

# **Adaptation of the Broadloom for Pile Weaving**

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Faculty of Art

College of Art and Social Sciences

Kwame Nkrumah University of Science and Technology Kumasi, Ghana.

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## DECLARATION

I hereby declare that this submission is my own work towards the MA and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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(Head of Department) (Signature) (Date)

## **ABSTRACT**

The production of pile fabrics has been limited to the big textile establishments which make use of power and sophisticated looms that are capable of producing complex or intricate designs. This situation has been in existence since the development of the dobby and jacquard looms which scope has gone beyond the simple plain, twill and satin / sateen weaves to the production of complex or intricate designs. An adapted broadloom has been designed and constructed to increase the scope of the local industry. This project is therefore an attempt to adapt the broadloom such that it can be used for pile fabric production, thereby increasing the scope of the local textile industry and reducing the unemployment situation in the country. A sample has been produced, after the adaptation, as proof that the adapted loom is capable of producing such type of fabric. The whole process and mode of production of the sample have been explained and illustrated in the text. Pictures of the sample weave and the adapted loom have been provided in the report to substantiate the fact that, the broadloom can easily be adapted to suit that purpose.

## **ACKNOWLEDGEMENTS**

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## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Statement of the Problem.**

The production of woven pile fabric is only done on Powered Looms and not on Broad Looms. Printex, the only factory in Ghana that is now engaged in this line of fabric production, offers no training programmes for people to study this art. Even if they were willing to train people to produce pile fabrics, how many people can they offer the opportunity? What will be the cost of training? Will it be affordable to people in all income groups?

Limited production of pile fabrics is a contributory factor to the high cost of toweling fabrics in Ghana. There is the need for adapting the technology to suit local production of pile fabrics. This will not only offer employment to people but also expand the scope of the local textile industry and the textile curriculum of Ghanaian Schools and Colleges. This thesis therefore seeks to modify the existing broadloom for the production of toweling fabrics in Ghana.

#### **1.2 Objectives**

The objectives of the project are to:

- (i) design the sample modified Broadloom and pile fabrics to be woven.
- (ii) identify, describe and discuss materials and tools required for adapting the existing Broadloom.
- (iii) produce sample pile fabrics on the modified Broadloom.

- (iv) produce an illustrated report on the modified broadloom weaving.

### **1.3 Hypothesis**

A careful modification of the Broadloom would make it suitable for pile or terry weaving.

### **1.4 Delimitation / Scope**

The project is limited to the use of a modified Broadloom for weaving sample pile fabrics.

### **1.5 Methodology**

The descriptive, experimental and analytical methods of research were adopted to describe the tools, equipment, materials and processes involved in modifying the existing broadloom and weaving the sample pile fabrics. The experimental research approach was used for the production of sample fabrics on the modified broadloom and the analytical research approach was used to appraise the efficiency and effectiveness of the loom for the weaving of pile fabrics.

### **1.6 Limitations**

As a result of frequent breakage due to the poor quality of some of the spun cotton yarns bought for the project, the production process was slow and difficult, making it impossible for the researcher to produce samples for all the designs outlined for the project. The researcher's inability to provide the proper mechanism for controlling the



length of gap between the fell of the cloth and the two succeeding picks of weft resulted in the creation of variable loop height in the sample fabric.

## 1.7 Abbreviations

Some of the abbreviations used in the text include:

C.N.C. - Centre for National Culture

ITTU - Intermediate Technology Transfer Unit

M.O.E. - Ministry of Education

NBSSI - National Board for Small Scale Industries

NFED - Non-Formal Education Division

NGO's - Non-Governmental Organizations

S.S.S - Senior Secondary School

KNUST - Kwame Nkrumah University of Science and Technology

## 1.8 Definition of Terms

Some of the important terminologies used in the project are:

**Beaming** : The process of stretching the long warp taut and rolling or winding onto the Warp beam in the loom.

**Beating in (up)**: The process of pushing or forcing the weft yarn inserted in the shed close to the fell of the cloth with the beater.

**Bobbin**: A package of yarn spun or wound on a central supporting core or former: the core or former without yarn on it. It is also called pirn or quill.

**Bobbin Winder**: A device used for winding yarns onto bobbins.

**Bobbin**: A small wooden with metal rod used for carrying weft yarns.

**Braiding:** Interlacing of separate strips of cloth or yarn by diagonally plaiting one over and under another. This does not interlace at right angles. Used decorative purposes.

**Cam:** A wheel shaped in a special form to change the up – and – down movements of heald shaft on looms.

**Castle:** A wooden device used to check the height of the heddle frames for leveling before the tie – up.

**Crosses:** These are established during warping to facilitate the shed creation in weaving.

**Dents:** The space in-between the splints of the reed in which the individual threads are passed through.

**Draft/Drafting:** In weaving, draft shows the order in which the warp yarns are passed through the eyes of the healds and the number of the healds used for a design.

**Fell of cloth:** The end of the cloth in the loom, formed by the last picks beaten in.

**Ginning:** The process of removing cotton seeds from the fibres.

**Guide String:** A strand of thread or string usually of a contrast colour wound around the Warping mill to direct the weaver the length and direction of the warp to be laid.

**Harness:** Two or more shafts on which the healds are hanged.

**Healds:** The individual strings arranged on frames to form the heddle.

**Heddlings:** The process of passing the warp ends through the eyes of the healds.

**Horse:** A wooden frames on which the heald shaft hang.

**Lams:** The connecting links between the harnesses and the treadles.

**Peg Plan:** Referred to as the Tie-Up which shows the manner in which the individual treadles are to be tied to the heddles to show how they will be raised for weaving.

**Picking** : The insertion of weft yarn in the shed by the fingers or shuttle. It is also known as shooting.

**Pick (shot)**: A single length of weft, from one edge of cloth to the other.

**Plied yarn**: The method of doubling, tripling etc. of yarns for weaving.

**Presser wheel**: A device used for beating-up in circular looms.

**Raddle**: A wooden device with dents used for spreading yarns during beaming.

**Raddling** : The spreading of the warp sheet across the loom equally among the spaces in the raddle (a broad wooden or metal comb) to check the width of the cloth to be woven.

**Reed**: A comb-like structure in the beater.

**Reeding**: The passing of the ends/warp threads through the dents in the reed.

**Reed Hook**: A flat metal piece, some shaped like the letter “S”, used for reeding.

**Shedding**: The process of creating the V-shaped opening in the warp for picking by raising or lowering alternately to separate the warp into two sheets.

**Spool Rack**: A wooden frame with metal rods used for unwind yarns from bobbins.

**Winder**: A wooden device used for unwinding hanks.

**Treadles**: Devices stepped on or depressed for lowering and lifting of heddles to create a shed.

**Threading/Heddling Hook**: A metal hook with a wooden handle used for passing the warp yarns through the eyes or center loops of the healds or heddles

**Warp**: The yarns, also called ends that run lengthwise in a woven fabric.

**Warping**: The process of putting many long yarns together to form the warp.

**Warping Board**: A wooden frame which is mounted with twelve pegs around which any length of warp could be wound.

**Warping Mill:** A wooden frame which consists of four upright post mounted on a metal rod which spins freely in a socket at the base around which any length of warp could be wound.

**Weft:** Sometimes called the pick, shot, woof or filling yarn is the yarn that run breathwise in a woven fabric.

### **1.9 Importance of the Study**

The result of this project will substantiate the fact that the Broadloom can be adapted to make it suitable for the production of terry fabrics. This will offer people already involved in the production of woven fabrics the chance to explore their creative abilities to foster creativity and ingenuity in the designing process and weaving of pile fabrics. This will greatly expand the scope of the local textile industry and the curriculum of Ghanaian schools and colleges.

This will also serve as an encouragement to the government, the Non-Governmental Organizations, National Board for Small Scale Industries, the Industries, the Intermediate Technology Transfer Units, Ministry of Education, the Non-Formal Education Division of the MOE, other organizations and individuals to invest in this art of fabric production. This will again help in the recruitment of more people into the textile industry thereby helping to find solution to the unemployment menace.

### **1.10 Arrangement of the Text**

Chapter two is connected with the review of related literature. This however, caters for the art of weaving, looms, loom operations, types of looms, horizontal loom, vertical loom, kente loom, jacquard loom, the broad loom, weaves, the plain weave,

the twill weave, the satin or sateen weave, pile or terry fabric, formation of the pile, looms used in pile/terry fabric weaving, fibre suitable for toweling, cotton, viscose rayon, linen, and properties of some fibres.

Chapter Three deals with tools, materials and production processes. Under this, the researcher looked at equipment used, types of broadloom, accessories, modification of the broadloom, tools and materials required, materials, designing of sample fabric, preparation for weaving, warping, beaming, heddlings, reeding, tie-up, weft preparation and weaving.

In Chapter Four, the result of the project is given in the following discussions: the appraisal of the adapted parts of the broadloom, the appraisal of the woven sample, comparison between the Broadloom Sample weave and the Factory woven Pile fabrics, the interpretation of the results from the comparison of samples, problems encountered and some possible solutions and the test of hypothesis.

Finally, Chapter Five rounds it up with the summary, conclusions and recommendations. This part begins with the summary of findings from the project, the conclusions of the report and some recommendations made by the researcher.

## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE.**

Pile fabrics are normally woven on powered looms. It is therefore important that the reader understands woven fabrics. Woven fabrics on the loom are the result of interlacing sets of yarns at right angle in established sequences. The interlacing is the result of the combination of both warp and weft to produce a woven structure.

#### **2.1 The Art of Weaving**

Weaving is one of man's oldest industrial art. According to the Encyclopaedia Britannica (1968), man has practised the art of weaving since the mid-5<sup>th</sup> Century B. C. The source states that in the late 18<sup>th</sup> century, man took the first major steps towards turning the weaving art into an industry in the modern sense of the term.

Simpson and Weir (1967) state that one of the earliest methods of weaving was to tie the warp strands to a low hanging branch of a tree and weighting each strand by tying a stone on to the other end. This method of weighting the strands with pear-shaped pieces of clay or lead is evident in pictures of Greek looms and also form part of relics dating to 5<sup>th</sup> Century B. C. that were found during excavations in Greece as indicated by Encyclopedia Britanica (1968). Figures 1 and 2 are examples of this.

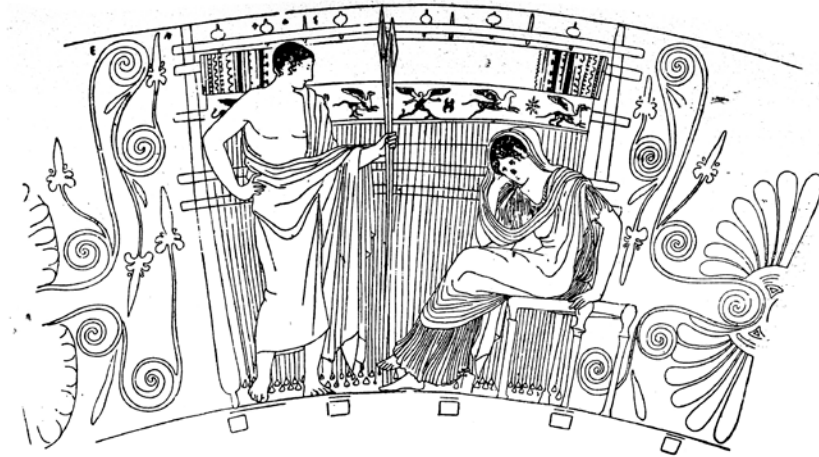


Fig 1

One of the earliest looms with ‘loom weights’ of pear – shaped pieces of clay or lead.

Penelopes loom from a Greek vase painting.

Source: Simpson and Weir (1967)



Fig. 2

Earliest – known illustration of a loom. Bowl found at AL BADARI (Central Egypt)

decorated with a representation of an ancient Egyptian horizontal loom dating 4400

B.C. Source: Eencyclopaedia Britanica.

Joseph (1966) is of the view that weaving is one of the oldest art forms known to man. The author's argument is based on the archaeological findings located in Switzerland and Egypt. Joseph states that remnants of loom weights and fabrics excavated in the Swiss lake region indicate that prehistoric man knew and practised weaving. According to her, while no looms were preserved from early civilizations, fabrics of fine quality have been found in excavations of tombs in Egypt. The author indicates that designs on early pottery forms unearthed in archaeological diggings provide evidence of man's skill in weaving and the type of looms they probably used (Fig. 2).

Weaving has resulted primarily from man's need to provide protection from the vagaries of the weather and developed to the phase in which aesthetic considerations have changed the form of production. The Encyclopaedia of World Art (1967) asserts that the art of weaving has evolved from a strictly utilitarian phase (concerned primarily with supplying protection from the elements) to subsequent phases in which aesthetic considerations have conditioned the forms of production, making them parallel to those of the art activity of a given period. It further states that although early man undoubtedly possessed some knowledge of textile art, which includes netting, wattling, basketry, the spinning of yarn and the weaving of cloth, the major development of weaving came at a fairly late date in man's cultural development.

According to Booth (1976), evidence exists of the practice of weaving in the Mesopotamian region during the Neolithic period (New Stone Age) of about 3500 B. C. The author states that Greeks were known to have exported cloth to the East in exchange for carpets by 600 B. C. This suggests that weaving has a long history and that this art was practised in different regions during the early periods of man's



existence. Weaving therefore is not new to man but is one of his oldest forms of art and dating as far back as the mid-5<sup>th</sup> Century B. C.

Different methods were used in providing structure for weaving to be effected and the earliest was to tie the warp strands to a low hanging branch of a tree and weighting each strand by tying a stone on the other end. It has been observed that there has been a systematic change in the type of structure used in weaving – from the simplest means of hanging the warp strands to a low hanging branch, through the various types of table looms, and foot-powered looms, to the electrically powered looms and finally to the electronic controlled looms.

## **2.2 Looms**

Simpson and Weir (1967) are of the view that the early looms used in weaving were very crude devices when compared with modern mechanical weaving devices. According to Joseph (1966), until the early 19<sup>th</sup> century, weaving was primarily a hand or manual process. During the late 1700s and early 1800s, scientists and inventors such as Jean Marie Jacquard and Edmund Cartwright developed weaving looms that were partially machine powered and later manufacturers produced looms that were entirely mechanical or power driven. Looms vary somewhat in structure and may be horizontal or vertical.

Although looms may be different, they all have a means of providing tension for the warp, a way of spreading the warp to create a shed for the weft to pass through, and a device for packing the weft (picks) tightly together ( Fig. 4). According to Simpson

and Weir (1967), the early types of loom are referred to as primitive looms (Fig. 3) and have characteristic shed sticks and leashes.



Fig 3a

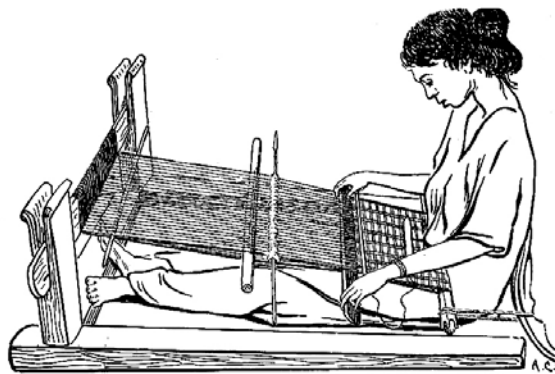


Fig 3b

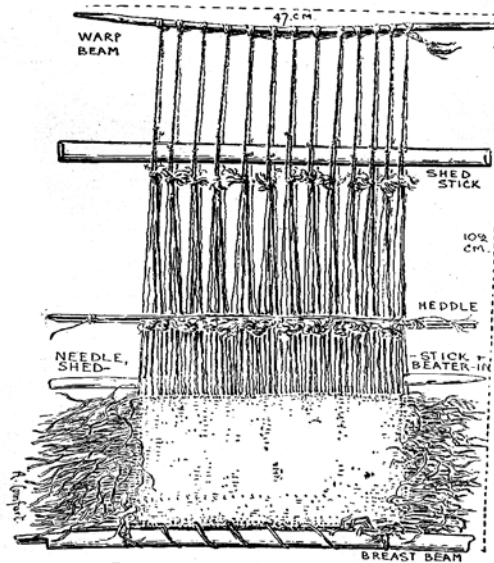


Fig 3c

Fig 3: Primitive Looms.

Source: L. E. Simpson & M. Weir, 1967.

## **2.3 Types of loom**

The following form part of large variety of looms available for weaving:

1. Horizontal Loom
2. Vertical Loom
3. Box Loom
4. Table Loom
5. Inkle Loom
6. Power Loom (a. Dobby Loom b. Circular Loom c. Jacquard Loom)
7. Traditional Loom
8. Broad Loom

### **2.3.1 Horizontal Loom**

The horizontal loom (Fig. 5 A,B) embodies a reed and two heddles which are attached to rough pedals and lowered by means of the feet. In the case of figure 5A the finished braid (woven fabric) was rolled up, but the warp was knotted round a peg stuck in the ground. When the weaving has proceeded almost as far as the heddles, the weaver leaves it and walks a few yards in order to release more warp from the peg, then rolls up the work and proceeds with the weaving. This process of the release of more warp in horizontal looms differs from the process in the Broad loom used by the researcher. With the Broad Loom, the weaver uses a handle (29; Fig. 30) which is connected with a cord to release a metal tensioning device – the ratchet pawl which checks the free movement of the ratchet wheel to which the warp beam is attached while sitting.

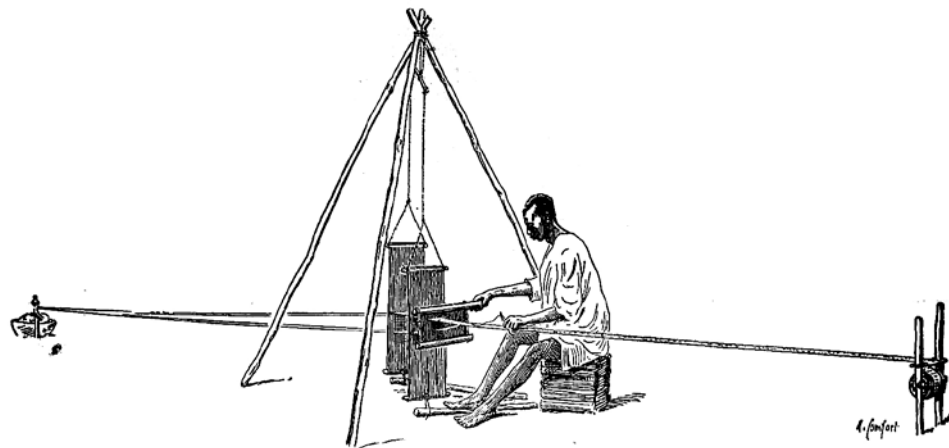


Fig. 4a

Horizontal Loom

Source: Simpson and Weir (1967).

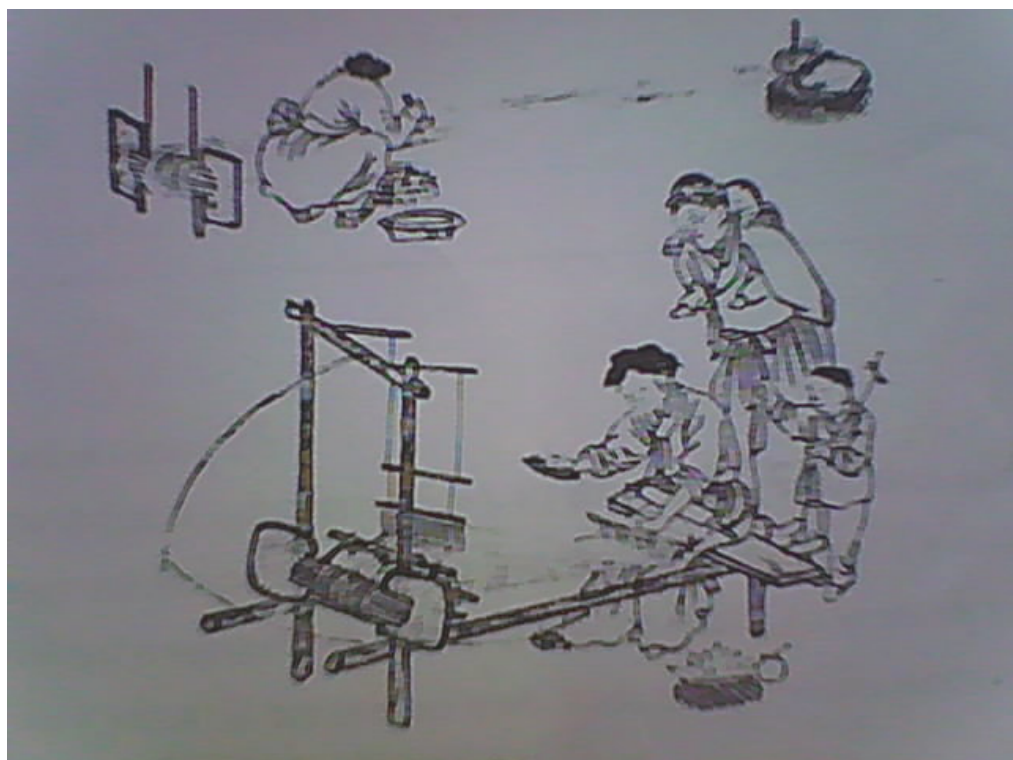


Fig. 4b

Horizontal Loom

Source: Encyclopaedia Britannica (1968).

### 2.3.2 Vertical Loom

The vertical or upright loom (Fig. 6 A. B.) embodies the same ideas as the other looms but is larger and stronger than the horizontal, box and table looms. It is made to stand on the floor and is equipped with an arrangement for altering the tension of the warp. Fig B shows a vertical foot - operated loom. It has treddles which are operated like that of the horizontal and the broad looms. Both horizontal and vertical types of loom are used in producing rugs, mats and tapestries for cushion or for covering the seats of chairs and stools.

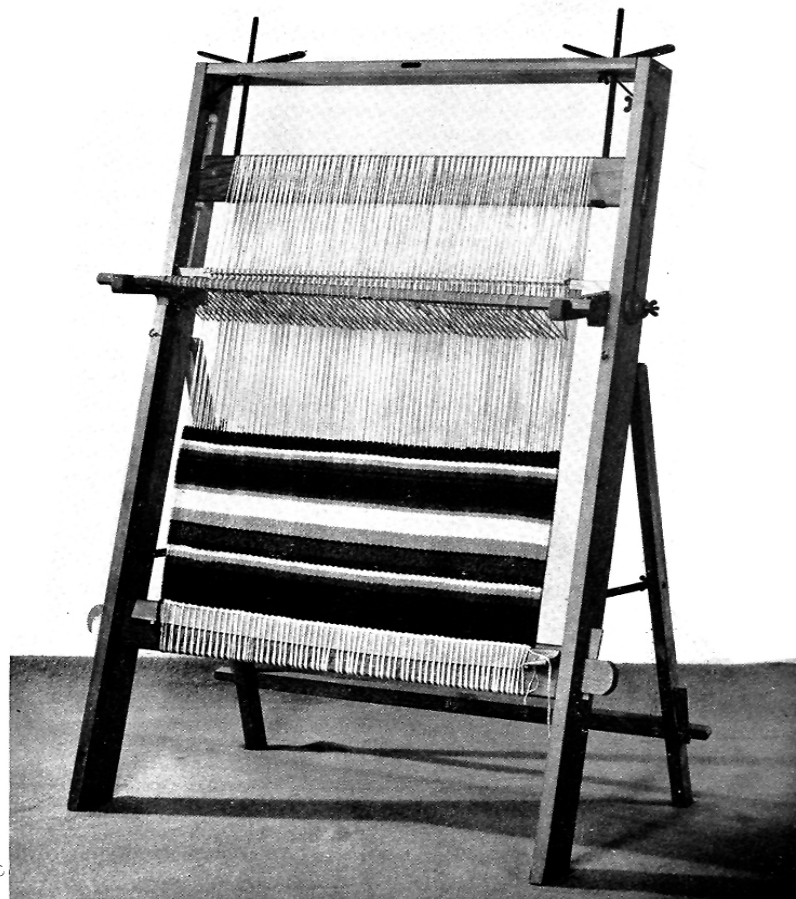


Fig. 5a

Dryad Upright Loom.



Fig 5b

Dryad Upright Foot – Powered Loom

(Fig 5a & b) Source: Simpson and Weir (1967).

### **2.3.3 Box Loom**

The box loom (fig 8) is a very simple type of loom. It has two rollers and two heddles and designed for plain weaving only. An additional pair of heddles is required for pattern weaving. The heddles on the box loom can be lifted, and the resulting patterns are in accordance with the order in which lifting is done.

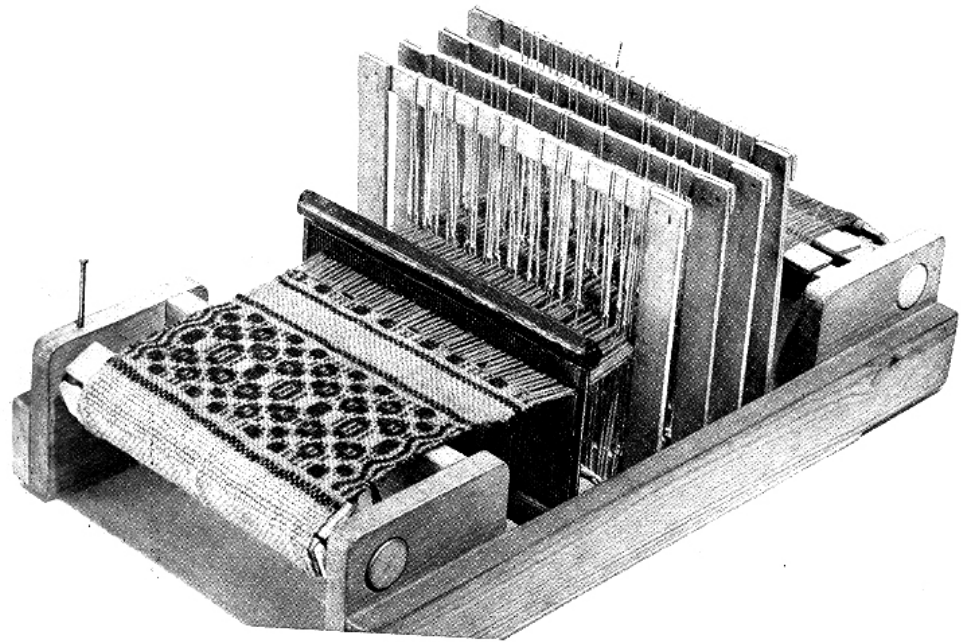


Fig. 6

Four – Heddle Box Loom

Source: Simpson and Weir (1967).

#### 2.3.4 The Table Loom

The table loom has no legs and foot pedals or treddles. It does practically the same work as a large pedal loom, but on a smaller scale. Generally speaking, the treddles in table loom are lifted with the hand, though some models have levers at the side to which the heddles are attached, and which when pressed, pull down the corresponding heddle frame for the shed to open.

Fig. 9A, B, and C, show three types of table loom. These differ in some details, the general construction and working principles are the same. Even though the same weaves may be produced on the table and broad looms, it is better to use the broad loom for broad and long lengths of fabrics because it takes a longer time to operate hand levers since one uses the hand in operating the levers and the same hands to pass

the shuttle through the shed. It is also difficult to weave a broad and long length of fabric on the small size of the table loom.

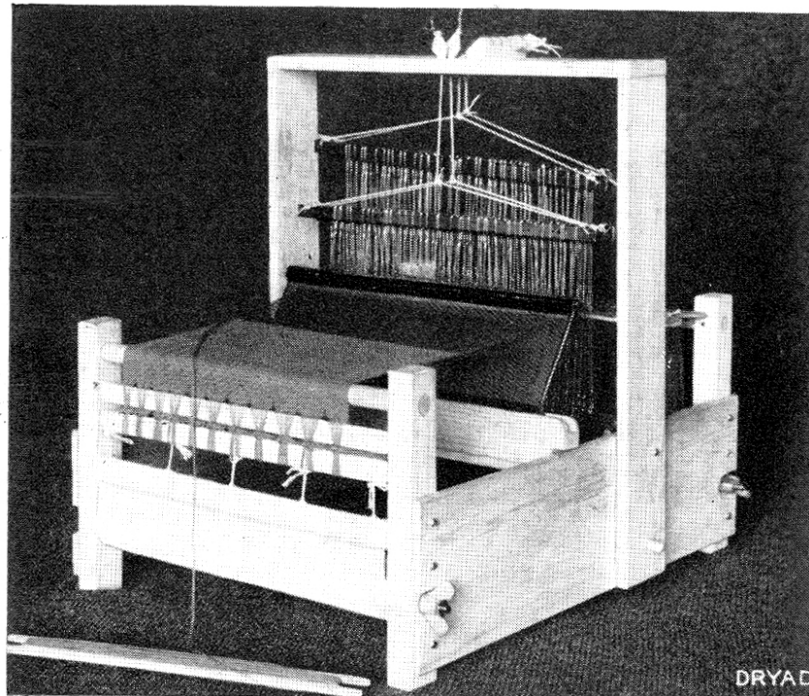


Fig 7a - Dryad 'Wendy' Loom.

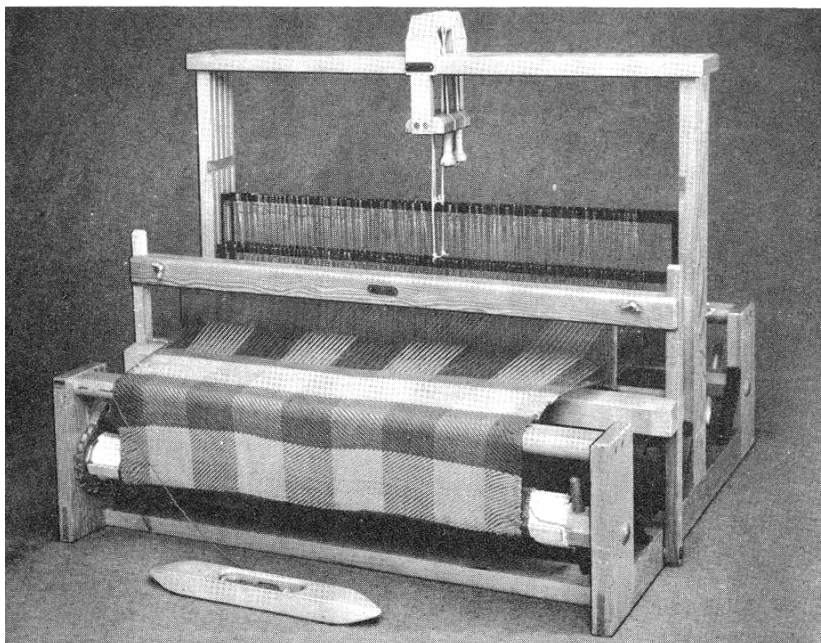


Fig. 7b – Dryad 'Cottage' Loom.



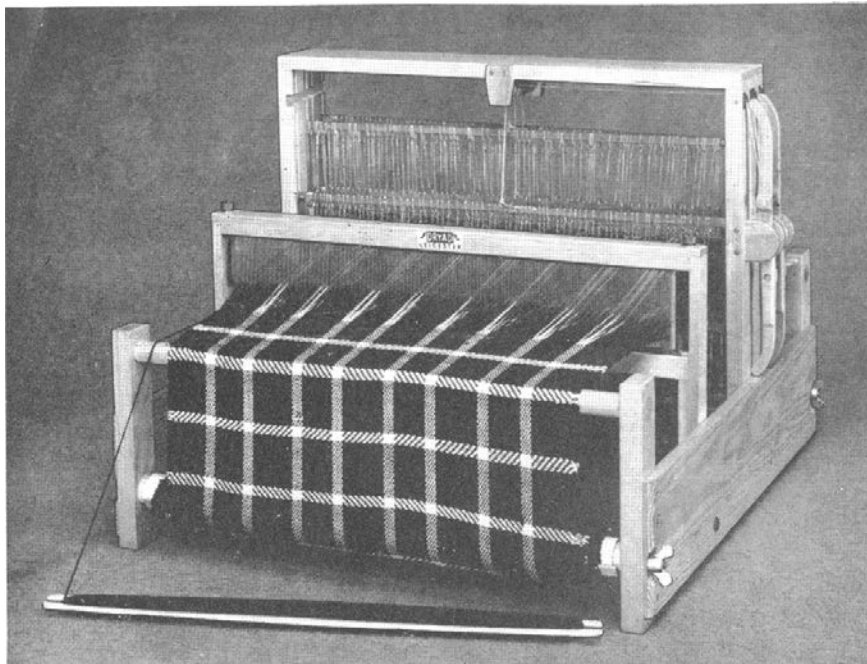


Fig 7c – Dryad ‘Wendicote’ Table Loom

(Fig. 7a, b and c) Source: Simpson and Weir (1967).

### 2.3.5 The Inkle Loom

Inkle Loom (Fig.10) which is of Scottish origin is an excellent loom on which braids with warp patterns are made. Weaving made on this kind of loom shows the warp thread so close that the weft does not show at all in the finished work. The function of the closeness of the warp threads is only structured, that is to hold down the interchanged warp threads and form them into a fabric.

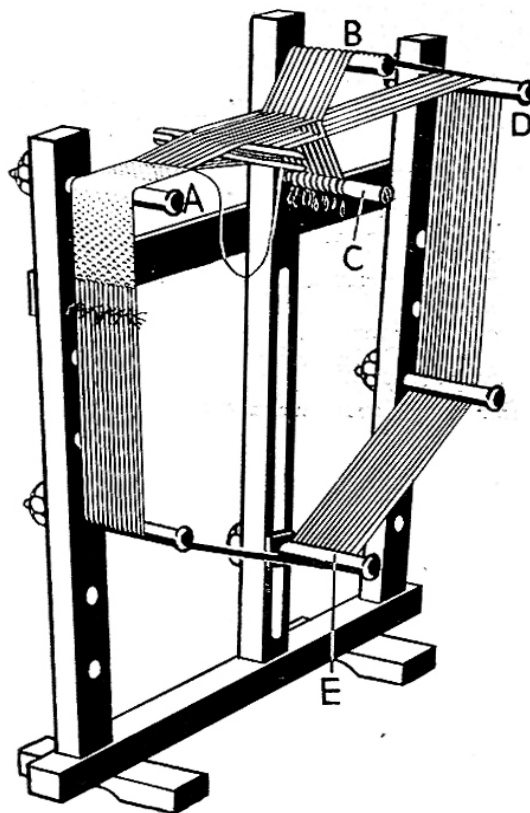
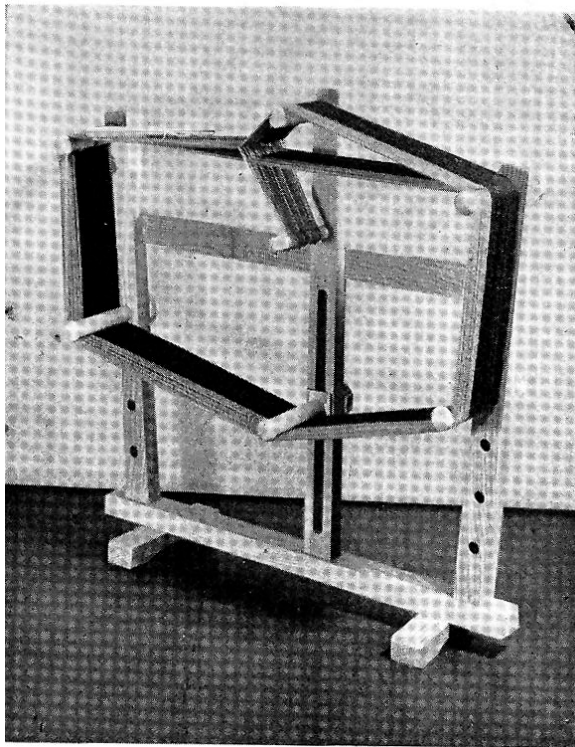


Fig. 8: Dryad Inkle Loom.

Source: Simpson and Weir (1967).

The Scottish Inkle loom embodies a kind of labour-saving device that allows the weaver to sit comfortably on a chair and weave very rapidly. Braids and girdles may be made with 3-or 4-ply wool or knitting cotton; or rugwool is made into strips which are sewn together to make attractive mats (Fig.11).

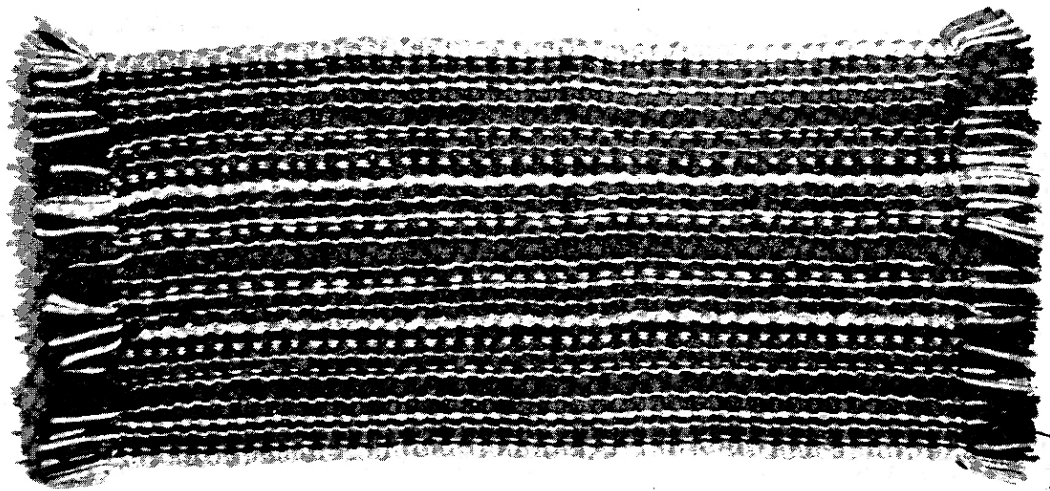


Fig. 9 – Mat woven on Inkle Loom

Source: Simpson and Weir (1967).

On this loom the warp is closely packed but the weft is not beaten very closely together so that only the warp is seen in the finished braid. To fit up this loom, one peg is placed in the hole at the top of the frame (right hand side), one in the lower hole on the same side, and another opposite to this on the left side. In Fig. 10, the pegs are fixed in the third hole from the bottom but this position can be altered to suit the length of warp required. Peg A is then put in the hole at the top of the left upright; the grooved Peg B in the hole at the top of the centre upright and Peg C on which the heddle strings are fixed in the hole immediately below Peg B. The first warp thread is taken from Peg A through the first heddle string on Peg C, over the grooved Peg B,

round Peg D, down and round the two lower pegs X, Y and back to A, where it is on itself.

The next thread goes straight from A, across and round Peg D, down and round the two lower Pegs X, Y and back to A, where it is tied as before. The third thread follows the same course as the first but passes through the second heddle string. The fourth follows the second and so on until enough threads have been warped.

Another Peg E is now placed over the warp at the foot of the loom, inserted in the slot in the centre upright and adjusted to produce the necessary tension. When weaving has proceeded so far that a shed can no longer be produced, the whole warp may be drawn round the loom to the desired position after removing Peg E. (Fig. 10).

It is worth noting that the Inkle Loom may serve as a warping board. This is done by removing the peg containing heddle strings and inserting other pegs as required.

### **2.3.6 The Power Loom**

The Power Loom (Fig. 12) is normally used in the textile factories to produce fabrics. This loom is electrically powered and its operations are automatic. The primary motions of shedding, picking, and beating-up are the same as those of the broad loom.

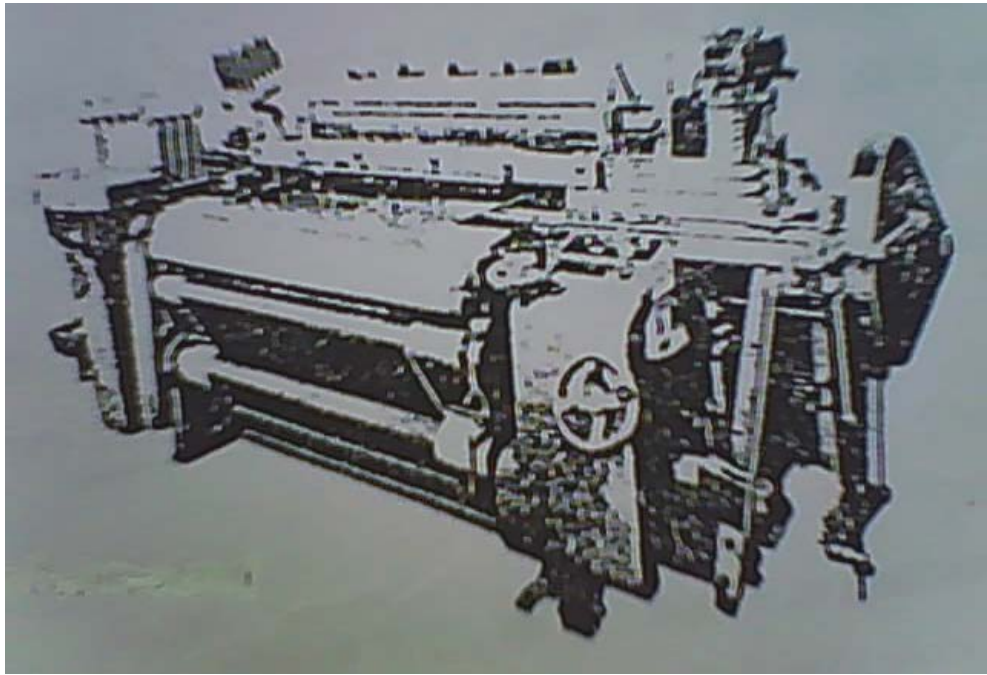


Fig. 10: The Power Loom

Source: Hall, A. J. (1963).

This loom uses cams in operating the shedding motion instead of the foot as in the foot-powered looms. The shape or profile of the cam is followed by a device called the cam follower, and the irregularities in the cam shape are translated by the cam follower into the motions of the loom (Fig. 13). Thus the cam follower translates the motion of the cams to the harnesses which are raised and lowered according to “messages” transmitted by the shape of the cam.

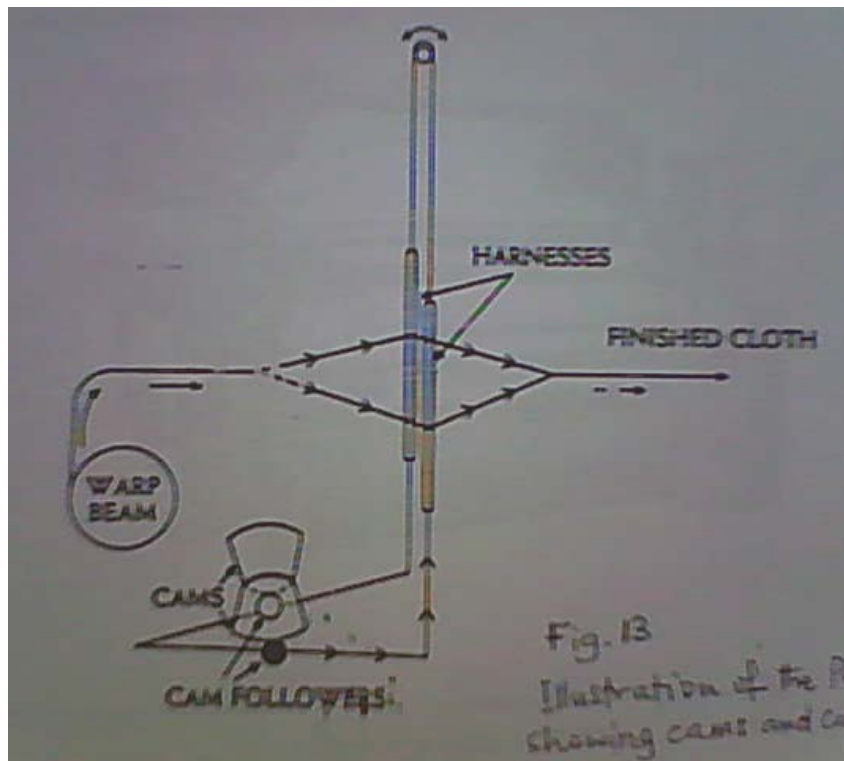


Fig. 11

Illustration of the Power Loom showing cams and cam followers.

In this way, simple patterns are created but when more complex designs are required, the dobby or the jacquard looms are employed. In the power loom, the movement of the shuttle, the replacement of the quills in the shuttle, the threading of the filling yarn, and the winding of quills are all automated. Such looms are rapidly being replaced by more modern machines with electronic control of motions.

### 2.3.7 The Dobby Loom

The Dobby Loom (Fig. 14) which is an English invention, is an attachment that is fixed to the plain harness loom to create shedding for more than eight shafts which is beyond the scope of the plain harness loom – the type of loom which uses pedals or cams for the shedding motion, and not more than eight shafts; this loom is not used for highly complex designs.

While the plain harness loom can control between two and eight shafts, the Dobby may control as many as thirty - two shafts. So when weaves of more than eight shafts (complex designs) are needed, the Dobby attachment is employed. The Dobby uses pegs or punched plastic tapes to raise the shafts to create a shed and it produces more complicated designs than the plain loom.

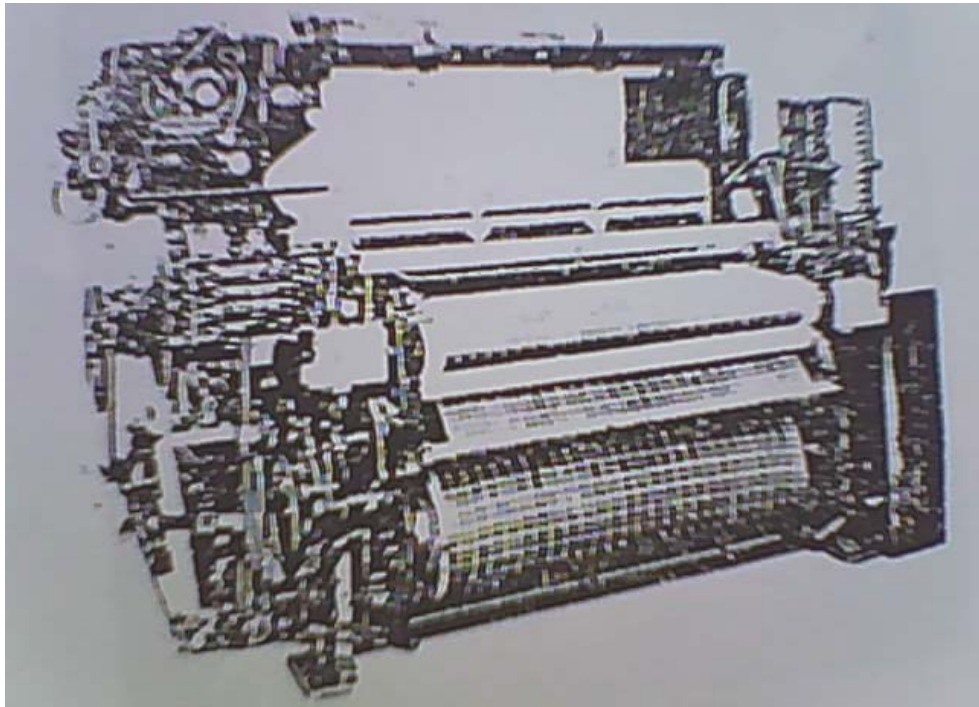


Fig. 12 – The Dobby Loom

Source: Hall, A. J. (1963).

Typical fabrics produced on the Dobby are huck toweling, pique, waffle cloth and shirting madras which have more complicated designs than other types of fabrics produced on other types of looms with the exception of the Jacquard.



### 2.3.8 Circular Looms

Looms in which the shuttle moves in a circular path, laying down the weft substantially in the form of a circle and producing tubular cloth, are known as circular looms (Fig. 15). The three reciprocating motions – shedding, picking and beating-up, mutually at right angles of the flat loom (looms which produce fabrics flat) are reduced to one – that of the heddles. The shuttles and the presser wheel (a device used for beating-up in circular looms) rotate at a constant low speed while laying a weft and beating it up.

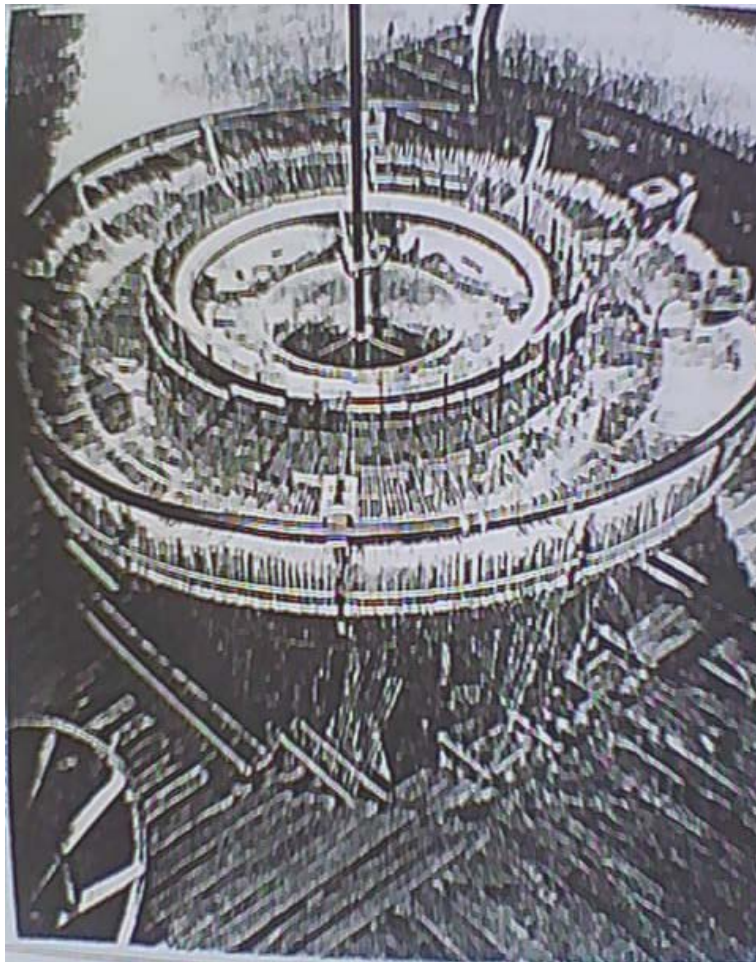


Fig. 13 – A Circular Loom

Source: Joseph, Marjory L. (1966).



With such looms, a high rate of cloth production can be achieved by the use of more than one shuttle, combined with segmental shedding in which the shed at any point is opened just as the shuttle reaches it and changes as soon as the shuttle has passed. Nevertheless, circular looms are not used to any large extent. They have long been used for weaving hose pipes because a more uniform structure can be achieved than by employing a flat loom.

### **2.3.9 Jacquard Loom**

The Jacquard loom (Fig. 16) was an invention of a Frenchman called Joseph Marie Jacquard in 1801 (Joseph Marjory L. 1966). The Jacquard loom has a system of shedding which is employed for fabrics requiring a greater variety of design that is beyond the scope of the Dobby loom.

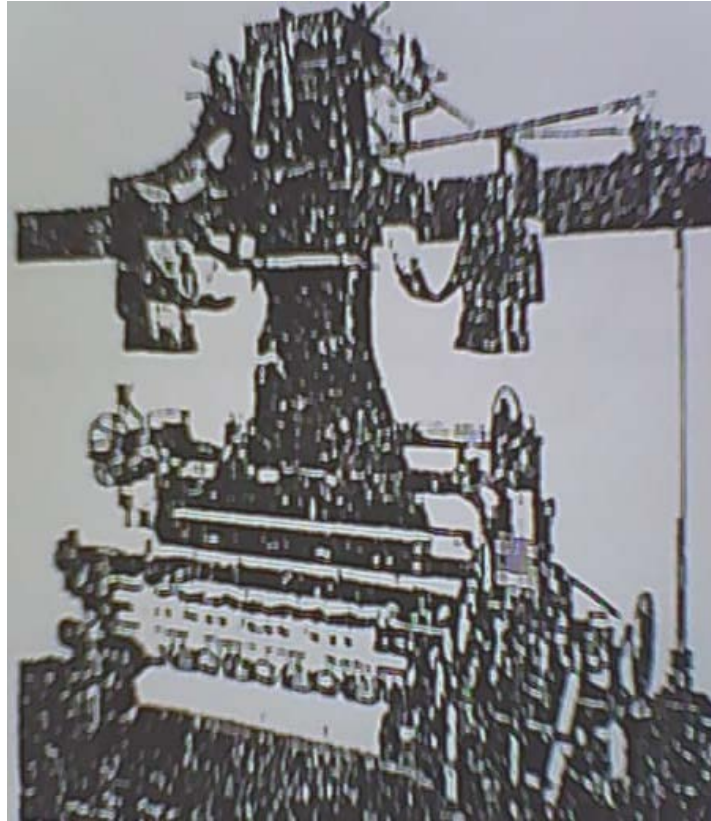


Fig. 14 – The Jacquard Loom

Source: Joseph Marjory L. (1966).

The Jacquard uses punched cards in creating a shed and produces very elaborate and complex designs. The weave is known as Jacquard weave. The ability of the Jacquard loom to weave a variety of complex fabrics is a result of the ability of this machine to control each warp yarn separately. Each warp yarn is threaded through a loop in the end of a leash or cord.

Before the loom is set up, a design is worked out on graph paper, and the position of each of the yarns in the design is analyzed. A punched card is prepared that corresponds to each of the weft yarns. The card contains a “code”, a set of punched holes that will determine which warp yarn must be lifted for each passage of the weft. The punched cards are laced together in the correct order for the design. As each card

advances to the operating position, needles rest against the cards. The needles are held under the pressure of a spring and when a needle position coincides with a hole in the card, the needle moves through the hole. The movement of the needle engages a hook, which in turn lifts the cords attached to the hook thereby raising the yarns they hold to form the shed. When the weft has been inserted the needles retract, the cards move to the next position, and different sets of needles engage holes in the next card. This, in turn, causes other warp yarns to be lifted to form a different shed for the operation to continue. Fabrics produced on the Jacquard include damask, brocade and tapestry.

### **2.3.10 Traditional Loom (kente loom)**

The Asante traditional kente loom Fig.7 is one of the indigenous Ghanaian looms used in the production of Kente cloth.

The structure of the Kente loom ((Nsadua) is similar to that of the Broad loom except for a slight difference in structure. Both looms have the same working principles. While the broad loom weaves broad fabrics, the kente loom produces narrow strips of cloth.

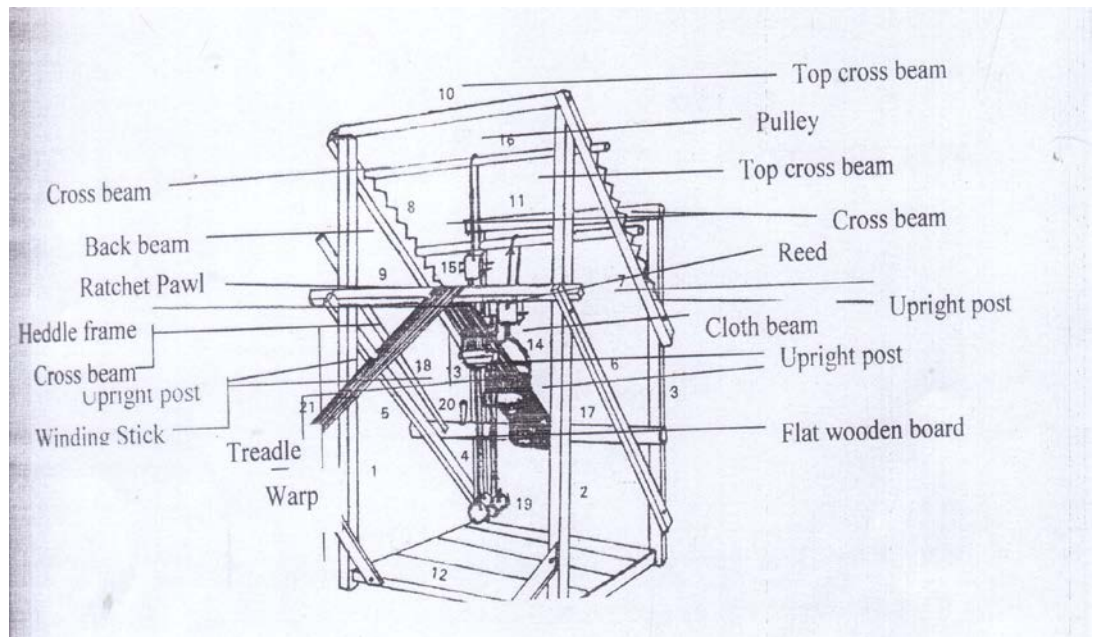


Fig. 15

Kente Loom.

### 2.3.11 The Broad Loom

The broad loom (Fig. 29, Plate 1), which has the structure of the table loom (see fig 9A, B and C), differs slightly by having legs, lams, and foot pedals or treadles. This loom does the same work as the table loom but on a larger scale.



Plate 1a – The Broad Loom (Side View).



Plate 1b – The Broad Loom (Back View).

The broad loom is operated by the feet, thus leaving the hands free for passing the shuttle through the shed. In this loom, as each pedal is depressed, the corresponding heddles are pulled down and the others being raised due to the working of the cords on the pulley; thus giving a better shed. The broad loom, which is the focus of study, has many parts and functions which will clearly be seen in Chapter 3 of this work.

As can be seen from the discussion of looms, looms are either vertical or horizontal and work on the same principle with the basic motions of shedding, picking, beating up and letting off. All loom basically have the same weaving processes – warping, beaming, heddlng, reeding and weft preparation before the actual weaving is done.

Nevertheless, the structure of the loom used in the production of pile fabrics differs slightly in that while looms for all other weaves have only one warp, the loom for pile fabric production has two warps – the ground warp and the pile warp. The weaving process is also slightly different, for this reason, for the broad loom to be used in pile fabric production, it should be adapted – providing another warp beam for the pile warp and thus making it suitable for pile fabric production.

## **2.4 Loom Operations**

Once the filling yarns have been prepared and the warp yarns have been set into place, the loom goes through a series of motions: Shedding, Picking, Beating-Up and Letting off (Fig. 4).

### **Shedding**

The shed is formed by raising the harnesses to form an open area between the sets of warps. The formation of the shed is known as shedding.

### **Picking**

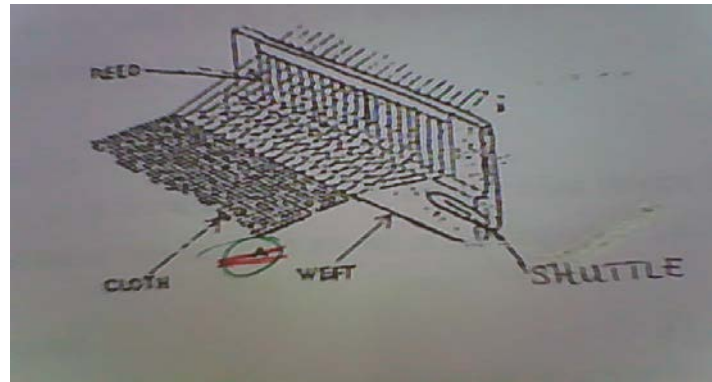
While the shed is open, the yarn is transported across the opening to lay a filling yarn across the width of the loom. The insertion of the filling is known as picking. A single filling yarn is known as a pick. Speed of weaving machines is generally expressed as the number of picks per minute or metres of filling inserted per minute. Speed obviously is related to the width of the loom and wider looms, weaving wider fabrics, would require more time for one filling insertion.

### **Beating Up**

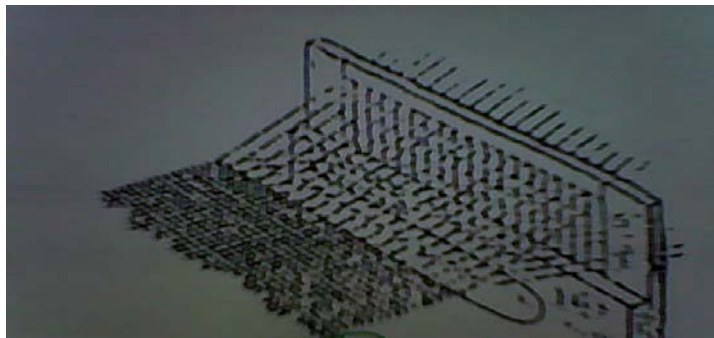
Beating up is done with the reed, the comblike device that pushes the filling yarn close against the woven fabric (to the fell of the cloth) so as to make it more compact.

### **Letting Off**

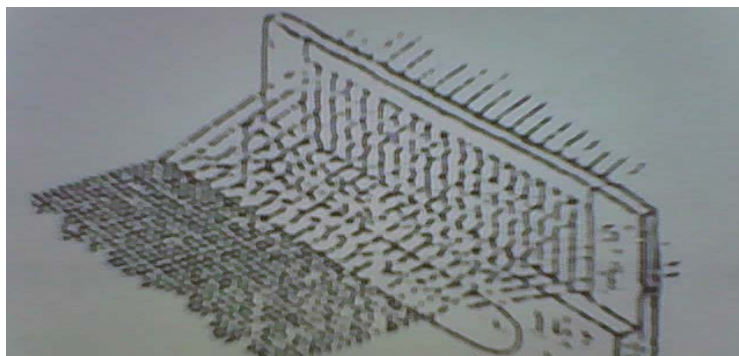
As the woven fabric is formed, it must be moved or let off from the warp beam and taken up on the cloth beam to make room for the formation of more fabric. All these functions are synchronized so that they occur in the appropriate sequence and do not interfere with one another.



a



b



c

Fig. 16 The three basic weaving motions.

(a – Shedding Motion, b – Picking Motion, c – Beating – Up Motion).



## **2.5 Weaves**

The weaves produced on all types of manpower loom are basically the same and these basic weaves are:-

1. Plain weave
2. Twill weave
3. Satin or sateen weave

### **2.5.1 The Plain Weave**

There are three basic types of weaves – the tabby or plain, the twill, and the satin or sateen. In the construction of the plain weave, which is considered as the simplest of all the weaves, the picks are made to pass over one end and under the next end in that sequence (Fig. 17A and B). There are variations of the plain weave such as the basket and the Ribbed weaves. Tabby weaves should be threaded in a 1, 2, 3, 4 repeat, this means the first warp yarn passes through the first heald on the first heddle shaft; the second warp yarn through the first heald on the second heddle shaft, the third warp yarn through the first heald on the third heddle shaft; the fourth warp yarn through the first heald on the fourth shaft and this process is repeated until the warp yarns are all exhausted.

The main characteristics of the plain weave are that because of the weft insertion – over one, under one nature, there are no long floats and the absence of floats make the weave stronger than other type of weaves.

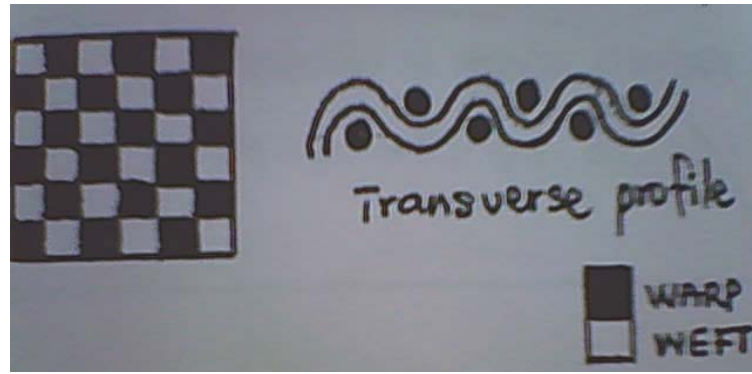


Fig. 17a

Tabby or Plain Weave Daft

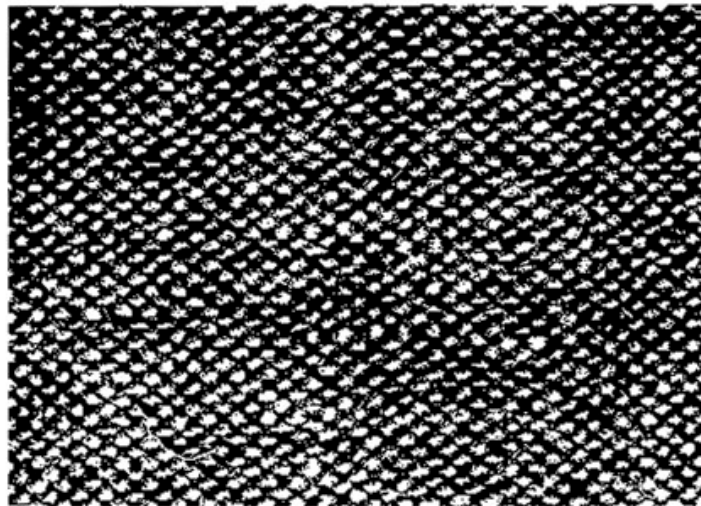


Fig. 17b Plain Weave.

### 2.5.2 The Twill Weave

The Twill weave is characterized by diagonal lines. The simplest type is the one created by the picks crossing over two ends and under one as in Figure 18A. The sequence is repeated in each successive pick but stepped over one end either to the left or right.

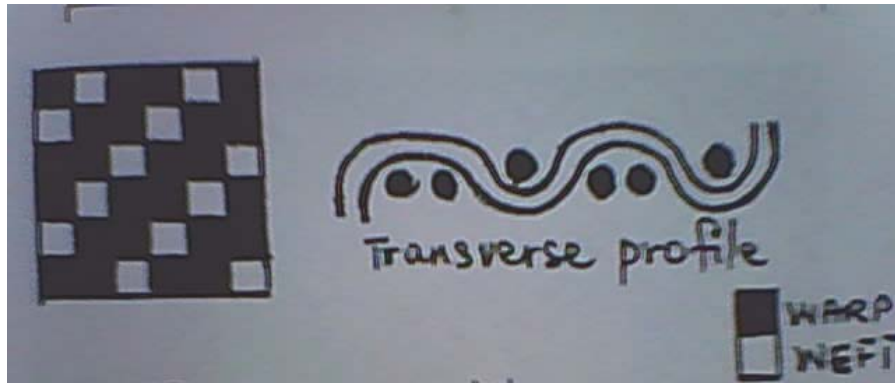


Fig. 18a – 2:1 Twill Draft.

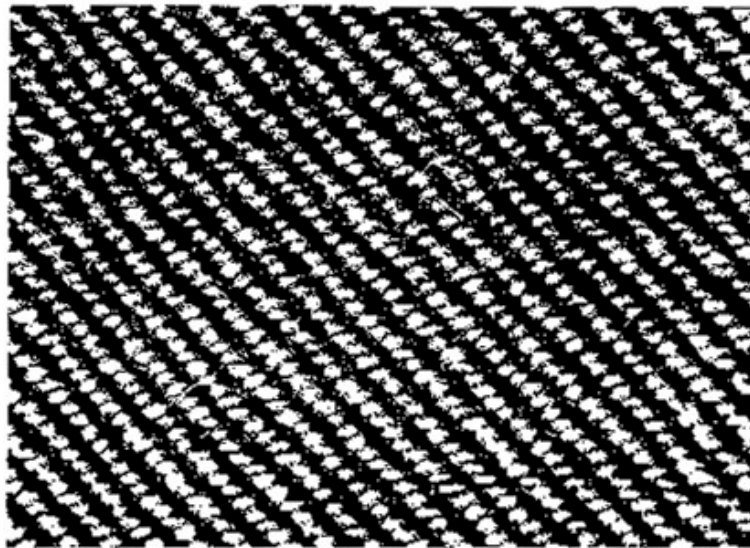
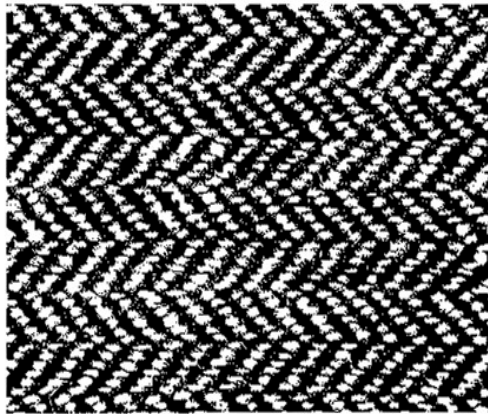
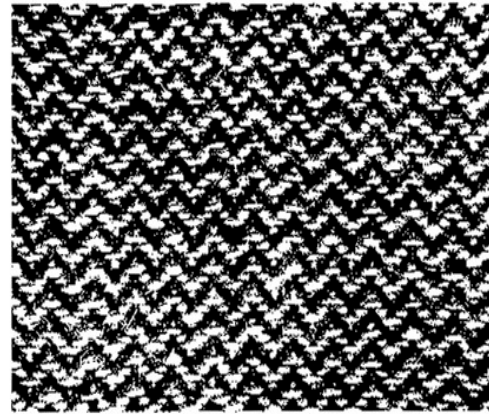


Fig. 18b – Twill Weave.

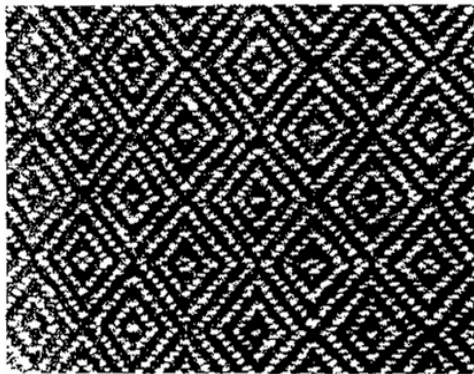
A great variety of patterns can be woven from the simple threading draft 1, 2, 3, 4, by altering the sequence of the order in which the pedals are used and also varying the tie-up of the heddles to the pedals. Twill should be threaded in a 1, 2, 3, 4, repeat pattern but can be varied by changing the relative number of the ends and picks in each repeat as in 2:1, 2: 3, 2: 2, 3: 1 by stepping the repeat in one direction (Fig. 18B), by breaking the direction of the diagonal at regular intervals (Fig. 19A) by combining several twills or modifying them to create a pattern (Fig. 19B, C and D) plate 2.



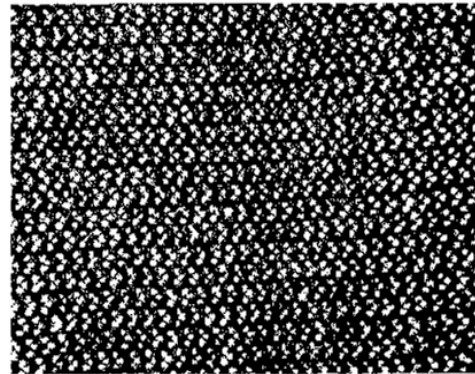
a – Reverse Twill



b – Herringbone



c – Goose Eye



d – Bird Eye

Fig. 19a, b, c and d – Twill Variations.



Plate 2 – Twill Variations – Goose Eye.

### 2.5.3 The Satin or Sateen Weave

The Satin or Sateen Weave drafts (Fig. 20A and B) somehow resemble those of twill yet they do not acquire the regular step in each successive pick as is characteristic of twills. The Satin or Sateen weave shows no evidence of strong diagonal lines as in twill so the satin or sateen weave fabric is smooth with an unbroken surface that is made up of long, floating ends (Fig. 21 A and B).

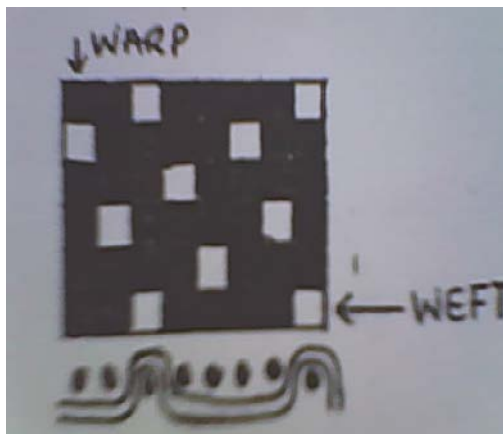


Fig. 20a

4:1 Satin Weave Draft

seven

Warp Float.

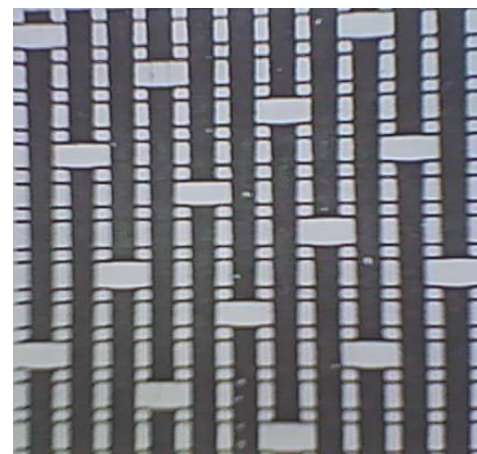


Fig. 21a – Warp – faced satin weave.

Warp yarns form float, crossing over

weft yarns between every interlacing.



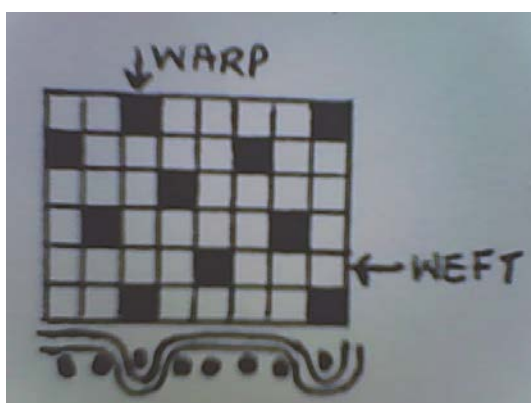


Fig. 20 b – 4 : 1 Sateen

Weave Draft Weft Float.

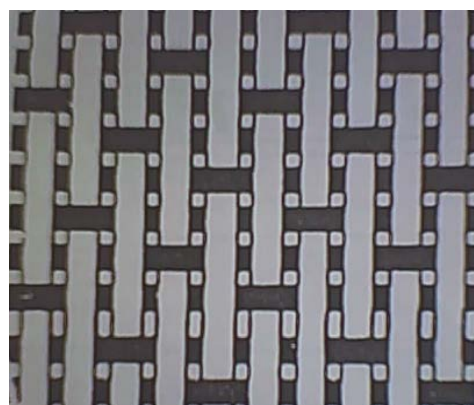


Fig. 21 b – Weft – Faced Sateen

Weave. Weft yarns form float  
crossing over four warp yarns

A true satin or sateen must have at least five ends and picks in each complete weave repeat – five ends and five picks in one repeat as shown in figure 22.

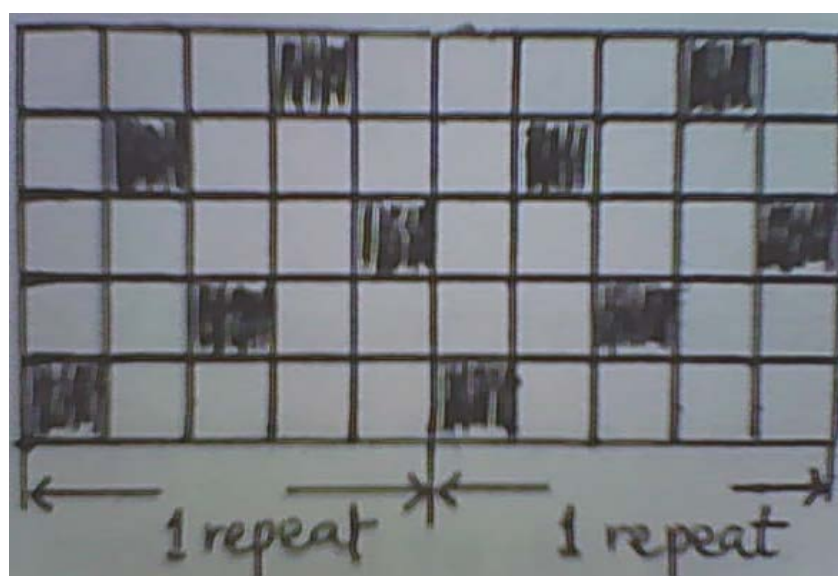


Fig. 22 – Daft showing repeat.

Of the three basic types of weaves – Plain, Twill and Satin/Sateen, it is only the plain and twill weaves that are used in the production of pile fabrics. Pile fabrics are the type of fabrics that have loops (cut or uncut) on their surfaces. Some of these fabrics are normally used for towels. The soft pile surfaces are made from extra yarns while the plain or twill forms the background, base or the binder when the piles are on both sides.

## **2.6 Pile or Terry Fabric**

Pile or Terry fabric forms one aspect of woven structures which have raised surfaces. As a textile term, the Encyclopaedia Britannica (1968) defines pile as the surface of a cloth composed of an infinite number of loops of warp threads, or else of an infinite number of free ends of either warp or weft (filling) threads that stand erect from the foundation or ground structure of the cloth.

The Chambers Encyclopedic English Dictionary (1994) also defines pile as the raised cropped threads that give a soft thick surface to carpeting, velvet. While Oxford Advanced Dictionary considers it as a nap upon cloth; now especially the downy nap of velvet, plush also loops in a carpet forming a nap. The textile term pile is regarded by Chambers Encyclopedic English Dictionary as an absorbent fabric with uncut loops on one side used especially for towels.

The World Book Encyclopedia (1963) is of the view that Terry cloth is a cotton fabric woven with loops on the surface that help absorb water. It is woven with one tight and one loose set of warp yarn. A filling yarn woven in between the two sets is pulled into

loops. Terry cloth is often called Turkish toweling and chiefly used for towels, bathrobes, sweaters and similar suits.

There are two general methods of distinguishing between such cloths; when the loops are uncut, the pile is usually termed “looped pile”; when the same or similar loops are cut, either in the loom during weaving or by a special machine after the cloth leaves the loom, the pile is termed “cut pile” (fig. 23). Other names applied to such cut-pile fabrics in which the effect is formed by the warp threads are velvet and plush, the former being used to define short pile fabrics and the latter to define long-pile fabrics. The word “velveteen” is used to distinguish the fabric when the pile is formed of weft or filling threads that have been cut.

Weft pile fabrics are composed of one series of warp threads and two series of weft threads which form the ground and the pile. In the weft pile fabrics, the pile weft is cut in a separate operation after weaving resulting in a surface consisting of short and very dense tufts. A feature of pile structures, also termed velveteen, is very high density of shotting. Warp pile fabrics on the other hand have one series of weft threads and two series of warp threads forming the ground and the pile.



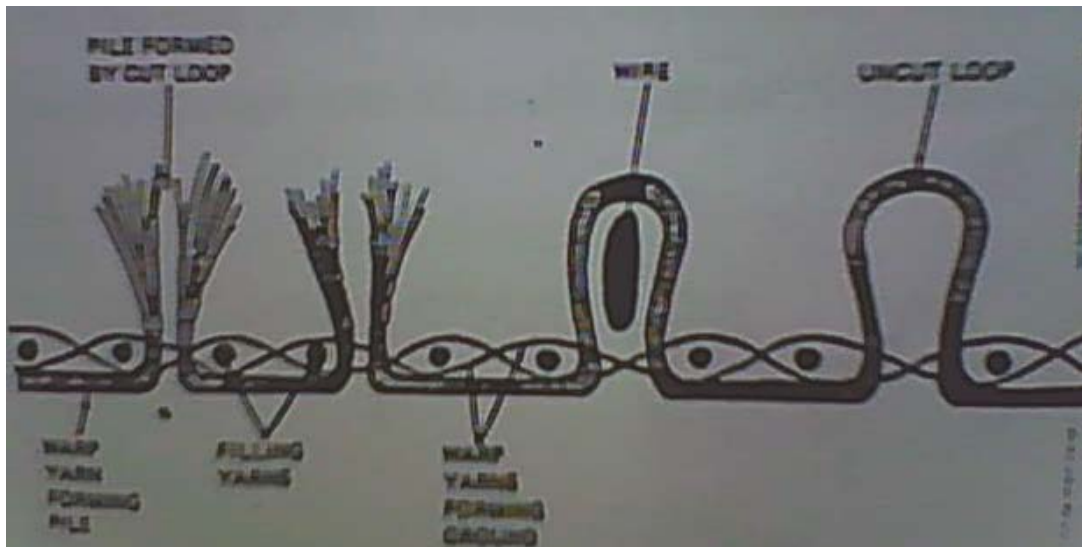


Fig. 23 – Pile Weaves.

Grosicki (1977) states that the Terry pile, also known as the Turkish toweling, is a class of warp pile structure in which certain warp ends are made to form loops on the surface of the cloth. Only one series of weft thread is used but the warp consists of two series of threads, the ground and the pile. The former produced with the weft the ground cloth from which the loops formed by the pile ends project. The loops may be formed on one side only or on both sides of the cloth thus producing single-sided structures respectively (Fig. 24A and B).

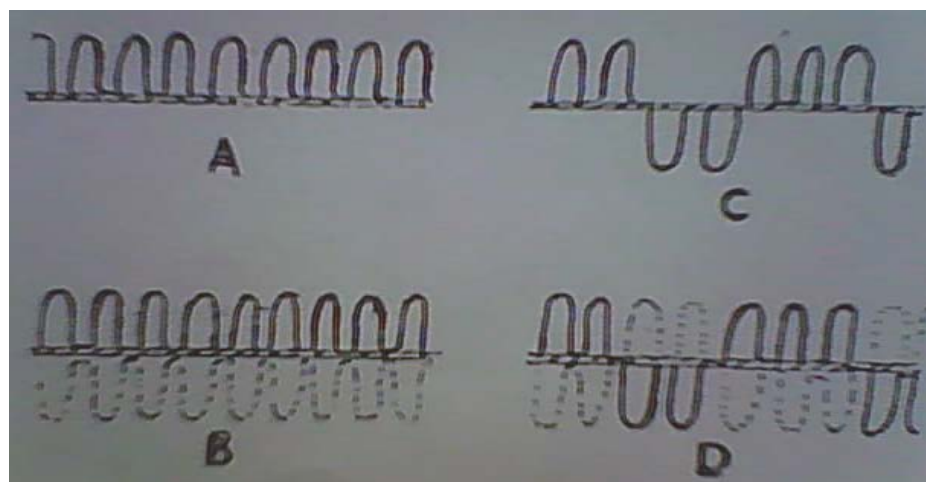


Fig. 24 – Single Sided and Double Sided Pile Structures.

Any one pile thread may alternate between the face and the back of the cloth, a possibility that is frequently utilized for the purpose of ornamentation. Structure C conveys the idea of pile thread alternating between the face and the back which permits the formation of pile figure on exposed ground whilst at D, the ornamentation is carried further by having two different coloured sets of threads which mutually alternate between the face and the back thus forming a figure in one colour on the background of another. Structure A has been used for producing mats, curtains, ladies' overcoats and dressing gowns. Structures B, C, and D represent typical towellings which form by far the most important outlet for these fabrics.

### **2.6.1 Formation of the Pile**

For effective production of pile fabrics, two beams are necessary – the ground beam which carries the ground warp is very heavily tensioned while the pile beam carrying the pile warp is only under slight tension.

The formation of terry pile depends on the creation of a gap between the fell of the cloth and two succeeding picks of weft. The height of pile largely depends on the gap, the length of which results in the formation of uninterlaced warp float. In order to form the gap, two succeeding picks are beaten up short of the true cloth fell and produce a temporary false fell as indicated at E in Figure 25. On the third pick of the ground, full beat up takes place, the three picks being pushed forward together to the true fell position.

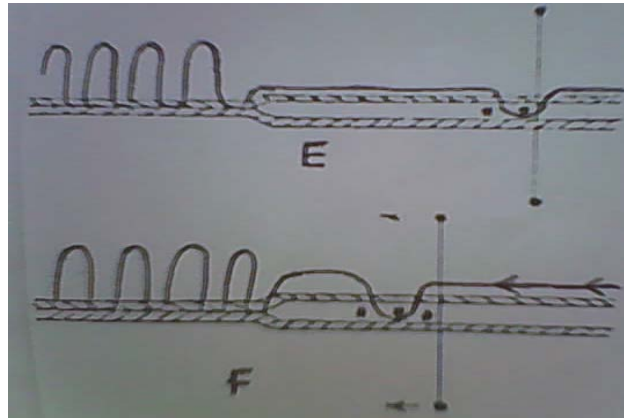


Fig. 25 Pile Formation.

During this action the three picks are capable of sliding between the ground ends which are kept very taut as depicted at F (Fig. 25). However, they cannot slide similarly between the pile ends, because they are locked with them and because the pile warp at that moment is slack. As a result, as they are pushed forward after the third pick, they pull length of pile warp from the beam and at the same time, force the excess length of pile yarn in front of them into a loop. In some systems the pile warp beam is automatically rotated forward positively during the full beat-up, that is the insertion of the third pick of the group, to deliver exactly the length of yarn required for a loop.

Grosicki (1977) continues that the gap is created by a variety of devices which can be divided into two main classes, viz:

1. Those in which the reed is drawn back the required distance (used in most of the conventional looms); and

2. Those in which the fell of the cloth itself is made to recede away from the on-coming reed during the insertion of the two succeeding picks (used in gripper and rapier machines).

## **2.7 Looms Used in Pile / Terry Fabric Weaving**

There are varieties of looms that are employed in the weaving of fabrics. Nevertheless, it is only a few that can be used in pile fabric production, and special mechanisms are required in pile weaving. Most of the terry/pile fabrics are produced on either dobby or jacquard machines (powered looms).

According to Tortora and Collier (1997), plain terry towels are also woven on dobby looms but with the development of electronic jacquard looms that can make both jacquard and dobby fabrics, dobby looms are becoming less important.

For the production of the figured piles (Fig. 26, Plate 3), the inverted hooked jacquard with a heald mounting was at one time highly favoured, but at present the machine used most frequently is the fine pitch (fine yarns used for small intricate designs), large capacity jacquard capable of running at appreciably greater speeds than the coarse pitch (coarse yarns used for large designs).

The variable beat-up motions are an essential part of pile weaving and they fall into two main categories. The function of these motions, as mentioned earlier, are to create a gap between the cloth fell and the first two picks of a pile forming a group of picks termed 'loose' picks as opposed to the picks beaten up fully which are known as 'fast' picks.

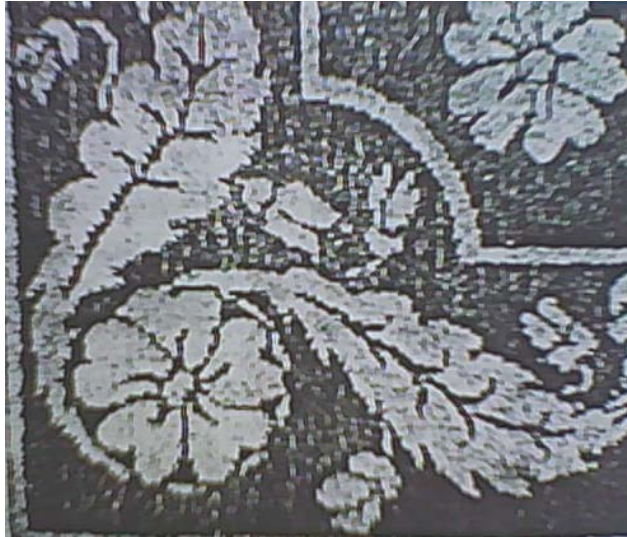


Fig. 26 – Figured Pile.



Plate 3 – Figured Pile

In the first group mechanisms, the reed itself is drawn back on the loose picks thereby leaving them a small distance short of cloth fell. A variety of devices exist to achieve this purpose in some of which the reed only and in others the sley itself may be controlled to provide a ‘short’ beat up. On the following pick the reed or sley is locked fast so that the preceding loose picks and fast pick are pushed together into the

cloth fell proper. The two reed positions are shown at A and B respectively in Figure 27.

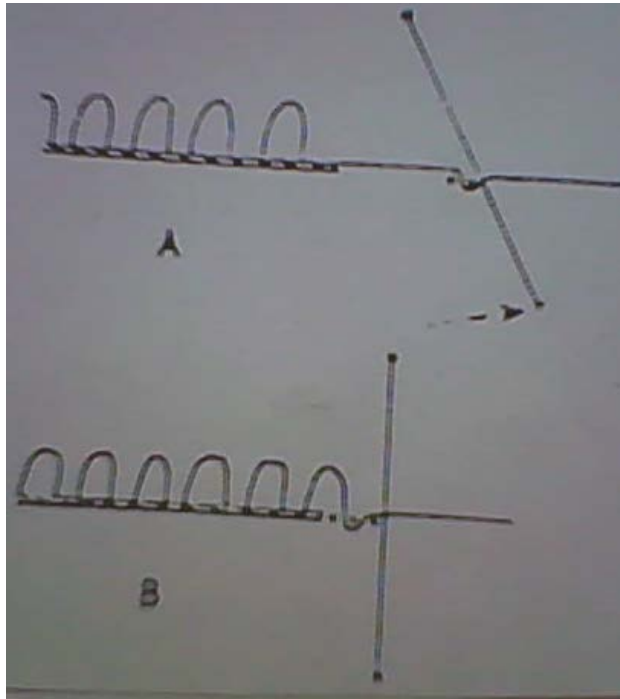


Fig. 27 – Reed positions during beat-up motion when creating gap for pile formation.

In the second group of mechanisms, such as are used at present in some gripper and rapier machines, the reed is permanently fixed in position and has a constant stroke. To create the gap on the loose picks, the cloth itself is drawn away from the advancing reed so that the two loose picks cannot reach the normal cloth fell position. On the third pick, this is brought forward again so that the three picks of a group join together with the previously woven cloth at the normal cloth fell point (Fig. 28 C and D). All the above motions must have the means of precise adjustment to vary the size of the gap in order to produce shorter or longer pile.

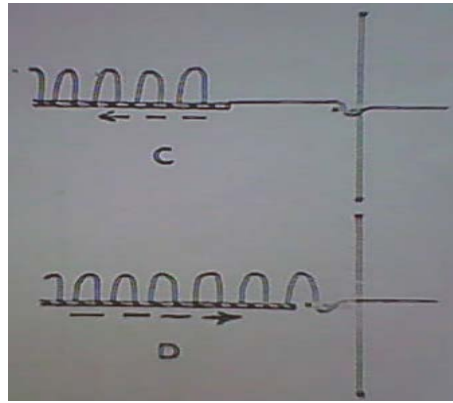


Fig. 28 – Reed positions in the second group of mechanisms where the reed is permanently fixed in position.

Another necessary mechanism in the formation of pile is the proper control of the pile yarn tension. The pile yarn must be slack when the first three picks of a group are being beaten-up, -at the point at which the loop is being formed, as otherwise the tension would pull the loops out. It is by this means that the fabric (sample weave) has been produced. Imperfect tension control at this stage does, in fact, result in variable loop height.

In some systems the necessary slackness is achieved by a very slight degree of tensioning of the pile yarn, the beam only just sufficiently weighted to form a clear shed. In other systems the pile warp is tensioned normally throughout but on the beat-up following the first fast pick in the group, a length of the pile warp equal to the distance of the gap is delivered positively which result in more regular loop height along the length of a towel, than can be usually achieved in the former method.

Some makers of pile weaving machines also include a fringing mechanism as one of the special devices. This is an express speed take-up motion capable of pulling the



cloth forward 30 to 60mm in the space of time taken to insert two or four picks thus producing an almost uninterlaced gap between two lengths. This is usually employed when the towel is to be finished with a tasseled fringe instead of a hem (Plate 4).



Plate 4 – Pile Fabric with tasselled fringes.

## **2.8 Fibres Suitable for Towelling**

A variety of fibres are produced naturally or artificially but it is only a few of these fibres that are used in the weaving of towelling fabrics. Cotton, viscose, rayon and linen are the most suited for towelling fabrics. These fibres do not only absorb moisture easily but also stand up well to frequent severe laundering.

### **2.8.1 Cotton**

According to Hall (1963), cotton fibre is obtained from the cotton plant which is cultivated as an annual plant in many tropical areas such as South America, the



southern states of the United States of America and countries such as India, Russia, China, Turkey, Sudan, Pakistan and Ghana.

The pink to white flowers of the cotton plant die naturally, leaving a pod or ball containing twenty or more seeds. From each seed grows outwardly a very large number of hairs or fibres. Cotton bolls are harvested by hand or machine picked. The cotton is then run through a saw or roller gin to separate the fibres from the seeds and also remove major impurities from them. The ginned cotton is then compressed into bales ready for export to mills where it is converted into yarns.

After ginning cotton, the downy short fibres covering cotton seeds are removed by a special type of gin producing a lint(cotton linters) which is a useful form of cellulose for conversion into viscose and acetate rayons.

### **2.8.2 Viscose Rayon**

Viscose-rayon staple yarns are also employed in pile fabric production but their tendency to resist frequent laundering is poorer than cotton yarns since the chemicals used in converting the cellulose into viscose rayons make them lose their natural make up – good tendency to absorb moisture.

### **2.8.3 Linen**

Linen fibres which are obtained from flax stalks are also used for creating the pile effect either to gain a slightly harsh feel such as in athletic towelling, or for an article capable of withstanding very harsh wear.

## 2.9 Properties of Some Fibres

According to Note on Textile Manufacture (1955), the following fibres – cotton, linen and viscose rayon have these properties:-

FIBRE	PROPERTIES
COTTON	<ol style="list-style-type: none"><li>1. Stronger when wet than dry.</li><li>2. Excellent washing quality.</li><li>3. Withstands boiling.</li><li>4. Excellent durability.</li><li>5. Moderate absorbency.</li><li>6. Withstands a considerable degree of exposure to sunlight without becoming tender.</li><li>7. May be ironed at high temperatures before scorching occurs.</li><li>8. Plentiful and relatively inexpensive.</li></ol>
FLAX (LINEN)	<ol style="list-style-type: none"><li>1. Strong (more brittle than cotton), and gains strength when wet.</li><li>2. Fairly good absorbency (better than cotton in this respect).</li><li>3. Cloth develops very little surface fluffiness after repeated washing (hence used for tea-towels).</li><li>4. As in 6 and 7 for cotton.</li><li>5. Relatively expensive.</li></ol>
VISCOSE-RAYON	<ol style="list-style-type: none"><li>1. Poor wet strength (little more than half dry strength).</li></ol>

	2. Fair capacity for holding moisture. 3. Not so durable as cotton.
--	--

Towelling fabrics should have the above properties; because it is these that make fabrics made from cotton and linen in particular, more suitable for towels than viscose-rayon and other fibres.

## CHAPTER THREE

### TOOLS, MATERIALS AND PRODUCTION PROCESSES

#### 3.1 Equipment Used:

The main equipment used in this project is the Broad Loom and its accessories (Fig.29).

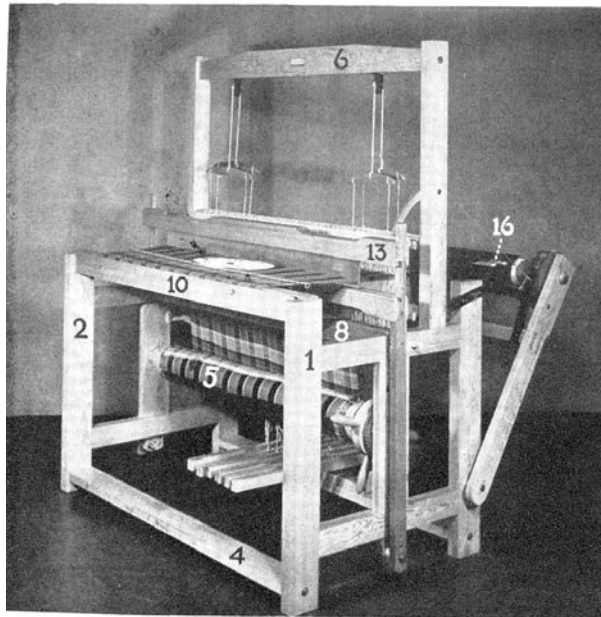


Fig. 29 The Broadloom

Source: Simpson & Weir (1967)

#### The Loom

The main frame of the Broad Loom is made up of four strong corner or upright posts labeled (1,2,3,4: Fig.30) which are held firmly together by four Cross Beams (5,6,7,8). The two front corner posts (1,2) are held together at the top by the breast beam (9). In front of the breast beam is a slat inserted to protect the woven fabric from friction. The two back corner posts (3,4) are also held together at the bottom by a floor beam (11), which carries two brackets supporting an iron rod fitted with six treadles. Attached to the back corner posts are two bars fixed obliquely to form the back frame

and between these bars is fixed the warp beam (12). This warp beam carries the warp yarns. Two vertical beams (13) which are fixed to the cross beams (5) and (7) hold the horse cross bar (14) from which the set of horses (15) are fixed.

The set of heddle frames (16) are supported by the horses. The cloth beam (17) or cloth roller is fixed between two vertical beams which connect the four cross beams. The cloth beam carries the woven cloth.

In certain types of the Broad Loom, the cloth beam is fixed between the corner posts (1 and 2) while the warp beam connects the corner posts (3 and 4).

Bolted to two of the cross bars (6 and 8) is the beater, batten or sley (18) which holds the reed which is used for beating up the woven cloth.

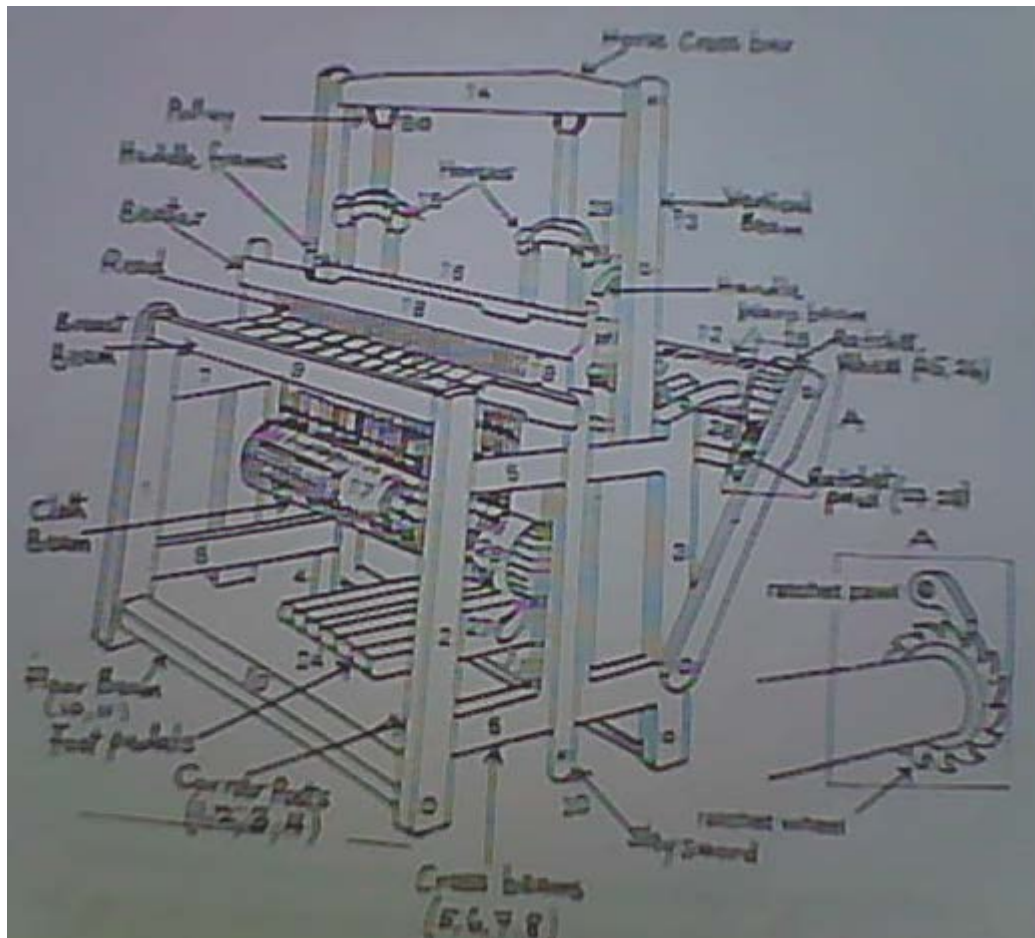


Fig. 30 The Broad Loom with Its Parts.

The reed (19) is carried between the reed cap which forms the top of the beater and the sley board or race board which forms the bottom beam of the beater. The reed cap and the race board which are together known as the reed/sley swords(20) is fixed to the reed case. Suspended on the heddle frames are the healds or heddles (21;fig.31 &32).

### 3.1.1 Types of Broad Looms

There are two types of Broad Loom. There is the one with two sets of lams (Fig.31) and the other with one set of lams (Fig.32)

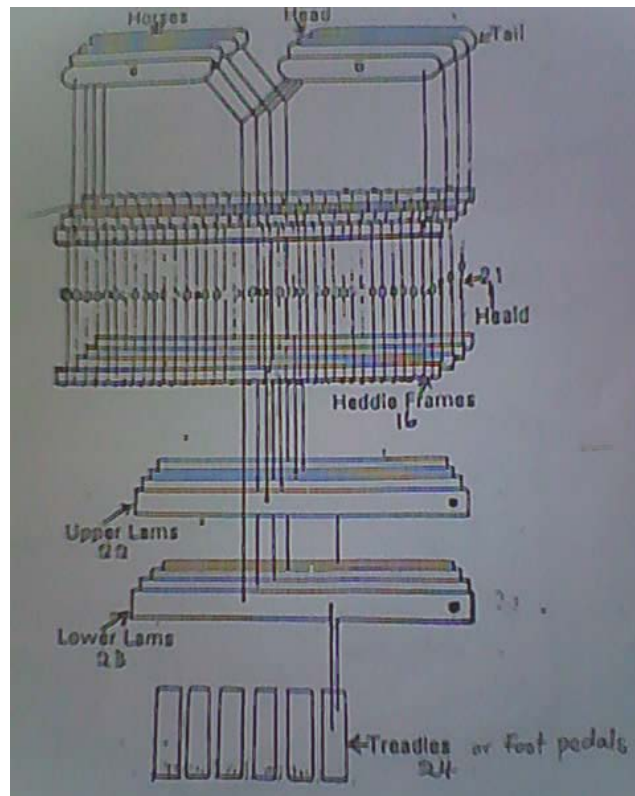


Fig 31 – The Broad Loom with Two Sets of Lam.

Connected to the lower parts of the heddle frames in the loom with two sets of lams are the upper set of slabs called the upper lams, while the tail ends of the horses suspend the upper parts of the heddle frames.

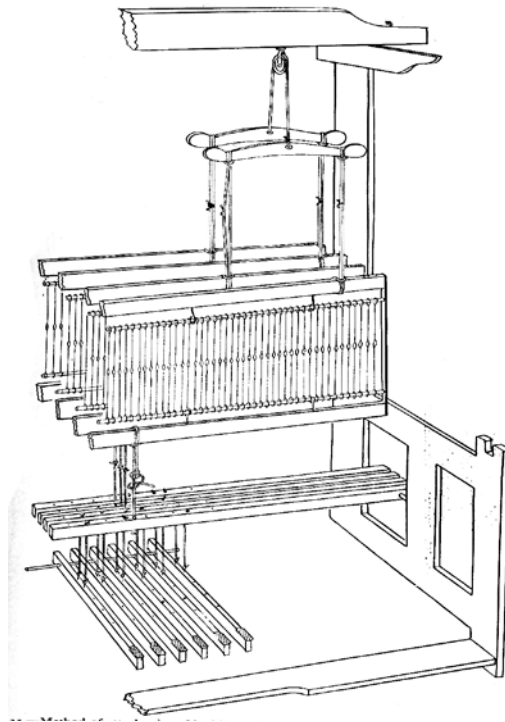


Fig 32 – The Broad Loam with One Set of Lam.

Also connected to the lower set of lams (lower lams 23) are the front ends of the horses. The lower sections of these two sets of lams are directly connected to the treadles or foot pedals (24). A treadle helps to open the shed when it is depressed. The ratchet wheels (25 and 26) are fastened to the end of the cloth beam and the end of the warp beam respectively.

The ratchet pawls or dogs (27 and 28) fixed on top of the ratchet wheel (25 and 26, Fig 30) respectively prevent the wheels from moving in the opposite direction. There is a handle (29) attached to the right vertical beam (13) used to release the warp beam.



### **3.1.2 Accessories**

The following broad loom accessories (Fig. 33) are crucial to the weaving process and weaving cannot occur without them.

Warping Board & Mill – used for warping.

Skein Winder – used to wind and unwind hank yarns.

Bobbin Winder – for winding yarns onto bobbins.

Spool Rack – used to unwind yarns from bobbins.

Bobbin - used for carrying weft yarns on bobbins for weaving.

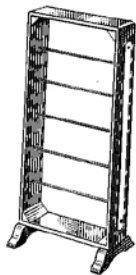
Castle – used to check the height of the heddle frames for leveling before the tie – up.

Threading/Heddling Hook – For passing the warp yarns through the eyes or center loops of the Reed Hook – For passing the warp yarns through the dents of the reed.

Raddle – For spreading and beaming the warp.



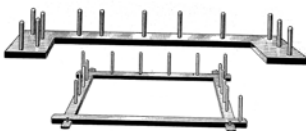
Warping Mill



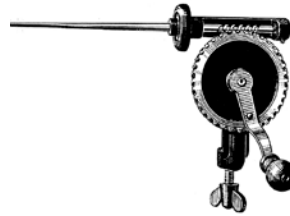
Spool Rack



Raddle



Warping Boards



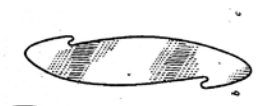
Bobbin Winder



Shuttle



Heald Hook



Reed Hook



Bobbin



Skein Winders

Fig 33 – Accessories of the Broad Loom.

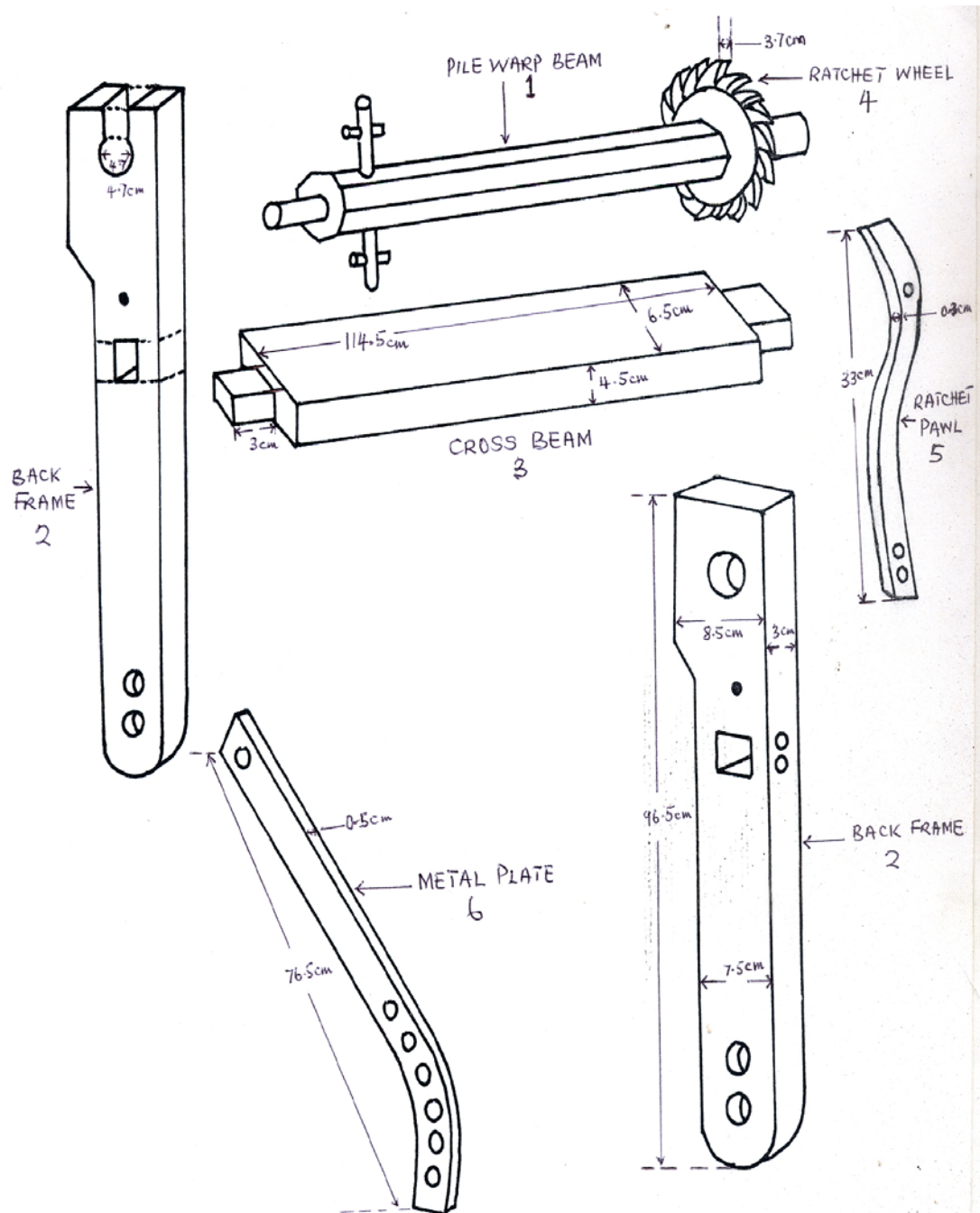


Fig 34 – Modified Parts Of The Broad Loom With Corresponding Measurements.

### **3.2. Modification of the Broadloom**

The Broad loom which is the main equipment used in this project, had been modified to render it suitable for weaving pile fabrics. To make this possible, the Broadloom was fitted with the following parts: (Fig. 34)

1. Pile warp beam for carrying the pile warp.
2. Two back frames for holding the pile warp beam
3. A cross beam to hold the two back frames firmly together.
4. & 5. A ratchet wheel attached to the pile warp beam and a ratchet pawl both of which serve as tensioning device.
6. Two metal plates slightly curved at the end with drilled holes  
to hold the framework to the Broad Loom.

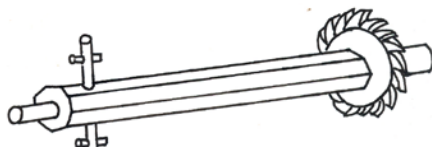
During the modification, part A of the pile warp beam was fitted into the slot “a” of the Back Frame and B into the slot “b” of the other Back Frame. Part C of the Cross beam was fitted into “c” and D into “d” of the two back frames. Part E of the ratchet pawl was fitted with screw at “e” on one of the Back frames to connect the ratchet wheel. The two metal plates were fixed with bolts and nuts on the two back frames at “f” and “g” respectively. (Fig. 35)



Back Frame



Back Frame



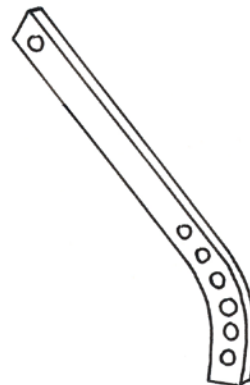
Pile Warp Beam



Cross Beam



Ratchet Pawl



Metal Frame

Fig 35 – Modified Parts Of The Broad Loom Showing How These Parts Were Fitted Together.

The modified part finally assumes the form as shown in figure below (Fig. 36) and plate 5.

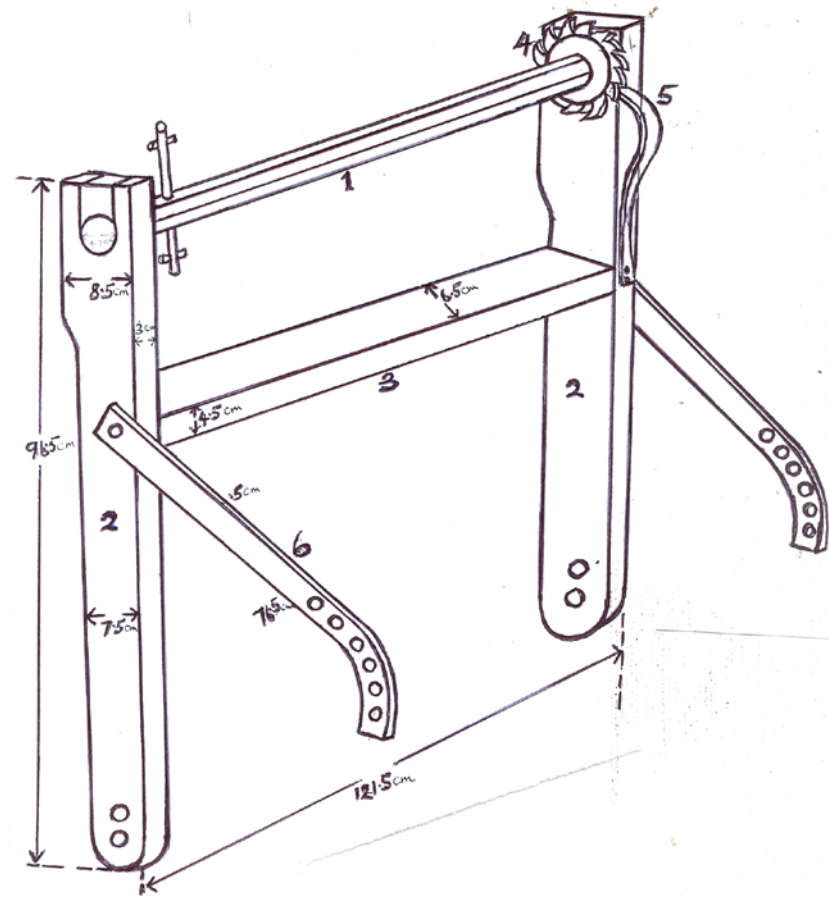


Fig 36 – Final Stage of the Modified Parts



Plate 5a: Final Stage of Modified Part (Back View).

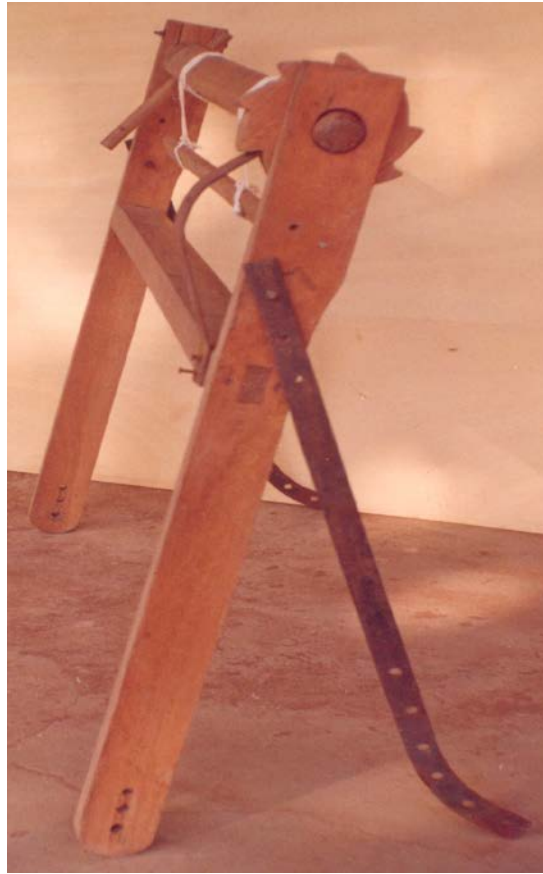


Plate 5b – Final Stage of the Modified Part (Side View).

This structure (Fig. 36) was then connected to the back side of the existing Broad loom with bolts and nuts at the base (plate 6). The two metal plates(6) were connected with bolts and nuts to the top of the corner posts(3 and 4) while the base of the two back frames are connected similarly with bolts and nuts at “x” and “y” to the base of the corner posts (3 and 4) of the Broad loom. A cord from the point “h” on the ratchet pawl (5) is also connected to the mid –point of one of the vertical beams (13) to control the tension of the pile warp.

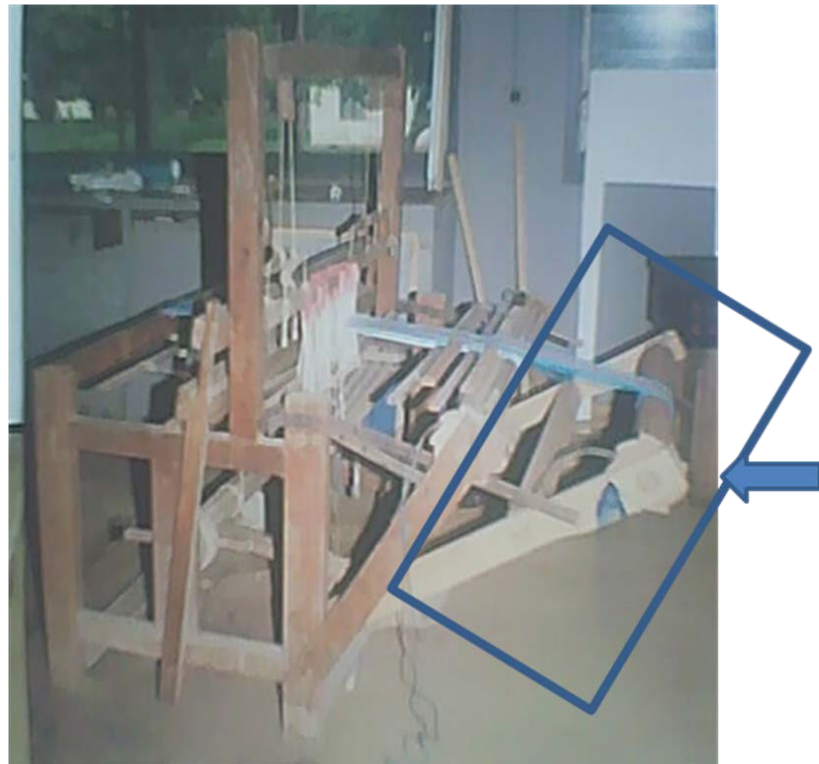


Plate 6: Attachment of Adapted Part to the Broad Loom.



### **3.3 Tools and Materials Required**

1. Saw
2. Hammer
3. Chisel
4. Try square
5. Mallet
6. Plane
7. Wood file
8. Glass paper
9. Brace
10. Bits

These tools facilitated the proper formation of the frame –work for the modification.

#### **3.3.1 Materials.**

Wood, nails, glue, form an essential part in the joinery work. Additional (modified) parts were constructed with well seasoned “Dawuma” wood cut and planed according to specific measurements as shown in Fig.34 and fitted with bolts and nuts. Cotton and linen were the materials most suited for toweling. They do not only absorb moisture easily but also stand up well to frequent and severe laundering.

### **3.4 Preparation for weaving.**

In the designed pile fabric, preparations made for weaving are: warping, beaming, heddling, reeding, tie-up and bobbin winding (weft preparation) in that order.

#### **3.4.1 Warping**

Two warps were separately laid for the project; one for the ground weave(white ) and the other for the pile weave(blue, white and red) labelled A and B in Plate 8. The ground warp has total of 192 ends with 24 ends for each selvedge and 144 ends for the main ground. Using a 24s reed, the ground warp is 17.8cm for the main ground and 1.3cm for each selvedge. The pile warp has a total of 144 ends and was arranged in the following order:

Blue - 50 ends

White - 4 ends

Red - 36 ends

White - 4 ends

Blue - 50 ends

The width of the pile warp, using the same reed (24s) is 15.3 (centimeters). Refer to plates 8 and 9 (page 61).

In warping process, the yarns of the ground warp were wound around the warping mill in the following order;

1. The yarns to be milled were put on the skein winder.
2. The yarns were tied onto the bottom peg A on the warping mill.
3. Milling was done by rotating the warping mill forwards and backwards with the left hand whilst the right hand guides the yarns in two ply along the guide sting to the top pegs B,C,D on the mill where the crosses were made ( Fig. 38a) ; Plate 7.
4. This process (No.3) continued until the desired number of ends were obtained and the ends were grouped into twelves to facilitate easy raddling.
5. Having finished with this process, strings were inserted where the crosses are and tied to secure them (Fig.38b).



Plate 7 – Researcher Laying Warp.



Plate 8 – Researcher Heddling after Beaming.



Plate 9 – Back Of Adapted Loom Showing Pile Warp and Ground Warp.

(A – Ground Warp, B - Pile Warp).

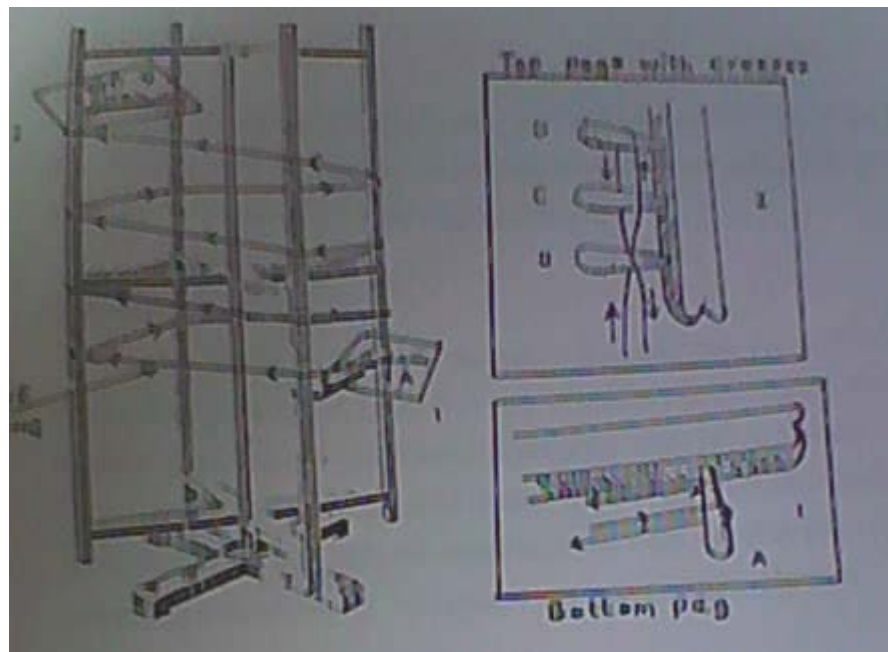


Fig 37a – Milling Process.

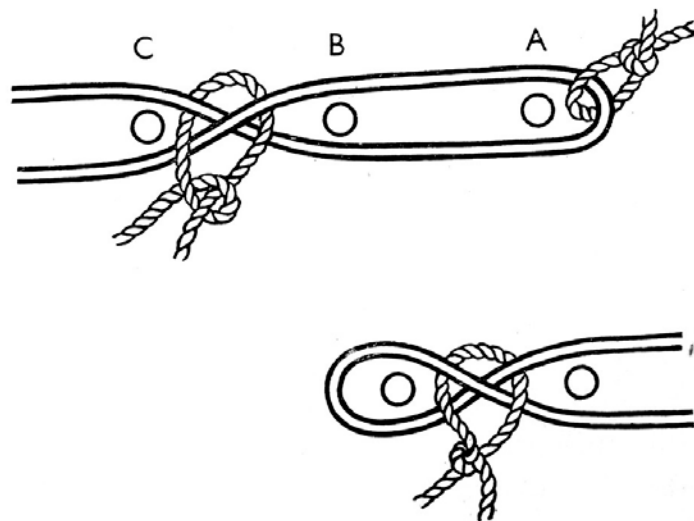


Fig 37b – Cross Preservation.

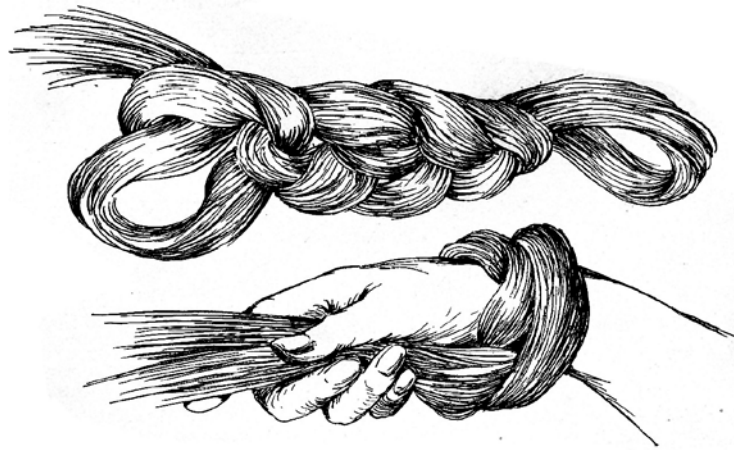


Fig 38 – Warp Removal.

6. The warp was removed by holding it from the bottom pegs on the warping mill and loose chain was formed with the entire length in loops to allow easy transfer on to the loom. (Fig.38c).

Yarns of contrasting colours were used to determine the length of the pile warp and wound around the warping mill as done with the ground warp. The ground warp measured 3 metres whilst the pile warp was 5 metres.

### **3.4.2 Beaming**

One end of the warp with the crosses was fixed onto the warp beam/roller by means of the cord attached to it. The ends already grouped into twelves were spread on the loom by placing each group in each dent of the raddle tied on the loom.

Whilst the crosses remained in place, with the help of the cross sticks (Fig. 39) the entire warp was wound onto the warp beam/roller while the other end of the warp was attached to a weight (Fig. 40). This process was repeated for the pile warp.

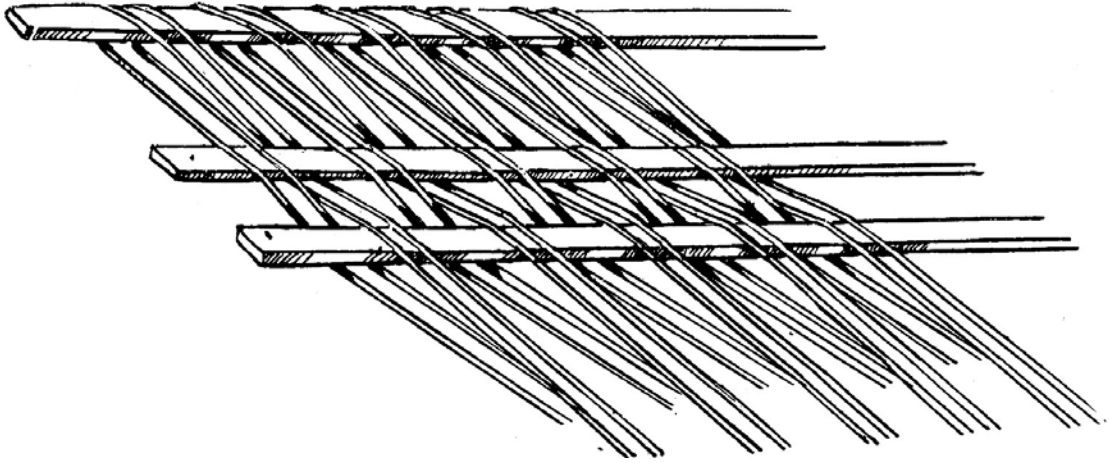


Fig. 39 - Cross Sticks.

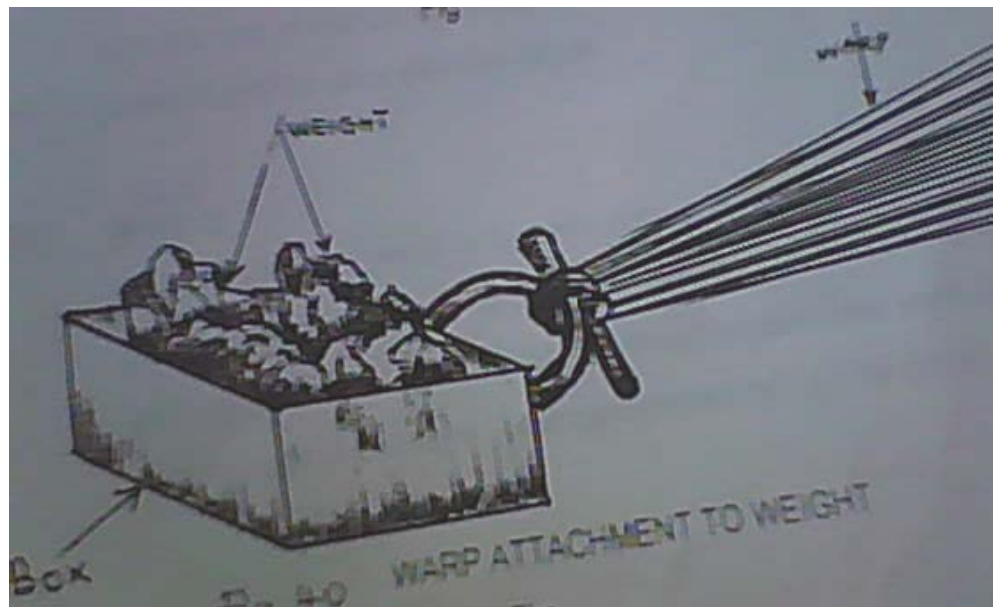


Fig. 40 - Warp Attachment to Weight.

### 3.4.3 Heddling

The two-ply yarns were passed through the individual healds on the four heddles as indicated in the design for the sample to be woven. The heddling was started from



one end of the warp to the other end. The heddling order was - 1234, 1234, throughout.

This indicates that the first yarn was passed through the first heald on the first heddle, then the second end through the first heald on the second heddle, the third end through the first heald on the third heddle and the fourth end through the first heald on the fourth heddle.

Heddling continued in this rhythm until all the ends for the ground warp were exhausted. (Fig. 41)

HEDDES	4				X					X					X					X					X
	3			X				X					X				X						X		
	2	X					X					X				X						X			X
	1	X				X				X				X			X				X			X	
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

Fig. 41 Heddling Order (Draft).

The pile warp was also heddled the same way as the ground warp but starting from the end of the 24 ends that formed the selvedge. This continued until it ended where the other selvedge began.

### 3.4.4 Reeding

The individual yarns were passed through the dents in the reed using the reed hook.

The yarns for the selvedges were doubled and passed through a dent after which successive ends of the ground and the pile warps were passed through the dents.

### 3.4.5 Tie-Up

The process of attaching the treddles to the lams and further to the heddle frames is referred to as the tie-up. The method of attachment differs from loom to loom. For this project, the following combination was used.

Treddie	Lams
1	1 & 3
2.	2 & 4
	} Plain/Taby weave
3	1 & 2
4	2 & 3
5	3 & 4
6	4 & 1
	} Twill weave

### 3.4.6 Weft Preparation

The yarns in hanks and cheeses were put on a skein winder and a spool rack respectively and the ends drawn and wound onto the bobbins fitted onto the bobbin winder. Two - ply yarn is used in this weaving and as a result, two hanks or cheeses were fixed on the skein winder or spool rack before being transferred on to the bobbin.

The wound bobbin was fixed in the shuttle and used as binder during weaving, however, many bobbins should therefore be wound ready for work to facilitate quick weaving process.

### 3.5 Weaving

The weaving of pile fabrics differs entirely from all other types of weaving due to

- (i) The number of warps used;
- (ii) The weaving mechanism

These can be seen on pages 42 and 59 under formation of the pile – 2.6.1



Plate 10 – Front of Loom Showing Part of Woven Pile Fabric.

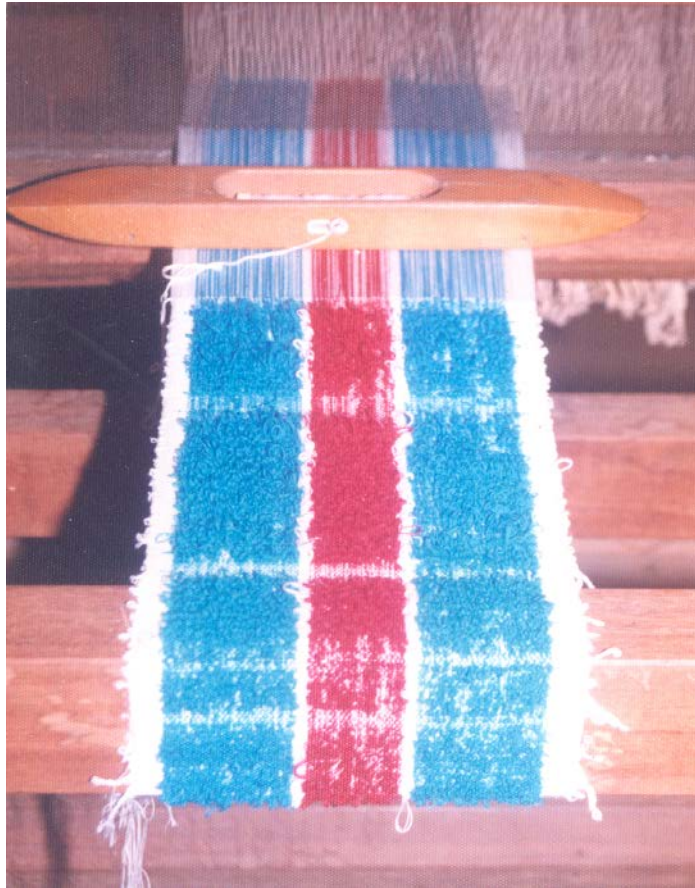


Plate 11 – Woven Pile Fabric As on The Loom.

## **CHAPTER FOUR**

### **RESULTS**

The preceding chapter took into consideration the equipment, materials, preparation and processes involved in the modification of the Broad loom and the production of the sample weave as a proof that the adapted Broadloom is capable of producing pile fabrics.

#### **4.1 Appraisal of the adapted part of the Broadloom**

The adapted parts of the loom were produced from a special, well seasoned wood – “Dawuma”. The wood was designed to take exactly the shapes of the required parts.

The adapted parts were properly formed, planed and well polished. The parts which required drilling were done to a specification to enable these parts to be well fitted to the actual loom for stability. The parts were fixed with special sizes of bolts and nuts and the other metal parts were also formed with similar precision such that the parts can be dismantled if not in use.

#### **4.2 Appraisal of woven sample.**

The colours used in the production of the sample weave were light blue, white and red forming the pile and white was used for the ground. In the arrangement of the colours, a broad red is placed at the middle of the fabric, bordered at the two extremes by a small strip of white then followed by a broader light blue at the two ends before the selvedge. The arrangement makes the work to be well balanced. The formation of piles in the sample weave can be clearly seen. These piles/loops are closely packed at some areas while other areas have few loops.

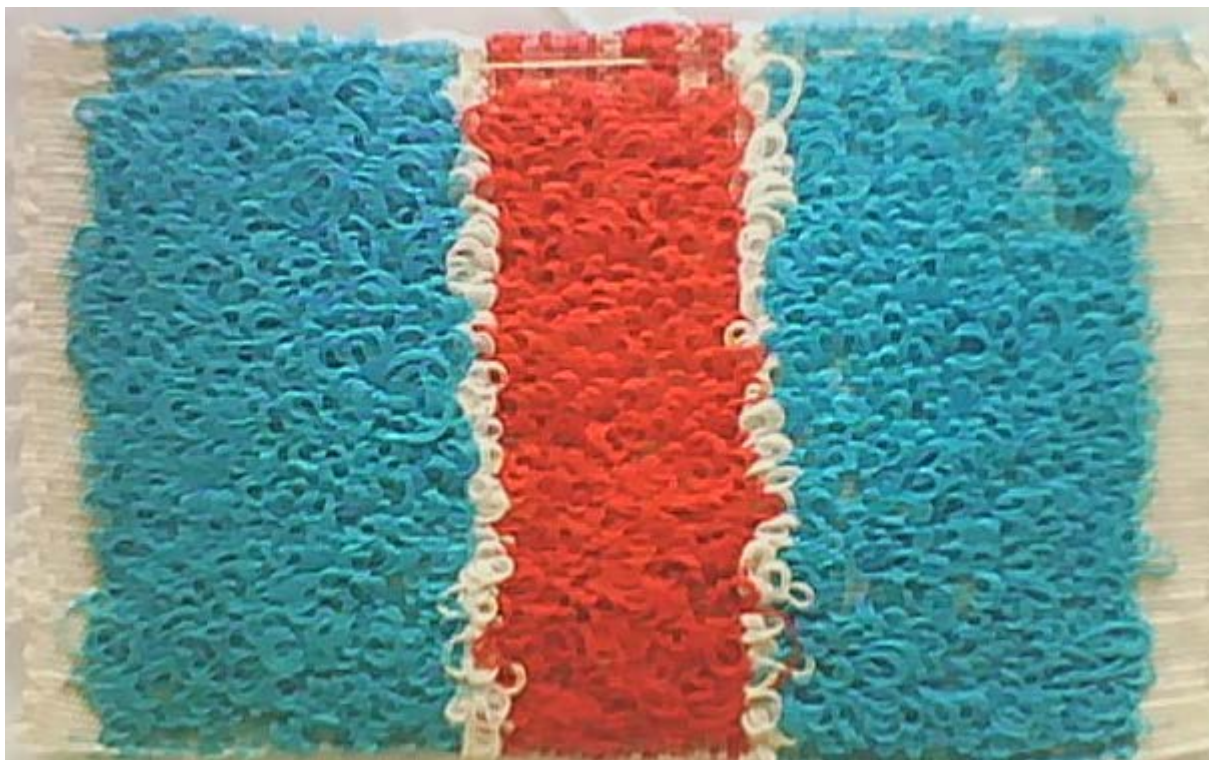
The piles/loops were formed on both sides of the woven fabric leaving the selvages plain since the fabric has been designed in that way. These loops vary in height and their closeness in the woven sample makes it to have a very soft feel.

#### **4.3 Comparison between Broad Loom Sample Pile Weave and Factory Woven Pile Fabrics.**

Critical observations of the above mentioned fabrics shows some similarities and differences between these fabrics as shown below:

<b><i>Broad Loom Sample Pile Weave</i></b>	<b>Factory Woven Pile Fabrics</b>
Sample 1	Sample 2
Loops closely packed	Loops not closely packed but have spaces between them
Loops have uneven height	Height of loops are even throughout the fabric
Fabric looks heavier and thicker	Fabric very light
Pile formation at both sides of fabric	Pile formation at both sides of fabric
Some areas are without piles	Piles are formed all over the surface apart from areas designed not to have piles.
Fabric looks more absorbent due to the thick piles	Fabric does not look so absorbent; a result of fewer piles over the surface
Cotton yarns used for fabric	Cotton yarns used for fabric
Seen under a piece glass	Single yarn used as weft.

(magnifying glass), it is observed that two-ply yarn was used as weft.	
Pile warp made up of two-ply yarn	Pile warp made up of two-ply yarn
Sample weave has no intricate designs or patterns	Sample weave has a sort of design or pattern such that there are some areas with piles at the surface and the same area at the opposite side has no piles
Fabric colourful with the same coloured piles at both sides of fabric	Fabric colourful with the same coloured piles at both sides of fabric



Sample 1

Sample Pile Weave on Broadloom.





Sample 2

Pile Woven Sample from the Factory.

Broad Loom Sample Pile Weave (Sample 1)	Factory Woven Pile Fabrics (Sample 3)
Loops closely packed (Compact)	Loops not closely packed like Sample 1
Loops have uneven height	Height of loops are even throughout the fabric
Fabric looks heavier and thick	Fabric weight and thickness almost as Sample 1
Pile formation at both sides of fabric	The same as Sample 1
Some areas are without piles	Piles are formed all over the surface apart from areas designed not to have piles.



Fabric looks more absorbent due to the thick piles	Same as Sample 1
Cotton yarns used for fabric	Same as Sample 1
Seen under a piece glass (magnifying glass), it is observed that two-ply yarn was used as weft.	Single yarn used as weft.
Pile warp made up of two-ply yarn	Same as Sample 1
Sample weave has no intricate designs or patterns	Sample 3 has intricate and complex designs or patterns made up from white and yellow ochre yarns (Figured Pile).
Fabric colourful with the same coloured piles at both sides of fabric	Fabric very colourful with different coloured yarns forming piles at the reverse side of fabric.  (Different colours for the positive areas of design on the surface while different colours appear at the negative areas of design at the reverse side of fabric)

#### **4.4 Interpretation of the Results from the Comparison of Samples**

The weight and thickness of Sample 1(Broad loom sample) may be the result of the combination of the compactness of the loops, the two-ply yarns used for the weft, the two-ply yarns used for the pile warp, and the height of the loops.

The tendency of one fabric to be more absorbent than the other may be due to a number of factors-the number of piles formed on the fabric, the type of fibre (yarn) used e.g. cotton, and the length of loops.



Sample 3

Pile Fabric (Factory Woven).

The production of intricate and complex designs or patterns is due to the type and scope of the loom used. While the dobby can produce complex designs, the jacquard can do more and the broadloom can never be equated to any of them.

From the observation made in Sample 3, the fabric having different colours at some places in the design while the other side also have different colours may be due to the use of two pile warps coupled with the type of loom used the jacquard which can produce figures in fabrics as in sample 3.

At this embryonic stage of development, the pile weave on the Broadloom cannot be considered to be better than the factory ones but with time, it can compete favourably with the factory weaves after passing through lots of development. Presently, it can be considered as equally good but not design wise, nevertheless, it can serve the purpose of being a towelling fabric.

#### **4.5 Problems encountered and some possible solutions**

Various problems were encountered at different stages of the work and the acquisition of a well-seasoned wood for the adaptation happened to be the first. It took the researcher sometime before the proper type of wood was acquired.

Other problems were encountered during the production of the sample weave, and some of these problems are: uneven height of the loops; lack of loops/piles at some areas of the woven fabric.

The lack of loop formation at some areas is the result of the tension given to the pile warp beam. Where the tension is so great, it turns to pull the pile warp thereby leaving the area devoid of loops/piles. Also during the take-up motion- rolling the woven fabric onto the cloth beam; if great care is not taken and the pile warp yarns are pulled greater than it should, then the warp will stretch and leave some areas without loops.

The uneven height of the loops/piles was the result of the inaccurate measurement of the gap that was created between the fell of the cloth and the two succeeding picks of weft. The distance of the gaps created gives the height of the loops/piles; the shorter

the gap, the shorter the loops and the longer the gap, the longer the height of the loops.

The height of the loops also depends upon the release of the pile warp yarns. The length of the pile warp yarn released gives the height of the loops after beat-up.

It has been observed that in order to have an even height of loops, the distance created between the fell of the cloth and the two succeeding picks of weft should be the same throughout during weaving.

The size of the ratchet wheel of the pile warp is the same as that of the ground warp. In order to release the same length of pile warp yarns, it has been observed that the teeth of the ratchet wheel of the pile warp beam should be shorter than that of the ground warp. In this way, the pile warp beam can release even length of warp to give even height of loops. The length of the teeth of the ratchet wheel should be the same as the gap to be created.

As a result of frequent breakages in the spun cotton yarns used for the project, the production process was very slow and difficult making it impossible for the researcher to produce many samples. Although the researcher has encountered diverse problems in this work, he has found the work to be an interesting and thought - provoking exercise.

#### **4.6 Test of Hypothesis**

The hypothesis of the project states that:-

The Broadloom could be adapted for weaving of pile/terry fabrics.

The justification of this hypothesis is clearly seen in the analysis made so far. The piles have been adequately produced in the woven sample fabric after the successful production of the adapted parts. This however, confirms the adapted loom's viability in the production of pile fabrics. Therefore weavers using the Broadloom could greatly adopt the adapted loom's usage in pile fabrics production.

The width of the warp could be increased further and some designs tried on this loom.

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.**

#### **5.1 Summary of Findings.**

The adaptation of the loom, the weaving of sample, appraisal etc. have revealed that:

The Broadloom could easily be adapted for producing pile fabrics.

Pile fabrics could conveniently be produced on the adapted Broadloom.

Even pile/loop height is the result of the even gap created between the fell of the cloth and the two succeeding picks and the tension given to the pile warp beam.

Too much tension to the pile warp beam results in the absence of loop formation in some areas of the fabric.

The length of the teeth of the ratchet wheel of the pile warp beam should be short to deliver exactly the same length of warp for even loop height throughout the fabric.

Cotton yarns are the best for weaving pile fabrics since their tendency of absorbing moisture is greater than other types of yarn.

#### **5.2 Conclusions**

Pile fabrics ever since have been considered as fabrics whose production is only limited to the factories that make use of heavy industrial weaving machines.

As a result of this, since the demand for toweling fabrics is high and the production cost in the factories is high, the price for these fabrics are also high leading to the low patronage of pile fabrics produced in the factories. This leads to the influx of the Ghanaian market with secondhand toweling fabrics whose prices are moderate to meet the pockets of majority of Ghanaians.

The high production cost from the industrial establishments is also due to the high cost of the raw materials – cotton which is not produced in abundance in . The importation of this raw material coupled with its heavy taxes had led to the winding up of some of the establishments that go into this production and the high cost of the products from existing ones. But at the end of this research, it has been clearly seen that pile fabrics can, in a small way, be done not only in big industrial establishments but also at home on the Broadloom. In this way the Ghanaian market will be flooded with towelling fabrics which will be low in price enough to meet the pockets of the average Ghanaian if only many weavers will take this weaving up.

### **5.3 Recommendations.**

Since pile fabrics could be produced on the adapted Broadloom, it is therefore recommended that the loom should be produced in large quantities by the Ministry of Education (MOE) for distribution to the Senior High Schools (SHS) and other institutions where Visual Arts is pursued and for that matter textile.

The MOE should produce the loom and distribute to the Non-Formal Education Division (NFED) of the MOE for people to use in producing pile fabrics to alleviate their poverty since educating the populace to become functional literates without

employment will not help to improve their living standards. Higher institutions such as Universities, Government Organizations, National Board for Small Scale Industries (NBSSI), Non-Governmental Organizations (NGO's), Centres for National Culture (CNC), Intermediate Technology Transfer Units (ITTU), and individuals should incorporate the weaving on the adapted loom into their activities to enhance the weaving industry in Ghana to increase the variety of woven products. This will help to earn more foreign exchange for the country through exportation of pile fabrics. This will also reduce the importation and price of pile fabrics in the country.

The Government, NBSSI, NGO's, ITTU's, CNCs, and benevolent organizations and individuals should take more interest to invest in research works carried out by students in higher institutions of learning such as the universities. This special recommendation is made because the Thesis Grant and Scholarships awarded to students are meager vis-à-vis the economic situation of the country whereby the major currencies in the world such as the Pound Sterling and the United States of America's Dollar dictate the pace for the economy of Ghana.

Future researchers utilize this project report as the foundation reference material in any future research work to improve and develop pile fabric weaving on Broad loom in Ghana.

1. Future researchers should try and find out if there could be any possibility of weaving intricate/complex designs or patterns similar to that of factory weaves on the Broadloom.
2. In doing this they should find a device for creating equal lengths of gap between the fell of the cloth and the two succeeding picks of weft.



3. They should also reduce the teeth of the ratchet wheel of the pile warpbeam in order to release shorter lengths of pile warp for even height of loops.
4. Finally the Ministry of Agriculture should encourage the cultivation of cotton to be in abundance for use in the production of these and other fabrics to reduce the heavy amount used for the importation of these raw materials.

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