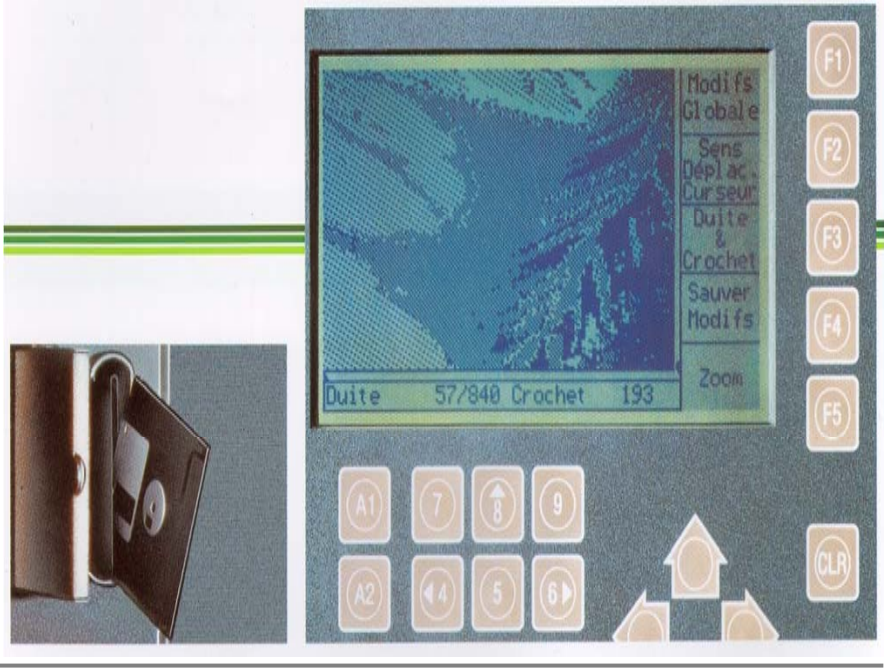
Cast Out Plan: Rows # 1, 10, 19, 20, 29, and 38

Case c

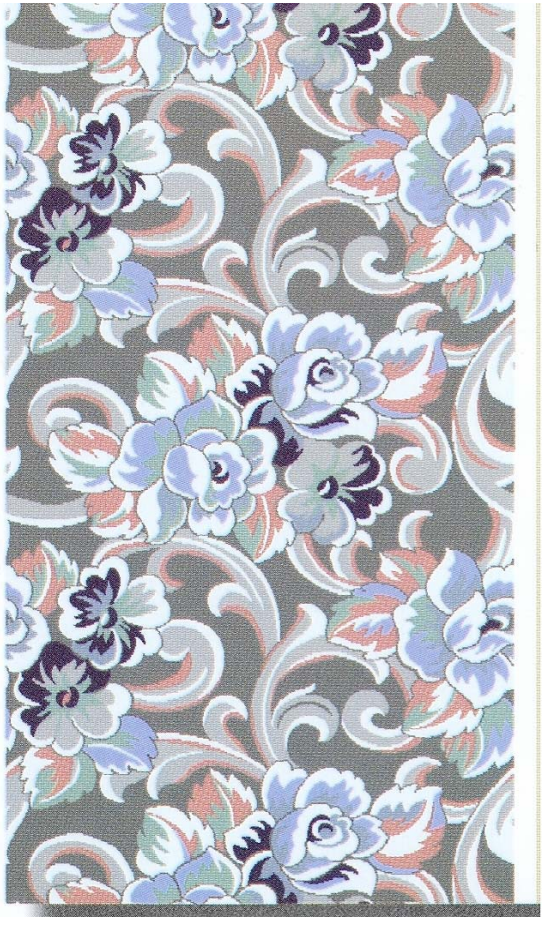
Number of Cast Out Rows = (304 - 240) / 8 = 8 Short Rows

Cast Out Plan: Rows # 1, 7, ~~14~~ 13, 19, 20, 26, ~~33~~ 32, and 38

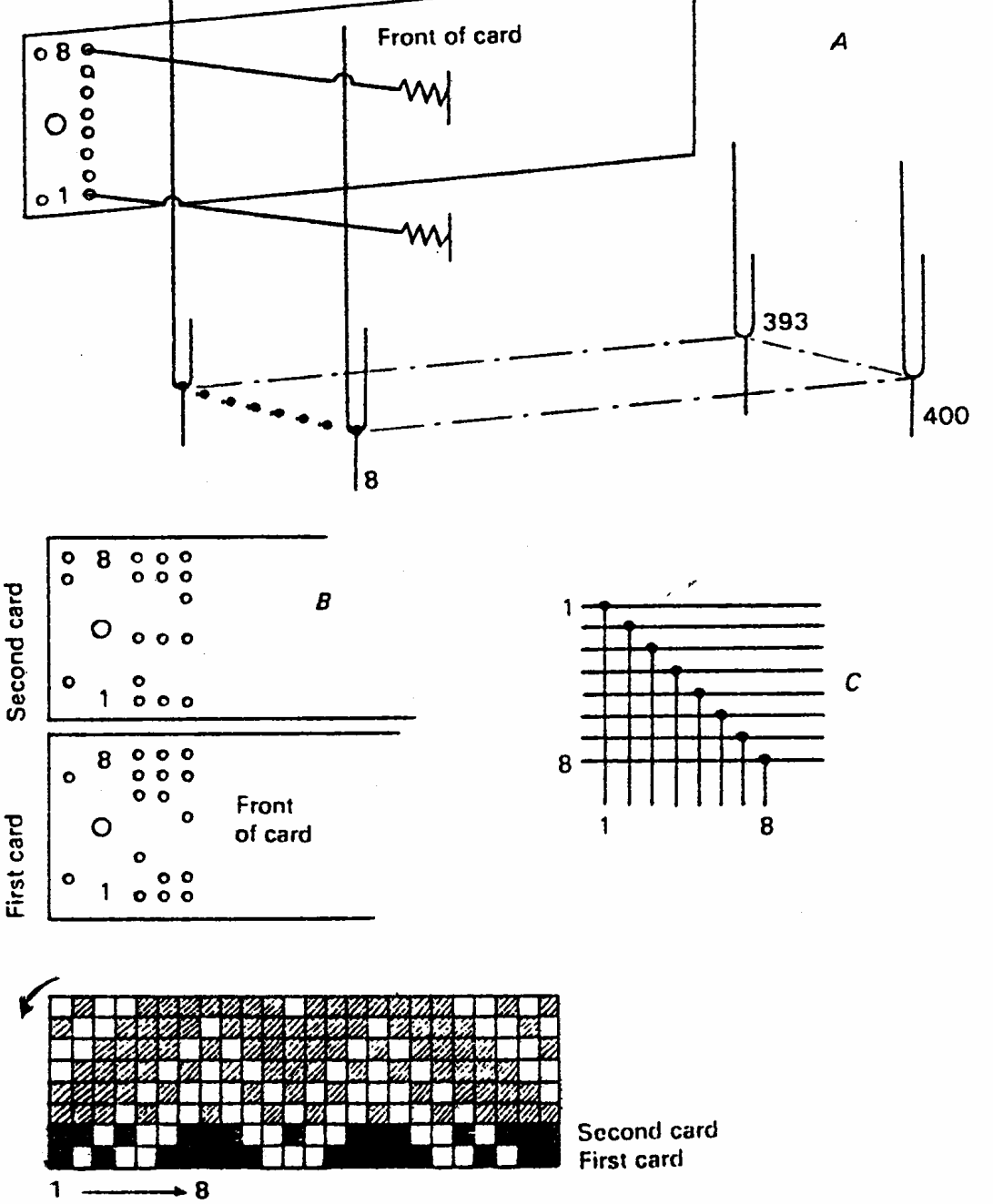
Jacquard designs



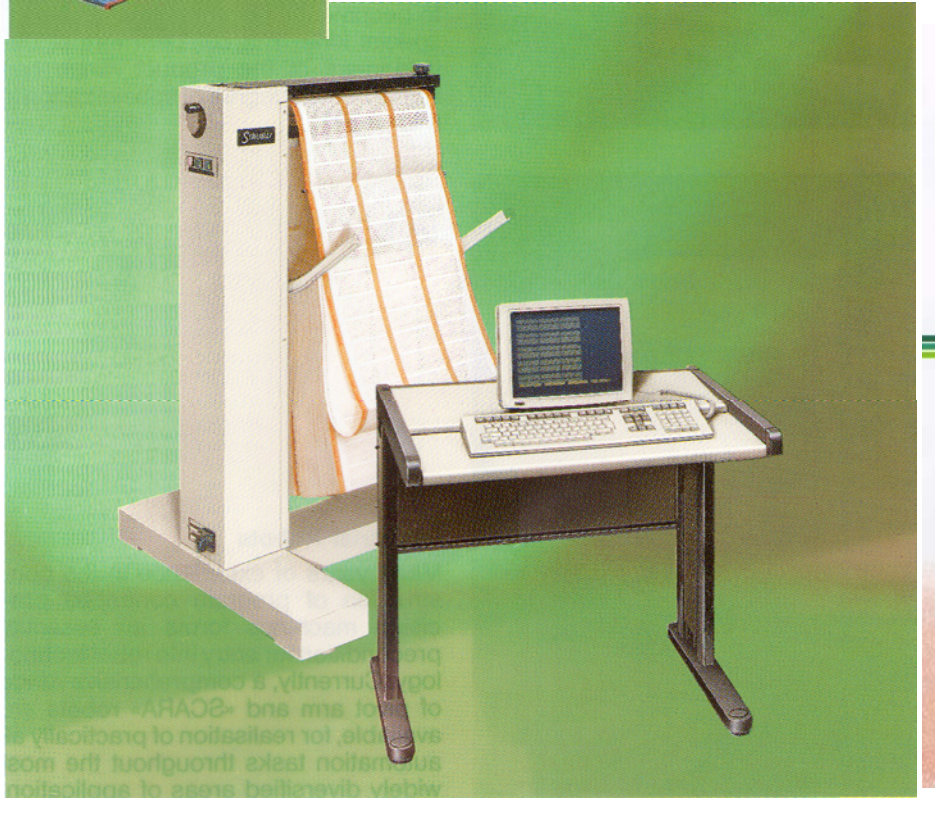
Jacquard designs



Card-cutting instructions



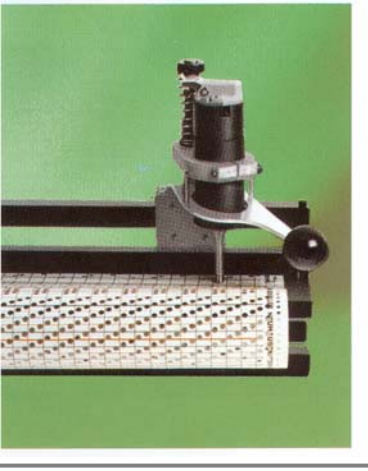
Punching the cards for a Jacquard pattern.



Loops of pattern papers placed in jacquard head .

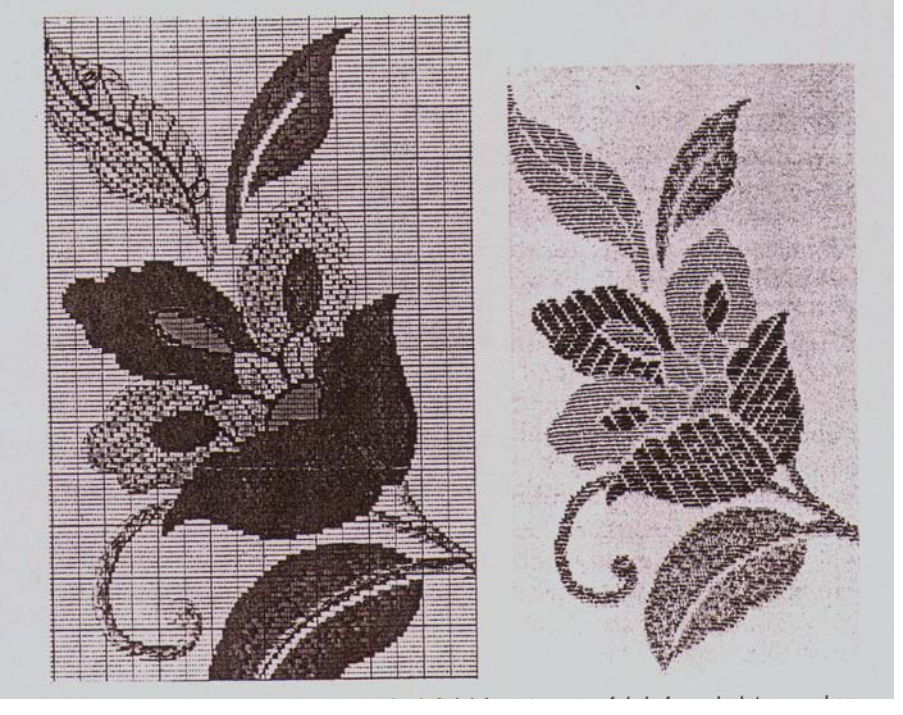
«On-line» Program Changes in the Weaving Room

The portable programming device, Type 18-58 II, or the pocket device, Type 18-59 II, permit direct access to the data stored in the control unit of the electronically controlled dobbies.



JACQUARD WEAVE

- The design for the cloth is worked out in point paper pattern first. In the figure given below, a point-paper design on the left for a tapestry fabric for upholstery and on the right a sample of the actual woven fabric on a Jacquard loom.



Computer-Aided Design Control in Electronic Jacquard Weaving

Magnetic tape rather than cards are used with computer control as explained below.

Computer-Aided Control in Jacquard Weaving

- Since it takes a long time to produce a point-paper design (two hundred hours for one design), the computer can scan the pattern very rapidly and, by means of a program, convert the warp and filling interlacing into a binary number form that can be "read" by the computer.
- A point - paper design is displayed on the computer screen. At this point, the designer can change the pattern by drawing on the screen with a light sonic pen.
- Advantages of these systems are as following:

Computer-Aided Control in Jacquard Weaving

- Computer systems may be too expensive, however, automation shortens the lead time between the design concept and the production of a sample.
- More than one version of a design can be made so there is more opportunity for experimentation in the designing process.
- Fast sampling may be economical because styling approval can be given quickly.
- Manual card cutting is eliminated, for sampling as well as for large-scale production.
- No need for special personnel training and thus, paying competitive wages for jacquard card cutting.
- The magnetic tape required for making the final design can be stored in the computer for future use.
- In the computer-aided system, the information remains in the computer and can be used to control the design directly.

STEPS OF PRODUCING A JACQUARD FABRIC

Manual System		CAD System	
Item	**Time**	**Item**	**Time**
Art Work		Art Work	
Transfer Out Line of Art Work to Design Paper	Several Hours	Copy Art Work to Computer File	Few Minutes
Painting	Several Hours	Done in the above step	
Draw Weaves (Ground and Design)	Several Days	Assign Weaves	Several Minutes
Punch Pattern Cards Short Row by Row	Several Days	Create Punch File	Few Minutes
Lace the Cards	Several Hours	Send Punch File to Loom Electronically	Few Minutes
Stop the Loom to Set the Pattern	1/2 Hour		
Weaving		Weaving	