Research on Humanities and Social Sciences
ISSN 2224-5766 (Paper) ISSN 2225-0484 (Online)
Vol.7 No.24 2017

Invention of a Loom with Dual Shedding Systems to Accelerate Cottage Weaving In Ghana

* Vigbedor Divine[1], Gbadegbe Richard Selase[1], Quashie Mawuli[1], Amankwa Joana[2] and Florence Emefa Agra[2]

Address: 1. Department of Industrial Art, Ho Technical University, P. O. Box, 217, Ho, Volta Region, Ghana.

2. Department of Fashion Design and Textiles, HTU

West Africa. Cell Phone Contact: +233-243-176248

* Email of corresponding author: vigbedor@yahoo.com

ABSTRACT

The history of the textile industry has grown tremendously due to the people's ingenuity, energy, tools, equipment and natural resources. The device used for weaving a fabric is called loom. The loom has undergone series of changes from the vertical to the horizontal after which other accessories were added and that includes heddles, reed, harnesses, levers, cloth roller and the warp beam. In this project research, an additional mechanism of foot pedals has been incorporated onto the table loom for dual shed creation. This was made possible by the attachment of chains and springs to the pedals via the lams and the shafts. In this study, a Population of forty-six (46) respondents was sampled out of the Target Population using the stratified Random Sampling technique. The descriptive research method was used to describe the various stages involved in the construction of the loom. Primary data for the study were collected using interview guides and observation. A major finding of the study is that, good shedding mechanism is a prerequisite for producing quality woven fabrics. Therefore, the decision by the researchers to design and produce a loom with dual shedding systems is in the right direction. Owing to the complex nature of the loom, it is recommended that a regular and rigorous maintenance culture is adopted to prolong its life span. Furthermore, potential users of this loom must be given proper education on how to prepare the loom for weaving.

Keywords: Weaving, Textiles, Loom, Treadles, Shed

INTRODUCTION

Weaving is probably as old as human civilization, and one of the basic necessities of man is clothing. It covers our bodies and protects us from outside effects as well as the working environment.

Weaving is a dynamic art which has brought a lot of developments to the fashion industry and as a means of livelihood to many. The earlier method of weaving was tiring, slow and consumed time and energy. It started vertically as the warp was laid and the individual ends supported by weight and the ends selected to insert the weft with the hand. Horizontal looms were introduced with accessories such as the warp beam, cloth roller or beam, reed, shuttle and the healds to ease and support the weaving operation.

The table loom or hand loom has undergone several innovations after its invention in different civilizations. The warp ends are wound on a beam, with the individual ends passed through the eyes of the healds and then through the dents of the reed.

Levers connected to the heald shafts on the table loom when depressed lift a number of the shafts (depending on the type of design being woven) to create a shed. The remaining shafts are also engaged in subsequent operations for shed creation and onward insertion of the weft yarn or pick.

The inserted weft yarn is then beaten-up "to and fro" by the help of the reed. The creation of a shed, picking and beating-up as well as the letting-off and taking-up of the woven cloth are done by the hand, making the operations on the table loom slow, tiresome and time consuming. There is therefore the need to modify the shedding mechanism of the table loom so as to lessen the burden the "hands" undergo when weaving is taking place.

To do this, the researchers embarked on this study aimed at introducing an additional set of foot-powered treadles, with chains and springs attached to the table loom. It is believed that this innovation will increase the speed with which shedding is done on the table loom without undue pressure on the hands. It is also the expectation of the researchers that the general efficiency of shed creation on the table loom will be boosted substantially.

2.0 REVIEW OF RELATED LITERATURE

In order to strengthen the theoretical framework of this paper and to establish its uniqueness, frantic efforts have been made to review related literature from various sources such as the internet, books and monograms. The review was done under the following sub headings: Overview of Weaving, History of Weaving, and weaving machines.

2.1 Overview of Weaving

Weaving according to the Longman Dictionary is to form threads into materials by drawing the threads at a time under and over a set of longer threads stretched out on a loom. The Textiles Terms and Definition also defines it as the action of producing fabric by interlacing of warp and weft threads.

Marks and Robinson define weaving as being the interlacing of warp and weft threads to produce a fabric and that it is done on the weaving machine. The encyclopaedia states that it is the making of cloth by crossing two sets of threads over and under each other and that a weaver must thread the loom before weaving. From the above definitions, weaving can be worked through a medium such as a loom or weaving machine.

Halsey and Youngmark (1975) define a loom as a device which will keep warp threads under tension to make it possible to weave cloth by the hand or by power from electricity. Lyle classified the loom as shuttle loom (loom that uses shuttles) and shuttleless loom (loom that uses devices such as grippers, rapiers, water and air jets).

2.2 History of Weaving

Adanur (2001) states that Egyptians made woven fabrics dated as far back as 6000 years ago and that of the Chinese over 4000 years ago. Lord and Mohammed (1981) were of the view that human beings clothed themselves with materials since the dawn of history.

According to Rodee (1977) the ancestors of the Pueblo and the Indians began to weave around AD 800's. Simpson and Weir ((1946) recorded the practice of hand loom weaving as far back as the 5th century B.C.

2.3 Weaving Machines

According to Gupta, primitive people observed the interlaced grasses and twigs in the nests of birds and developed devices for the construction of clothing. Lord and Mohammed described the early loom's main structural components as very simple, the warp ends were tensioned by individual weights and the weft yarn inserted by suitably shaped stick. It continued by citing the functions of the warp control, filling or weft insertion as well as the beat-up as recognizable but the shedding is completely absent.

As looms developed, the functions of shedding became apparent because it made the insertion of the filling easier but the process still was discontinuous.

Furthermore, shafts or harnesses were used as well as other techniques such as the dobby similar in principle to a jacquard. The 20th century saw the use of the rapier, water and air jet to insert the filling which increased the productivity of the loom.

Marjory (1986) also affirms that, the basic loom is made up of a warp beam, heddles and harness and this depends on the type of fabric to be woven.

According to Adanur (2001), De Vaucanson made a loom 1975 and was further developed by jacquard to control individual warp ends separately. In 1978, Cartwright invented the power loom which could be operated from a single point or source. By 1800s looms were made from cast iron and operated by steam engine. Loom

productivity was low due to the shuttle and was replaced with shuttleless looms being the second generation of weaving machines.

Rossman, an engineer developed the projectile between 1930 and 1953. By 1972 and 1975 rapier and the air jet were introduced respectively but operated as a single phase machine. The last decade came with a multiple weaving machine developed which offered the potential to achieve almost completely rotary motion and high productivity.

Adanur (2001), further groups the system of warp yarn manipulation into four namely crank, cam or tappet, dobby and jacquard shedding.

The crank, cam and dobby mechanisms control harnesses; the jacquard system however provides control of individual warp yarns. These innovations came as a result of the scientific study of the relationship of man and his working environment known as ergonomics.

According to Gradjean (1975), ergonomic was to ensure that items were compatible with and properly matched with those who had to use them and had increasingly been applied in industry to improve performance and reduce human stress.

McCormick (1967) on the other hand, states that, before designing an artefact, one has to make anthropomorphic survey of the population for which it is designed. Murrel (1975), is of the view that, machines are employed as tools, levers, knobs, switches, buttons and paddles to facilitate work and to receive feed-back information in any given operation. He further continues that while we take pains to ensure that our clothing fit well dimensionally on our bodies, we expect a standard variety of machines to match humans whose dimension show great variation.

Gradjean (1975), further states that, artefacts need to be adjustable to cater for people whose dimensions are near the ends of the range. The chief compensation of those, whose dimensions are outside this range, is that, they will often qualify for special tasks for which their exceptional dimensions are advantageous. Ergonomics had brought to the fore a lot of changes to various machines and textile machineries are no exception, especially the weaving machine or the loom. The construction of the loom with two sheds will help increase the rate of production and act as a disability friendly equipment or device.

3.0 METHODOLOGY

3.1 Overview

This session of the paper describes the various research methods adopted to obtain data for the study. It is sub-divided into: Population for the Study, Sampling Technique, Research Methods and Data Collection Instruments.

3.2 Population for the Study

A Population is defined as a complete set of individuals, objects or events having common observable characteristics in which the researcher is interested. The Target Population studied includes Textiles students from the Industrial Art department of HTU, Fashion students of HTU as well as Fashion and Industrial Art lecturers of HTU. The Population also includes the Cottage Weavers in the Ho Municipality of Ghana. The table below paints a clear picture of the Target Population.

Table 1: Target Population

Population	**Size of Population**
Textiles students of HTU	20
Fashion students of HTU	30
Textiles lecturers of HTU	10
Fashion lecturers of HTU	14
Cottage weavers	12
Total	**86**

3.3 Sampling Technique

In this research, the accessible population for the study is heterogeneous in nature. The heterogeneity of the accessible population was treated under proportional stratified sampling using stratum to identify each of the strata which come in different representations. Consequently, each category in the population will be treated as a stratum. Leedy (1974) asserts that for quality research, at least 30% of the accessible population is a fair representation for acceptable results. It also enables the researcher to lower the variance of the research. However, due to the scarce resources available for the study, 50% was used to arrive at a smaller sample population.

Table 2: Schematic Diagram of the Proportional Stratified Sampling Design

Population level	Total Population 72				
Proportional Stratification level	ST1 20	ST2 30	ST3 10	ST4 14	ST5 12
Randomisation Level (Sampling) 50%	10	15	5	7	6
Total Randomised Stratified Sample (Data Level)	43 36				

* ST – Stratum

3.4 Research Design

In this study, the descriptive research approach was used to obtain information concerning the existing looms and current status and describing the conditions in which it operates (Key 1997). It was also utilized for a systematic and accurate description of the various stages of the study. Through the use of the descriptive method, the various stages involved in the design and construction of the loom as well as its mode of operation were described.

3.5 Data Collection Instruments

The research instruments employed for the study were basically interview and observation. This was due to time constraint and inadequate resources.

3.51 Interview

Interview was one of the research instruments used in collecting primary data for the study. Adgedu et al (1999) explain that interview is a face to face meeting between a questioner and a respondent. It is an oral questionnaire which is often used in collecting data for descriptive studies and action research. Interview according to this source is superior to other data collection devices in the sense that the response rate is high and issues can be clarified. Respondents are usually willing to talk than write and thus provide immediate response. Moreover, the key reason for using interview is that it allowed the researchers to clarify ambiguous answers and, when appropriate, seek follow-up information.

Interview guide was designed in this regard. Leedy and Ormrod (2005) explained that in a semi-structured interview, the research may follow the standard questions (interview guide) with one or more individually tailored questions to get clarification or probe a person's reasoning. Interview was therefore used to solicit data from respondents concerning the topic.

3.52 Observation

The natural way of gathering information is by observation and it is most direct in terms of studying people when one is interested in the explicit behaviour and the result achieved or obtained is real and precise through mechanical and electronic means (Sidhu, 1984).

Participant and non-participant observation are the two main forms of observation. The former deals with the behaviour of a person or a group of persons and the researcher plays an active role in the said situation and records the action or procedure of work. The researcher on the other hand can be an observer and not part of the group performing the action.

The latter (non-participant) is the type of observation in which the investigator or researcher is not directly concerned in the activities or situation being observed. Considering the nature of the study, the researchers employed the non-participant type of observation which allowed them to observe various types of table looms in the Ho Municipality. It was observed that the table has levers which are depressed by the hand to create a shed for weft insertion. This was considered to be tiring and laborious as the weaver has to stand still throughout the weaving session. Upon careful brainstorming and experimentation, the researchers decided to improve upon the table loom by introducing foot pedals for easy shed creation.

4.0 PRESENTATION AND DISCUSSION OF DATA

This part of the paper presents and discusses data obtained for the study through the administration of the research instruments. It is sub-divided into Tools and Materials, Design and Construction of the Loom and Mode of Operation.

4.1 Tools and Materials

The following tools and materials were used in the execution of the project:

Wood
Woodwork Bench
Screws and Nails
Drilling device
Chisels
Hacksaw
Screw driver
Plane
Clamp
Saw
Measuring tape
Try square

4.11 Wood

This is a solid material normally obtained from the trunks and branches of trees. It is processed and used for various purposes. Almost the entire structure of the loom was made of odum tree, which has been seasoned to withstand all seasonal changes.

4.12 Woodworker's Bench

The working bench is made of wood and metal components. It serves as a supporting tool in constructional work or operation. A bench vice has an integral wooden jaw which tightens when a screw is rotated. It is often mounted on both the front and rear of the bench. It was used in cutting and putting of the wooden pieces together.

4.13 Screws and Nails

A thin pointed piece of metal that is pushed through pieces of wood to fasten them together. Most of the wooden and metal joints of the loom were also fastened with screws as well as bolts and nuts; that is, where nails are not applicable. This is illustrated in Plate 1 below:

Plate 1: Screws and Nails

4.14 Drilling devices

Both the hand and the powered drills were used. These tools were used to drill circular holes in the metal levers and wooden treadles of the loom as shown in Plates 2 and 3 below:

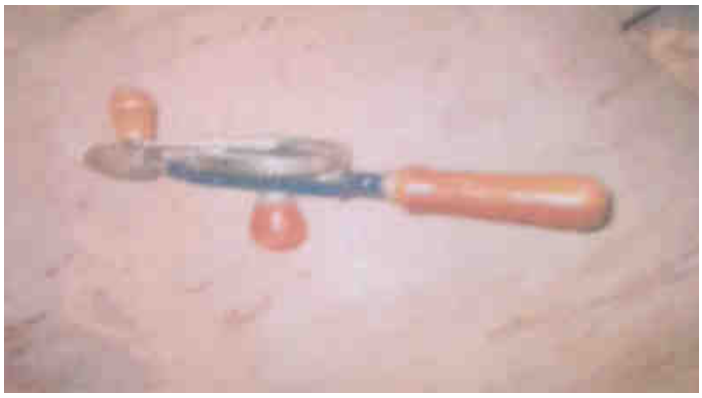

Plate 2: Hand Drill

Plate 3: Machine Drill

4.15 Chisel

It is made of metal blade and wooden handle. The blade is rectangular in shape and is either tanged or of a socket construction. The base of the tang has a shoulder to stop it from being driven too far into the handle. A

brass ferrule prevents the handle from splitting where the tang enters. It was used to cut some parts of the wooden members to shape, to fit exactly into position. This is shown below in Plate 4.

Plate 4: Chisels

4.16 Hacksaw

It has a replaceable blade held in tension in a frame. Hacksaw frames are adjustable to accommodate 250mm-300mm length blade. Blade pitches of 14, 18, 24 and 32 teeth per 25mm are available. Soft materials require course pitch and hard materials require a fine pitch of blade. The hacksaw was used to prepare the metal heald shafts.

Plate 5: Hacksaw

4.17 Plane

It consists of a piece of sharpened steel (the cutting iron) fitted into a wooden or metal stock. The cutting iron is 38mm-60mm wide with only the corners slightly round to prevent them from digging-in when planning. The stock is of wood or metal (cast iron) 200mm-260mm long. The plane when in use has sap iron 0.5mm-0.8mm away from the cutting edge. The plane is used in smoothening and cleaning-up the surfaces and edges of wooden members ready for assembling and flashing-off of assembled joints.

Plate 6: Plane

4.18 Clamp device

The longest among the clamps used by the woodworker is the Sash Clamp. It has a long metal body with two jaws. The clamp was used to hold the rectangular frame on the loom as well as the sley.

Plate 7: Sash Clamp

4.19 Screw Driver

The screw which comes in various sizes is used for loosening and tightening screws. It is made up of a metallic rod normally tapered at one end and fixed into a plastic or wooden handle. In this project, it was used to loosen and tighten parts of the loom.

Plate 8: A Set of Screw Drivers

4.20 Saw

The two types of saws used are the rip saw and the tenon saw. The rip saw is used for cutting and splitting. It has pointed teeth with knife-like edge. The front edge teeth being about 70-80 to the line of the teeth. It was used to cross-cut the wooden board for the lams and treadles.

Plate 9: Rip Saw

The other (tenon saw) belongs to a group of saws known as “back saws” which are made of brass or steel stiffening rib folded over the thin blade to prevent it from bucking. The teeth are sharpened for cross cutting. The handle is of a close type and shaped so that the saw is easy to use in a horizontal position on the bench. See Plate 10 below:

Plate 10: Tenon Saw

4.21 Measuring tape

It is a tool used for taking measurements. It consists of a along narrow piece of cloth, soft plastic or thin metal pieces. It was used to take the right dimension of the loom parts before they were cut. Plate 11 shows the Measuring Tape.

Plate 11: Measuring Tape

4.22 Try square

It is an important tool used to determine the square nature of any material meant for construction work and for enabling lines to be marked at right-angle to a given surface. It is made of a blade and a set at right angle on a flat side to the stock by means of rivets which pass through brass plates on each side of the stock. The stock is made of metal to give a more accurate way of doing things. It was used in the construction of the rectangular frame containing the heald shafts.

4.2 Design and Construction of the Loom

The design and construction of the loom with dual shedding systems was based upon the table loom as shown below:

Plate 12: Table Loom

The above diagram in Plate 12 consists of wood members (beams) which have been constructed into a rectangular frame by gluing and firmly securing with screws. Other accessories or components attached to the loom structure consist of the cloth roller, warp roller, reed, sley, heald wires and shafts controlled by levers via chains. The table loom is mounted on a table (thus the name table loom given to it) to give it height for the operation to be effective.

The hand operates the levers which are depressed and its corresponding shafts are lifted to form the top sheet of ends while the rest of the shafts which have not been lifted form the bottom sheet of ends, thus, a shed is created for the insertion of weft carrier or shuttle by hand across the width of the opening.

The last inserted pick is beaten to the fell of the cloth by the hand and weaving continues until the warp yarn is exhausted. The woven fabric is taken up onto the cloth roller. This is achieved by letting-off the warp beam.

4.21 The Loom with Dual Shedding Systems

The design of the loom comprises assemblage of wooden frames as depicted in the diagram below.

Figure 1: Front view of Loom

The loom with dual shedding systems is composed of two structured frames made of various components and accessories such as the lever, heald shaft and heald wires. The frames have been designed in such a way to carry the heald shafts which are secured firmly in a groove located at the two sides of the frame. The upper end of the grooves is fitted to the lever that supports the shafts with a chain to keep it in equilibrium and also for the lifting of the shafts when there is a depression on the lever.

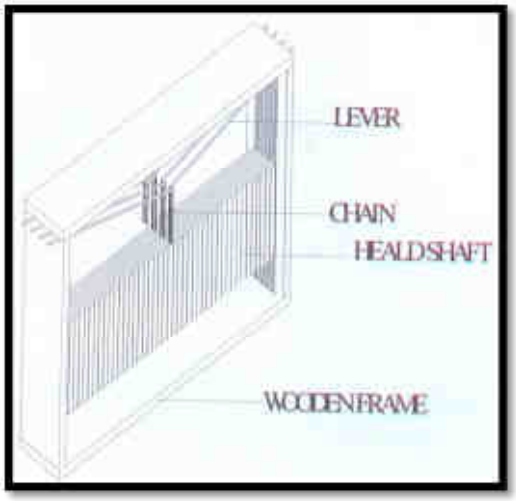

Figure 2: Rectangular Frame

There is also the Intermediate frame which consists of a set of lams, cloth roller, warp roller, treadles and supporting chains and cords. The intermediate frame has four upright wood members which are supported with horizontal members at the sides, top and the bottom. The front and the rear are connected to the cloth and warp roller respectively. A well-structured two sets of lams are mounted to the base of the frame in a criss-cross manner. These wood members are secured with glue, screws, bolts and nuts to keep the intermediate frame upright and sturdy as shown below:

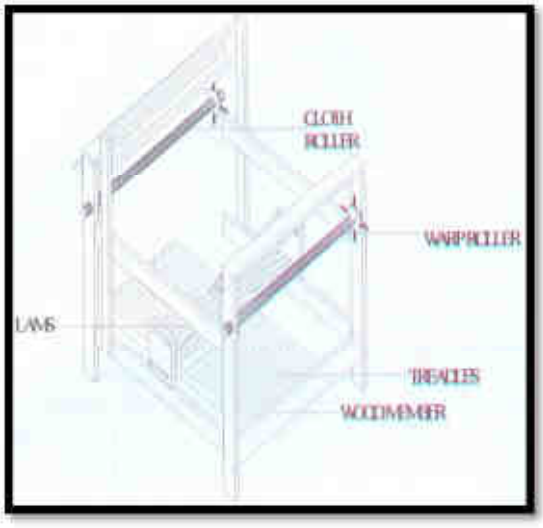

Figure 3: Intermediate Frame with components

The figure below shows four solid vertical wood beams which have been erected with the supporting beam in between to keep them sturdy. Between the two front solid beams is fitted a cloth roller and the warp roller. At the extreme end of the cloth roller is the rachet wheel and handle. Attached to the beam is a pawl which is used to control tension in the front section of the loom. The warp roller also has a rachet wheel and a handle at its extreme end with a pawl to control the tension.

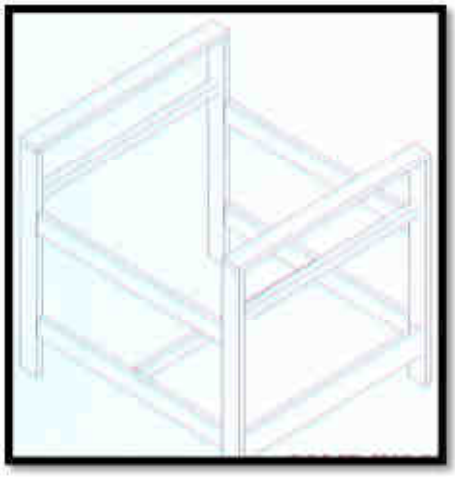

Figure 4: Wood framework

Beneath the top cross bar supporting the vertical beam is another cross bar at the bottom, on top of which is mounted a vertical wooden structure designed to hold the lams in position. The lams are arranged in criss -cross manner, having four odd and four even numbers. The bottom lams are secured with metal rods and the top ones are secured with a set of springs.

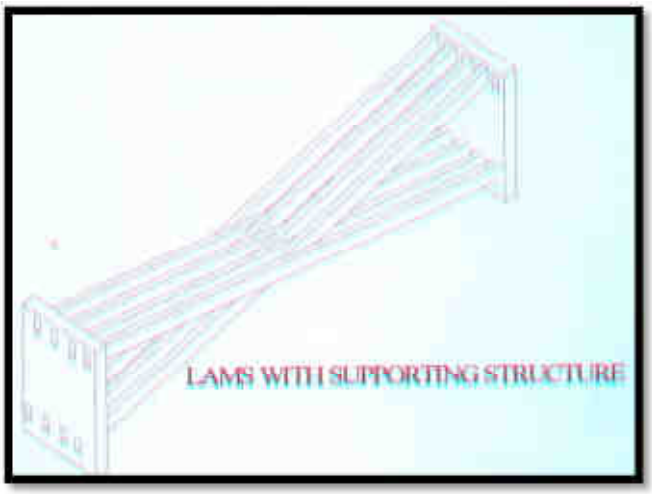

Figure 5

Below is the arrangement of the treadles from the rear of the loom. The treadles numbering 8 are secured and pinned to the back of the loom with a metal rod. They are held in position with a spring and kept in equilibrium. The spring attached to the treadles are secured at the base of the rectangular frame. The treadle extends from the rear to the front of the loom to a point appropriate for the weaver to use during weaving. A cord is used to secure the lams to the treadle according to the weave structure to be woven.

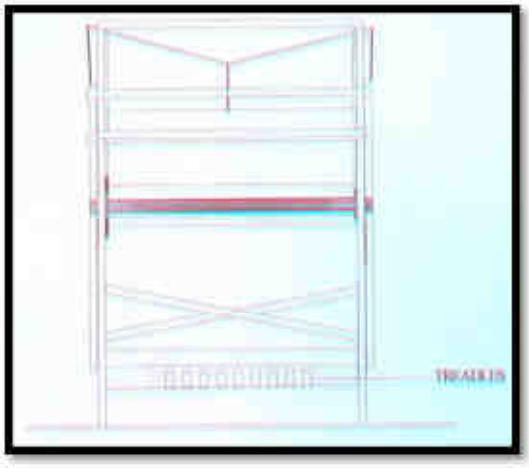

Figure 6: Treadles fixed to back of loom

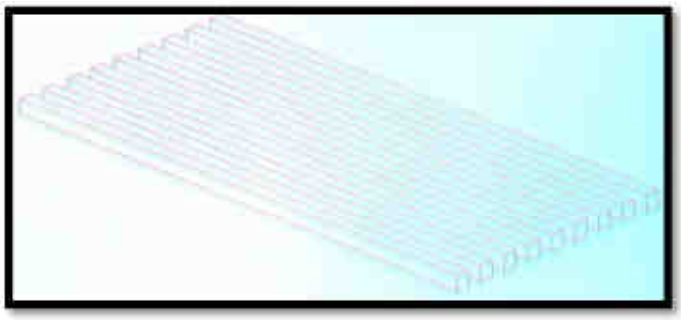

Figure 7: Treadles

4.21 Finishing

The loom was finished by polishing with sand paper and then spraying with lacquer. The plate below shows both the front and back views of the finished loom. The warp yarns have been beamed onto the warp roller and threaded though the heald eyes and the dents of the reed and finally secured onto the cloth roller.

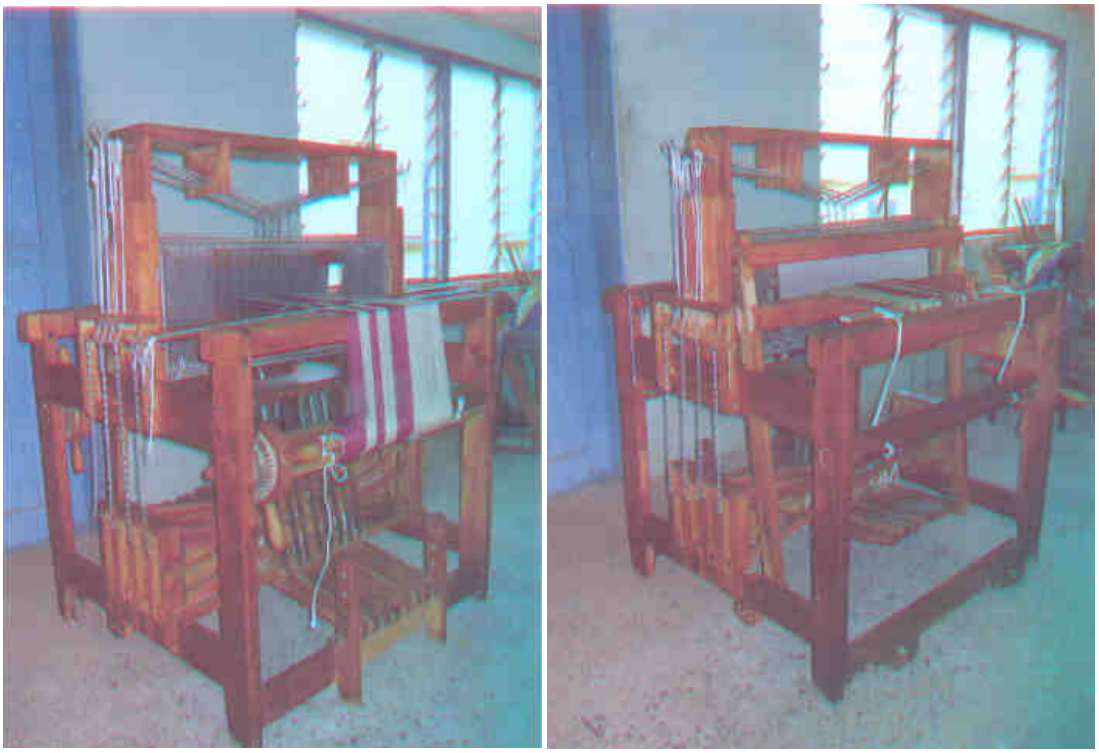

Plate 13: Front and Back Views of the Loom

4.22 Mode of Operation

To operate effectively on a manual loom, one should have enough freedom to use the hands for picking and beating-up. This project research therefore aims at providing a dual mechanism which will allow the weaver the free will to use either the foot or the hand to create a shed via series of connections from the treadles, lams and levers to the heald shafts. For a shed to be created on the loom, the weaver has to depress a treadle in accordance with the pattern to be woven. As the treadle is depressed, it pulls along a set of lams which have been connected to the treadles by cords. The lams also pull the corresponding shafts in turn via a lever which connects the shafts. Levers depressed lift the corresponding shafts to form the top sheets of warp yarns and those shafts that are not lifted form the bottom sheets of warp yarns. The gap between the top and bottom sheets of warp is the shed. The weaver inserts the weft into the shed by means of a shuttle. After picking, beating-up is done by moving the sley forward to push the weft to the fell of the cloth. This process of creating the shed, picking and beating-up continues until the warp beam is exhausted or weaving is completed.

This new loom prevents over-crowding and congestion as compared to a 4 shaft loom. There is also the ease to tie-up the treadles to the lams and to untie whenever the need arises with a minimum loom downtime.

5.0 APPRAISAL AND RESULTS

The research project was aimed at improving the efficiency, speed and productivity of cottage weaving. The research also looked at the essence of ergonomics to ensure that the loom has features that make it friendly and convenient for both the abled person and the physically challenged who are willing to weave. It was constructed for students, amateurs and professional weavers.

The designing and construction of the loom took six months. The construction of the detachable rectangular frame took a lot of time because the tracks through which the shafts run had to be carefully carved but the appropriate tool was not available at the time. There are 8 shafts on the loom. This makes it possible for complex and intricate weave designs ranging from twill, diamond, satin and sateen weaves to be produced on the loom. Apart from this, the width of the loom has been broadened to accommodate broader width fabrics. Also, beat-up is made effective on the loom because the weight of the sley structure has been reduced for easy movement and handling. The dual shedding system loom is not only disability friendly but it also saves time, energy and there is also increased productivity during weaving. A maximum of 16 shafts can be installed on the loom to weave very intricate designs as compared to the broadloom. The new loom's mode of operation is also very easy to grasp

and understand when one receives training especially in the fixing and tying-up of the treadles and lams. One added advantage is that there is ease in creating a shed on the loom, without putting too much pressure on the treadles, lams and shafts. Adjustments can easily be carried out on the shafts, treadles and lams to ensure an effective weaving process.

6.0 CONCLUSION

Weaving is one of the occupations of the youth in the Ho Municipality of Ghana. Weaving which was started by our forebears was bequeathed to the youth as a form of occupation. Most of the young chaps who engage in the craft of weaving are gifted. Only a few learn it as trade. The most popular form of cottage weaving in Ho and its environs is Kente weaving. Although broadloom and table loom weaving are not common in the study area, the researchers were of the view that the loom with dual shedding systems will lessen the burden of shed creation and reduce apathy among the youth in the Municipality towards weaving. It is hoped that by the introduction of this loom, students, amateurs and professionals in the cottage weaving industry in Ghana will find weaving very easy and lucrative.

7.0 RECOMMENDATIONS

Since the loom is made of some metal parts, it is recommended that regular oiling is done to prevent friction and wearing off of parts as well as free movement of the loom components. Thorough cleaning with water and soap should be done from time to time to remove dust and dirt. It is also recommended that the loom must be placed in an open and dry environment preferably in a shed so as to prevent the fast deterioration of the wood. Proper education on the assemblage of the loom such as tying of the treadles to the lams and the shafts and fixing of the sley and healds is required to operate the loom.

REFERENCES

[1] Longman Dictionary of Contemporary English, (1987), New Edition longman Group UK Limited, Essex, Pp. 1193

[2] The Textile Institute, (1991), *Textile Terms and Definition,* Biddles Limited, Surrey, Pp. 278

[3]Marks and Robinson (1976) *Principles of Weaving,* the Textile Institute, The World Book Encyclopedia, (2001), World book Inc., Chicago, Pp. 173

[4] Halsey and Youngmarks, L. (1975), *foundation of weaving,* Durid and Charles Limited, Canada. Pp. 58

[5] Lyle (1982), *Modern Textiles,* 2nd Edition John Wiley and sons Inc. U.S.A, Pp. 245 & 248

[6] Adanur (2001), *Hand book on Weaving,* Technomic Publishing Co., inc., Pennsylvania, Pp. 2 & 175

[7] Lord and Mohammed (1981), *Weaving: Conversion of Yarn to Fabric,* 2nd Edition, Merrow Publishing Co. ltd, Durham. Pp. 17

[8] Rodee (1977), *South-Western Weaving,* University of New Mexico Press, Albuquerque, Pp. 115

[9]Gupta, Garg and Saini (1999), *Text Book of Clothing and Textiles,* Kalyani Publishers, new Delhi, Pp. 52-55

[10]Marjory (1986), *Introductory to Textile Science,* CBS College Publishing, New york, Pp. 215

[11]Wynne (1997), *The Motivate Series – Textiles,* Macmillan Education Ltd., London, Pp. 182 – 191

[12]Gradjean (1975), *Fitting the task to the man,* Tailor and Francis, London, Pp. 136 - 151

[13]McCormick (1967), *Human Factors Engineering,* 2nd edition, McGraw Hill, New York, Pp. 537

[14]Murrel (1975), *Ergonomics,* Chapman and Hall, London, Pp. 340 - 349