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AN INVESTIGATION OF IKAT WEAVING AND WARP PRINTING, AND THEIR APPLICATION TO CONTEMPORARY DESIGN

by

Caroline Ashby

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VOLUME I

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ABSTRACT

This work seeks to consider the contribution that Ikat weaving and warp printing could make to contemporary textile design.

To do this the research first considered the historical background to Ikat weaving and warp printing by examining the visual and structural characteristics involved and the definitions used historically. Then by studying in some detail the methods of manufacture, dyestuffs, and design imagery of warp Ikats from South America and Central Asia, and weft and double Ikats from Indonesia and Japan a comparison of these Ikat techniques in particular was made. The first volume of this work concluded with a detailed study of warp, weft and double Ikats in Japan.

From this historic basis and analysis of the various techniques used experiments were devised to understand more clearly the effect of fibre, structure, colouration, warp design and its positioning on the image produced in the fabric. In investigating this a series of practical experiments was carried out on warp printed wool, cotton and silk fabrics and measurements made of the effects of the variables made. These results were used to undertake a second series of experiments using slub weft yarns, warp printed silk and warp printed cotton fabrics made from a double warp.

The work established from an historical viewpoint that the Ikat weavers were familiar and well practised within the traditional design limits of their craft but that these limits were differently defined for the various types of Ikat produce throughout the world.

From the technological experiments the factors controlling the image, its size, position and effect were determined so that ultimately exemplar design effects were created which suggested ways in which this technique could be developed in the future.

CHAPTER 1 HISTORICAL SURVEY

1.1 Introduction

The following historical survey forms the foundation upon which this research is based.

It initially defines the Ikat technique, and outlines the main characteristics of traditional Ikat procedures and demonstrates the dissemination of Ikat fabric throughout the world. Areas of four, hitherto unconnected countries have been selected to indicate the vast complexities and differences of the technique. They are South America, Southern Russia, the island of Bali in Indonesia and Japan. The findings of this survey are examined and recorded in order to define common factors or trends. These form the basis for new work. The majority of the fabrics illustrated and discussed throughout this thesis form part of a collection of Ikat examples compiled to enable first hand observation, as well as to advance the understanding of the technique.

1.2 Definition

The Ikat technique is primarily a traditional hand dyeing method totally dependent upon colour and without which the process would not exist.

It is achieved by protecting bundles of yarn with expanses of impermeable fibre which form a resist. The resists are applied in the form of a negative pattern usually to undyed warp yarn before fabric construction commences. The result of the whole upon dyeing and subsequent weaving constitutes an all over positive pattern.

1.3 Visual Characteristics

'Ikat' forms part of the Malayan word 'Mengikat'[1] which means 'to tie, bind or wind around'. It is a generally accepted word used worldwide to describe all fabrics patterned by this process. Each tribe or community that produces Ikat fabric, however, has its own local term which either portrays perceptions of light namely blurring, shadowing or clouding, or represents the same meaning as the Malayan word to tie or bind. The former describes accurately the very essence of the Ikat appearance.

This characteristic blurring or flickering effect is the natural result of the positioning of each partially dyed thread in relation to its neighbour. This 'image profile', as it shall be termed, occurs only on the perimeters of the motif where the colour changes, which creates softness and movement to the whole. When viewed from a distance, the finished fabric can sometimes create optical illusions.

It is an effect achieved by calculated control and its results vary according to the cultural influences and religious customs that prevail in the different geographical areas.

Each separate community permits different amounts of irregularity to occur within the image profile. Thus some Ikat fabrics appear to be more 'blurred' than others.

It is an aim of this thesis to investigate and understand the factors controlling this unique technique, its historic and artistic development thus to develop modern design processes based on such an investigation.

1.4 Structural Characteristics

Ikat patterned yarn can be placed in four essential positions either prior to or during weaving and the resulting fabric is termed accordingly:

1. fabric consisting of an Ikat patterned warp is described as 'Warp Ikat', see Fig. 1.1;
2. fabric consisting of Ikat patterned weft is described as 'Weft Ikat', see Fig. 1.2;
3. fabric that comprises Ikat patterned yarn in both the warp and weft, and includes precise integration of design of both yarns, is described as 'Double Ikat', see Fig. 1.3; and
4. fabric that consists of warp and weft Ikat patterned yarn whereby the design does not integrate precisely is described simply as warp and weft Ikat, see Fig. 1.4. These two latter types can be termed compound Ikat.

Each area or tribe throughout the world that continues an Ikat tradition employs one or more of these directional pattern methods. These methods are generally inherent, passed from generation to generation and each area or tribe is noted for its particular Ikat fabric that forms an integral part of its cultural traditions.

Warp Ikat

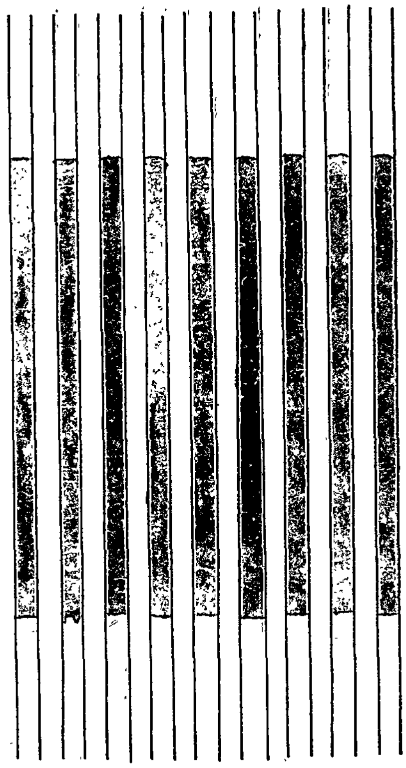


Fig 1.1

Weft Ikat

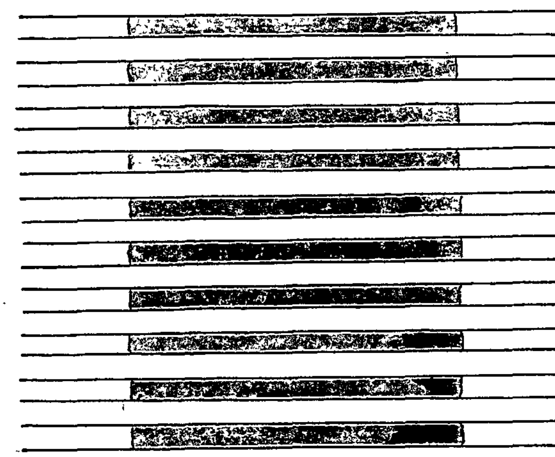


Fig 1.2

Double Ikat
(Compound)

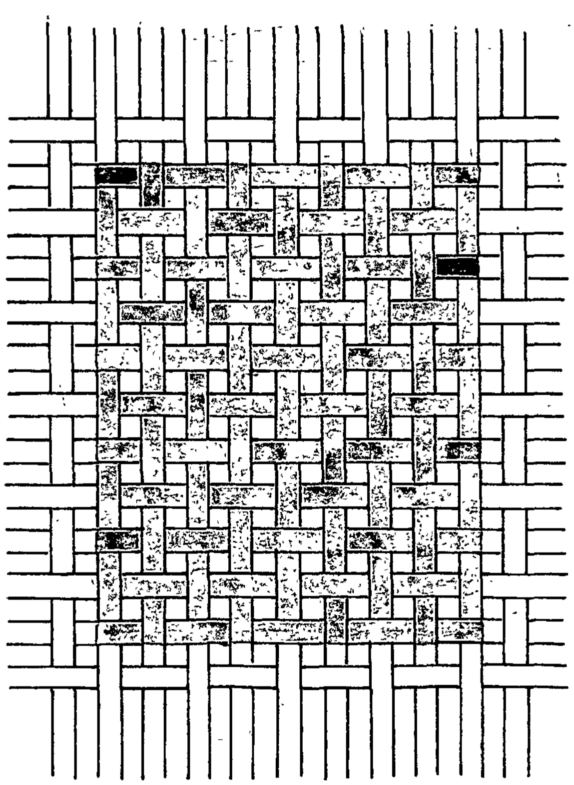


Fig 1.3

Warp and Weft Ikat
(Compound)

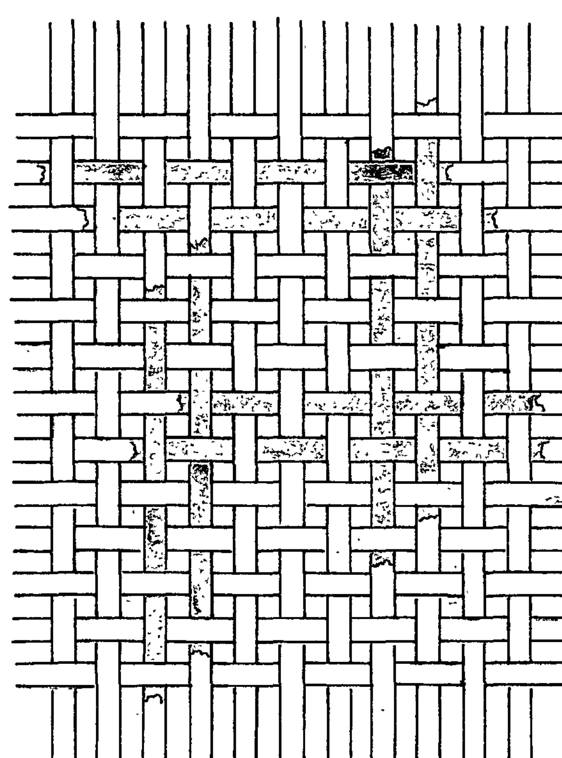


Fig 1.4

1.5 Fibre

In most circumstances the yarns used to create traditional Ikat fabrics comprise natural fibres that include silk, cotton, wool, ramie and banana fibre. Of these, cotton and silk are the most common and their compositional qualities to absorb dyes and to catch the light, appropriately enhance the Ikat effect.

1.6 Design

All manner of imagery is used for Ikat fabrics which include figurative, geometric, floral, anthropmorphic and zoomorphic designs. These are closely related to the religious, cultural or economic influences of the given area.

An indication as to the geographic origin of an Ikat textile is the overall amount of irregularity within the image profile that is permitted to occur prior to or during weaving. Generally this is the result of the yarn being mishandled.

Some tribes deliberately permit the irregularity to occur naturally, which continues to the point of manipulating the yarn itself, while others exercise great patience to ensure accurate alignment.

1.7 Structure

The structure of all Ikat fabrics is a simple interlacing of threads to facilitate the clarity of the resulting Ikat pattern. As it is the purpose to manifest the Ikat quality to its best advantage, the patterned yarn of the warp or weft Ikat fabric dominates its interlacing partner by being sett more closely.

In the case of compound Ikats, the fabric generally consists of a balanced gauze-like web that enables clear observation of both the warp and weft Ikat yarns.

The constructions themselves include plain weave, warp repp, 8 end satin, and very occasionally a twill. Additionally, velvet constructions are known, but these are extremely rare. Therefore, the general appearance and intensity of the Ikat pattern will vary according to the weave construction used. For example, if the warp is predominent and Ikat patterned, the resulting woven Ikat image will be very intense. If, on the other hand, the warp is predominant, and the weft Ikat patterned, the woven Ikat image will be faint or non-existent.

1.8 Imitation Procedures

The essential definition of the true Ikat is the hand process of producing resist dyed yarn for the purpose of creating intrinsically patterned woven fabric.

There are, however, additional procedures that simulate the Ikat appearance and have no connection with the resist technique. These constitute many forms. Table 1.1 records, for the purpose of identification, these principle 'imitation' procedures and indicates the types of surface to which they are generally applied.

Additional Methods Employed to Simulate the Ikat Appearance

TECHNIQUE		SURFACE
PRINTING	Warp	Yarn
	Block	Yarn/Fabric
	Fabric Print	Fabric
DYEING	Random	Yarn
	Hand Painting	Yarn
WOVEN	Jacquard	Fabric

Table 1.1

1.9 Origin

The origins and provenance of the Ikat technique are unknown on account of insufficient historical evidence.

Very special climatic conditions are required to preserve fabrics for hundreds of years which is why so few ancient Ikat fabrics exist today. Most have long since decomposed in damp environments.

Those examples that do exist are small, brittle fragments not conducive to thorough historical research. For this reason much speculation and difference of opinion prevails amongst the scholars as to the most probable theory of development.

One view considers that the Ikat technique evolved in India and spread into western, central and southeast Asiatic countries[2]. Evidence of the technique was recorded in 7th century A.D. frescoes in the famous Buddhist cave temples of Ajanta in Western India[3]. One painting depicts a seated woman covered in jewellery and wearing a simple horizontally striped sarong. Within the dark stripes Ikat patterning appears to be highlighted in the form of simple arrowhead shapes[4,5].

Another view believes the technique is indigenous to the islands of the Indonesian archipelago and from there spread to neighbouring countries of the Eastern hemisphere[6]. However, no fragments as early as the 7th century have been recorded.

A further view maintains that the Ikat technique did not emerge from either of these sources, but is one of Central

Asian location[7].

The earliest recorded Ikat fragments are preserved in the Horyu-ji kan, a collection of treasures originally housed in the famous Horyu-ji temple at Nara in Japan. Today these fabrics are on permanent exhibition at the National Museum, Tokyo[8]. There are nine fragments in all, one of which is illustrated in Fig. 1.5 and is regarded as the oldest[9].

In Japan it is referred to as either the "Taishi kantó", or the "Kanton-kin" or as "Kantó-nishiki". Each name represents the possible origin of the fabric[10].

"Taishi kantó" refers to Shôkoku Taishi the Crown Prince (574-622) who founded the Horyu-ji Temple at Nara in 607 A.D.[11,12]; he is said particularly to have favoured this type of fabric.

"Kanton-kin" indicates that perhaps the fabric was made in Kanton in Southern China, the centre for silk brocade weaving, where it is alleged that an Ikat effect was achieved by using a paste resist stencil printing technique to pattern the warp[13].

Kantó-nishiki" can be translated as colourful fabric or brocade (nishiki = brocade).

As with the possible origins already outlined these names and their meanings are open to conjecture.

It is generally accepted, however, that the Horyu-ji fragments were imported from or through China during or before the Chinese T'ang dynasty 618-913 A.D. They are attributed to the Japanese Asuka Period 552-644 A.D. and

Taishi Kantó

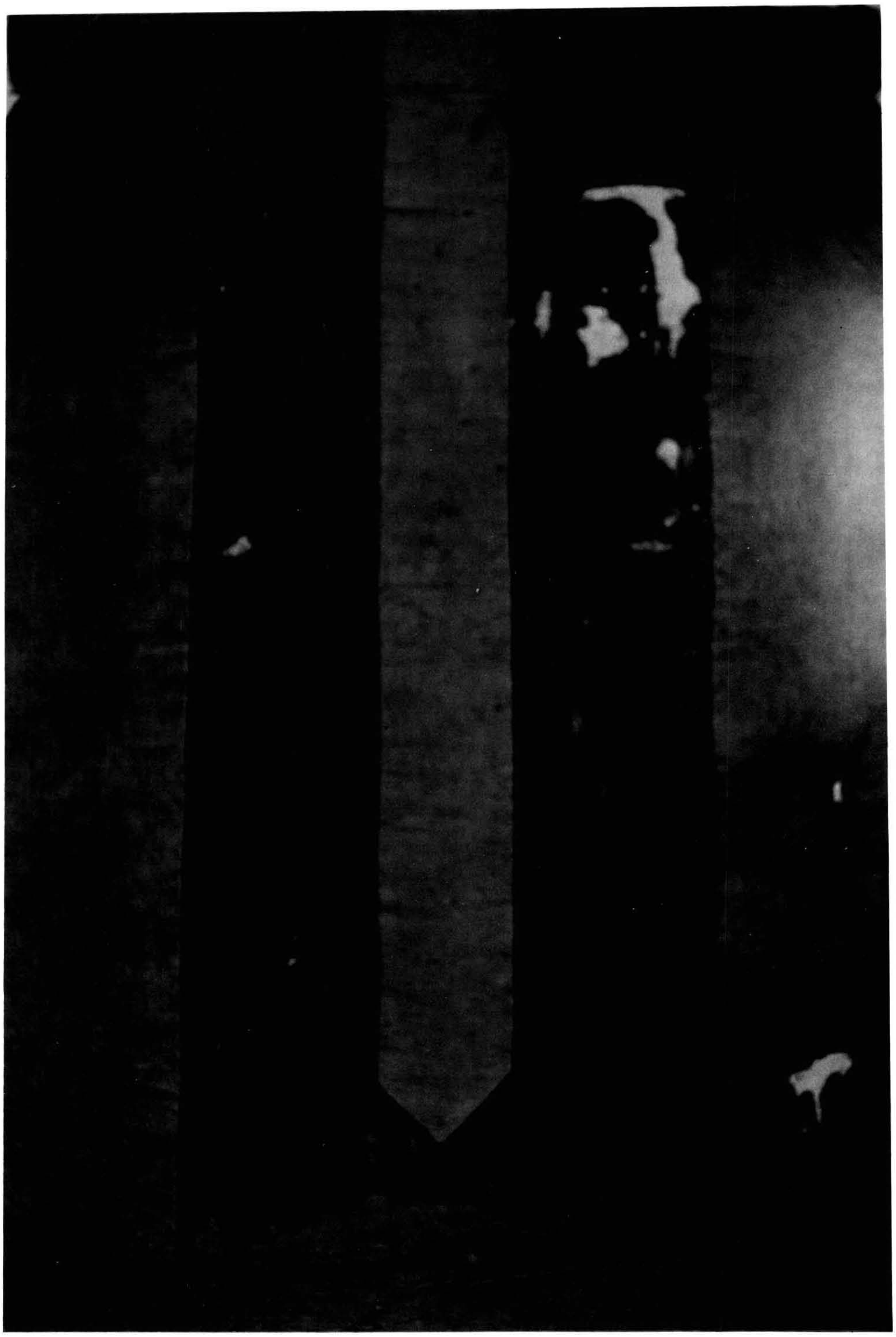


Fig 1.5

are fragments from banners used at Buddhist ceremonies[14,15].

The "Taishi Kantó" (see Fig 1.5) is a warp Ikat. The warp consists of filament silk and the weft of spun silk. The construction of the fabric is a balanced plain weave, and the colours that remain vivid comprise yellow, indigo, green and white on a scarlet ground[16]. Upon observing the technical excellence of this piece it would be easy to assume that it originated from China, a country famous for its sophisticated knowledge of textile techniques for thousands of years. However, no substantial evidence of the Ikat technique has ever been recorded there despite discoveries of Plangi and resist block printing[17].

It is thought another place of origin could be Indonesia since the combination of motifs as well as the motifs themselves are similar. In addition, the colouration of the "Taishi kantó" and some Indonesian fabrics are of an approximation. However, there is no evidence to suggest that the tribes of Indonesia had such an advanced knowledge of the Ikat technique at that time.

As there is little record of Ikat fabric from the middle ages it is necessary to compare the original fragments with the examples that exist today which date back only to the 19th century.

The only other possible location of origin of the Taishi-Kantó is Central Asia, an area linked to China and Japan by the silk routes.

It is felt by the author that information regarding the origins of the Ikat technique is extremely inconclusive. Since the 1940s no known major research has been undertaken in this field[18,19], and of the ethnological research that has been carried out since the latter part of the 19th century in specific geographical regions throughout the world such as Peru, Indonesia and the Middle East, the exact origin of the Ikat technique has yet to be discovered. Perhaps with the aid of modern technology, and the gradual accessability to restricted locations such as China, important new data could help clarify the confusion that prevails.

1.10 Dissemination

The Ikat technique, as has been shown, is a long established craft, which has spread in its different forms to many parts of the world. The world map illustrated in Fig 1.6, catagorises its distribution. In most cases, the craft continues in these areas in some form today, the complexities of the technique having been reduced and oversimplified by the introduction of machinery.
This has sometimes resulted in the production of crudely reproduced Ikat fabric which bears little resemblance to the intrinsic beauty of the handcrafted originals.

The World Distribution of the Ikat Technique

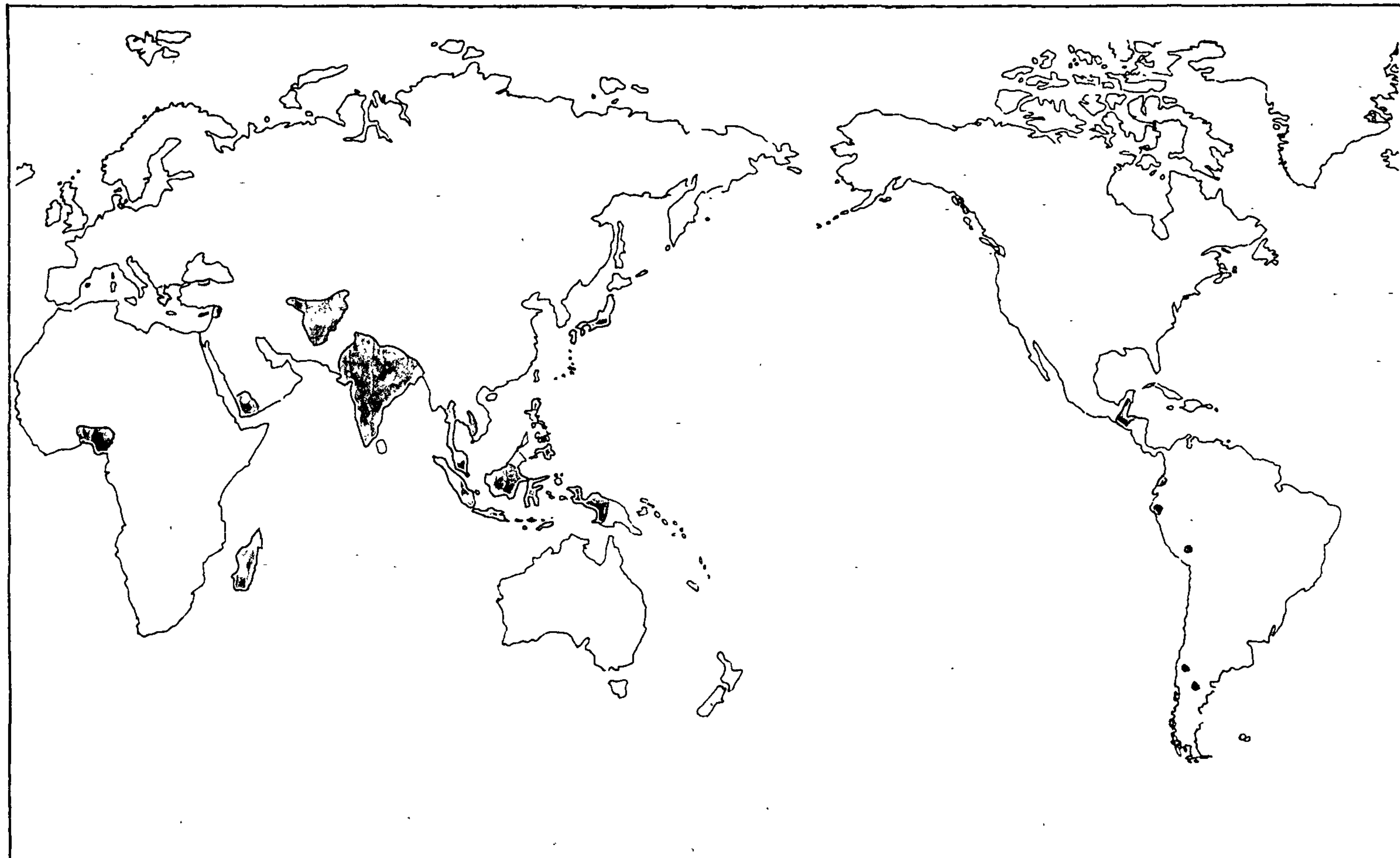


Fig 1.6

CHAPTER 2 WARP IKAT OF CHILE, SOUTH AMERICA

2.1 Introduction

The provenance of Ikat practices in the Americas is unknown. The Ikat method may have developed from the Inca's expert knowledge and use of textile techniques during their existence between the 12th - 16th centuries; or it could have been introduced by the Spanish in the mid 16th century, at the time of the conquest[20].

By observing Fig 2.1, the distribution of the Ikat technique can be seen scattered over the whole of the South American continent[21].

No. 4 marks the area of Chile, inhabited by the Araucanian Indians, an agricultural tribe, which was split into three distinctive ethnic groups. By the late 19th century, one of these, the Mapuche, had developed a comparatively highly advanced understanding of Ikat processes. The exact date of when this development began is unknown. Some scholars maintain a pre-Spanish evolution[22], whilst others believe a more likely explanation was a gradual expansion of knowledge from the mid 15th century onwards[23]. In a sense the Mapuche can be regarded as unique as they were the only tribe in the world to produce, amongst other things, woollen Ikat fabrics.

Distribution of Ikat Technique
in South America in the 1930's

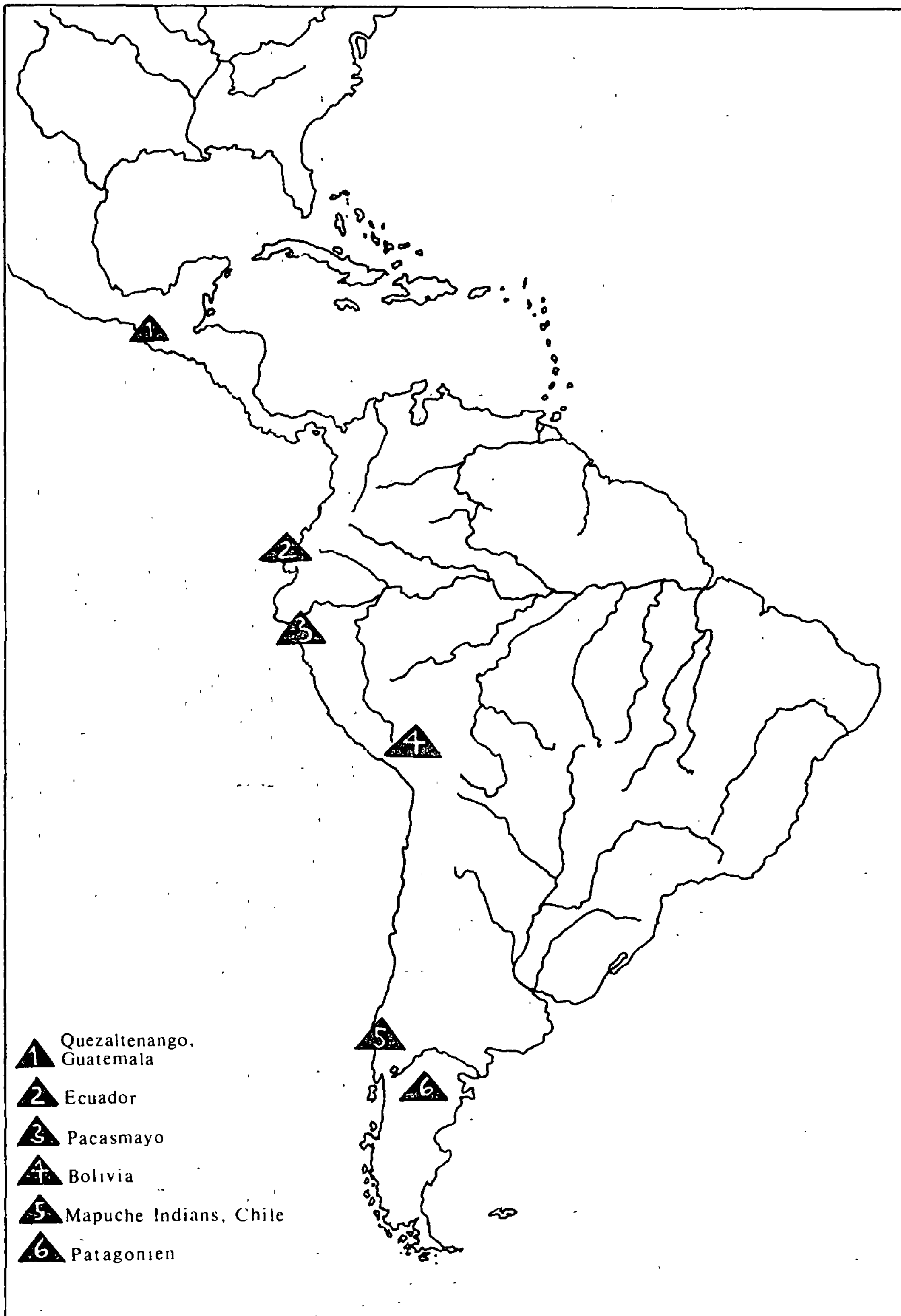


Fig 2.1

2.2 The Wool Ikat of Chile

2.2.1 End Uses

The local term used by the Mapuche to describe Ikat is 'Trarican' of which 'Trarin' means to 'tie' or 'bind'[24]. The fabrics produced by the Mapuche Indians were used for mens' ponchos,or 'macun' as they were known, as well as blankets or 'lamas'[25].

The poncho has been for centuries part of South Americans' national dress. It is believed to have been developed following the introduction of the horse at the time of the Spanish conquest. It was a seamless coat with a split opening for the head and upon the slightest exposure to moisture became compact and stiff, shedding rain like a roof[26,27]. This was of extreme importance as the winters in Southern Chile being in the south latitude between 37 and 40 degrees were excessively wet and cold[28].

Of all the many types of poncho fabric, the kind regarded with most esteem was the 'Trarican Macun'[29].

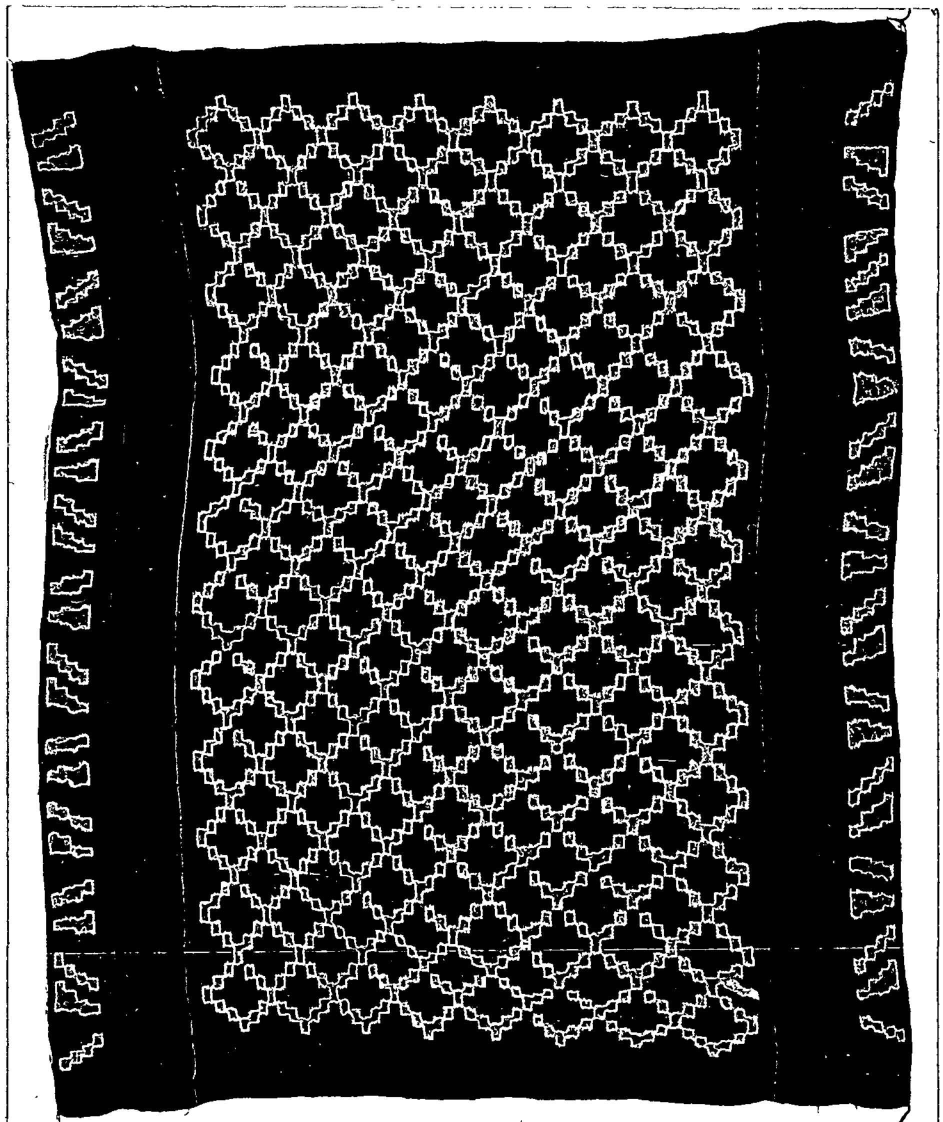
Fig 2.2 illustrates one such fabric, but this appears to have been made for use as a blanket, as opposed to a poncho[30].

2.2.2 Methods of Manufacture

The following technical account was recorded partly during the 1930's and 1960's.

The yarn for producing Mapuche 'Trarican' fabrics was originally always guanaco wool,from a type of Llama. With the introduction of sheep by the Spaniards, however, this

Araucanian 'Lamas'



Construction Details

Warp : 11.8 epc twisted wool. Resist dyed blue and white, plain coloured red and green stripes.
Weft : 3.5 ppc twisted wool. Dark Brown or blue.
Size : 115 cm x 150 cm.
Weave: Warp Repp.

Presented to Museum of Mankind London 1896
by John Rogers

Fig 2.2

original fibre became superceded. The cleaned and prepared wool was spun by hand by the women folk, with the aid of a cylindrical spindle or 'coliu'[31]. The resulting yarn was warped onto two upright poles, by two women, who passed the ball of yarn backwards and forwards between them [32,33], as Fig 2.3 illustrates.

The upright poles eventally formed the front and back beams of the loom, which were lashed to longer poles set at right angles, thus forming a frame[34].

At this stage, the mounted warp was prepared for weaving to commence, but when 'trarican' fabrics were being produced, it was to these tensioned warp threads that the resists were applied.

Fig 2.2 showed a continuing lozenge pattern, a traditional Araucanian decorative motif. To create such a pattern the warp was divided into sections of 18 ends each. A double layer of resists were applied in the form of firstly, the application of 'molla-molla', a white clayey mud, impervious to dye solutions[35]; secondly, these mud-covered areas were bound with Carex leaves or wool threads, to promote the resisting action and to keep the mud in place[36].

The resist tying process was carried out diagonally across the bunches of 18 ends. This method of protecting the yarn is most unusual, in comparison with other Ikat producing areas, (some of which will be covered in this thesis), as seldom were two layers of resist required. There are two probable reasons to necessitate this double protection.

Araucanian Warping Procedure

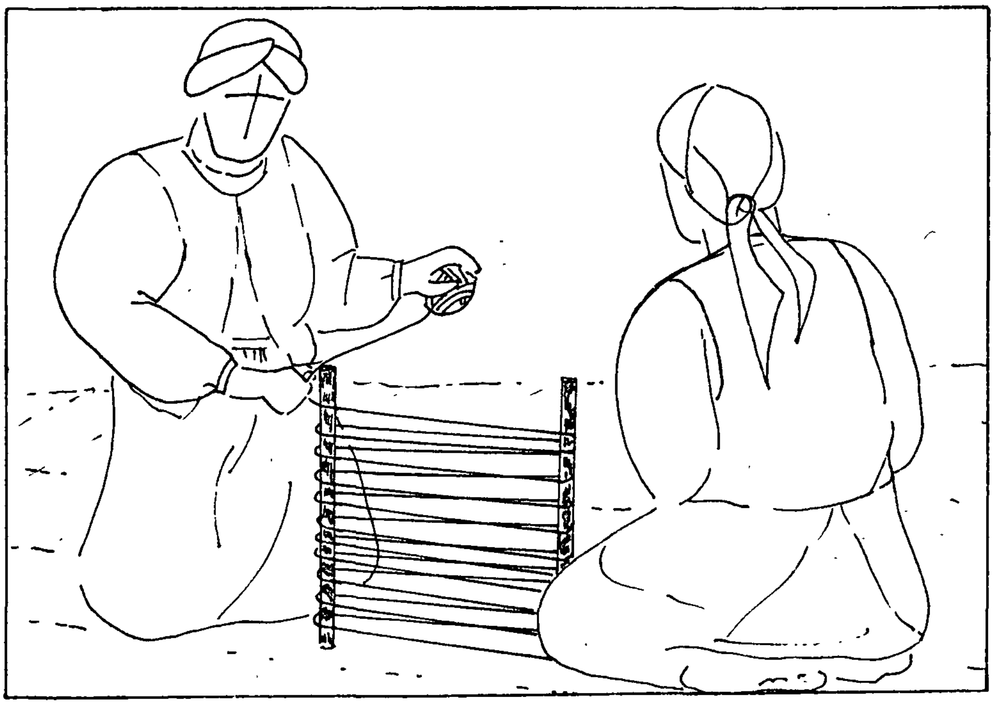


Fig 2.3

Firstly, bunches of wool form far more bulk than finer yarns, which may stop the yarn from being tied tight enough completely to resist the dye, which in turn may cause the woollen yarn to stretch and become damaged by such pressure. Secondly, handspun woollen fibres absorb dye at such a rate, that if the yarn were not bound tight enough, the resist would not be effective.

Upon completion of the tying process, the resist covered yarn was tied together at each end and the front and back beam poles were removed.

2.2.3 Dyestuffs Used

The main part of all the Mapuche 'Trarican' fabrics were dyed with indigo, a plant that grew indigenously. Additionally, plain coloured lateral stripes of yarn were added to the centrefields of already prepared 'Trarican' yarn, prior to weaving. The Araucanians developed a sophisticated knowledge of natural dyestuffs, either in plant or mineral forms, many different substances yielding the same shade[37].

Table 2.1 illustrates the range of dyestuffs likely to have been employed[38] to obtain the red and green colours of the lateral stripes in Fig 2.4.

With dyeing complete, the yarn was returned to the front and back beam poles, and these were reassembled to form the loom once again. The resists were removed and the women weavers carefully cleaned the warp yarn of the 'molla-molla'. Lease rods and a heddle stick were inserted and

Dyestuffs to Obtain Red and Green Shades
Employed by the Araucanians

Colour	Latin name	English	Part of plant
Red(Kelu)	Relbunium Hypocarpium (L) Hemsl	Chilean plant	Root
	Hoffmannseggia Falkarina	Wild bean	Bean
Brick red	Loranthus Sternbergianus, L heterophyllus	Mistletoe	Flower
Green(Karv)	Drimys Winteri	Cinnamon Tree	Wood and leaves
	Hymenophyllum dentatum, H pectinatum	Chilean fern	Leaves
	Nothofagus	Evergreen	Bark
	Dombeyi	Beech	

Table 2.1

Magnification of Araucanian 'Lamas'

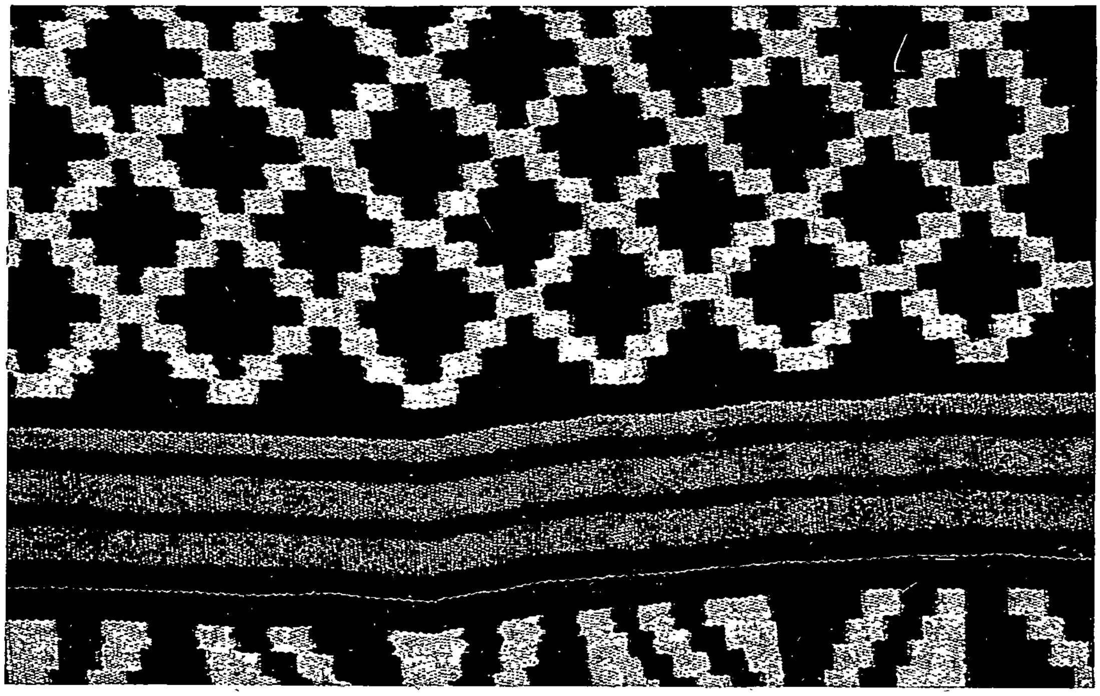


Fig 2.4

Araucanian Loom

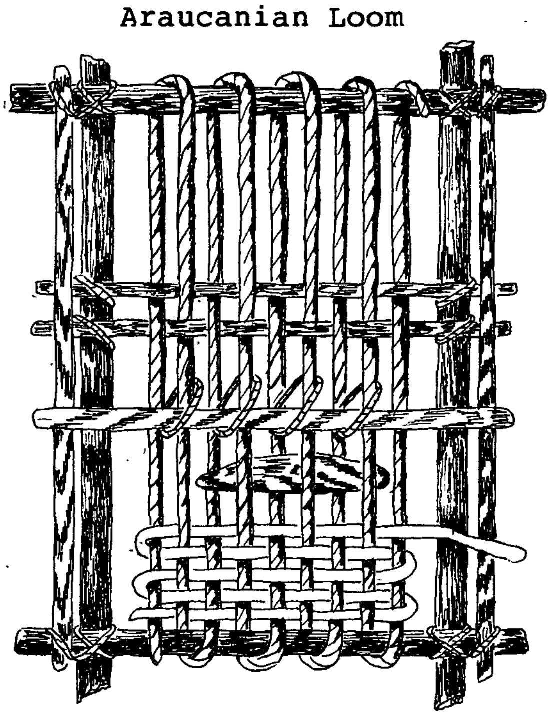


Fig 2.5

the whole loom was propped up vertically against the dwelling wall. Thus, in this position the fabric was woven, and as it proceeded upwards, unwoven yarn was released at the top and the finished fabric was rolled in at the bottom[39]. Fig 2.5 illustrates this type of loom. The construction of 'Trarican Macun' was always a warp repp, that facilitated bold representation of the Ikat patterning.

2.2.4 Design Imagery

As Fig 2.4 indicated the design imagery of this fabric comprises rectangular blocks placed in a lozenge formation, flanked by stripes and geometric motifs.

Araucanian motifs were generally of an abstract ornamental nature which were thought to be derived from Peruvian or Bolivian models and although the Araucanians opposed the presence of the Spanish between 1536-1810, there is evidence that they assimilated many influences of Spanish agricultural and material culture into their own[40].

Additionally, with regard to religious beliefs, the Araucanians were a tribe with Shamanistic traditions and the symbolic art that accompanied this was always of a decoratively geometric or zoomorphic bias. Clarity of image as opposed to exact proportional symmetry of design was of great importance and it was to heighten the blue and white contrast of the 'Trarican' ponchos that the lateral stripes of red and greens were included[41].

A further feature of Araucanian poncho or lamas weaving was the somewhat haphazard arrangement of the border pattern. It was never a unit completely encircling the fabric as is the case with the Peruvian or Bolivian textiles. Although the borders were placed in opposing pairs they often differed in colour, pattern and width[42].

CHAPTER 3 WARP IKAT OF TURKESTAN, CENTRAL ASIA

3.1 Introduction

Despite the geographical location, and commercial importance of Turkestan, Ikat fabrics can only be traced back to the end of the 18th century. Since that time, the manufacture of these fabrics has continued up until present day, with the technique at its most popular and in highest demand during the 19th century[43].

It was the domiciled tribes, namely the Uzbeks who lived around the trade route towns of Samarkand, Bokhara and the Fergana Valley, during the 19th century, who produced warp Ikat fabric[44]. A tribe with Arab, Turkish and Persian links[45], the Uzbeks preferred to follow the pure Islamic faith, rather than the religion of Shamanism, which was prevalent in Northern Asia[46]. The Emirate of Bokhara, independent until 1920, contained many mosques and theological colleges which had a great influence on the Moslims of the region[47].

Bokhara was made famous by the production of Ikat fabric. It was amongst the most important items sold in the bazaars, and was dispatched throughout the Emirate. Ikat fabrics were bought by members of most of the indigenous tribes, the Tajiks, Turkman and Uzbeks, besides being exported to Sinkiang (Western China), Afghanistan and Northern India[48]. The Fergana Valley towns, Chodjent, Kokand, Nanangen, Margelan and Andidjan, were other competitors in Ikat production, the most famous workshops being in Margelan[49] as can be seen from the map in Fig 3.1. The reason for the demand and popularity of Ikat fabrics was mainly a prestigious one. Depending on the type, quality and colour, a man's wealth could be recognised. They were considered luxury articles, presented as gifts at wedding ceremonies,or on other important occasions[50].

3.2 Terminology

The local word for Ikat is 'abr', which means 'cloud'. The construction of most Ikat fabrics was a taffeta made with a silk Ikat warp, and a cotton weft - 'Adrass', as seen in Fig 3.2. This type of fabric was known as 'mesru', meaning 'permitted' to comply with Moslim law, that men may not wear pure silk. Sometimes, a satin weave would be employed which was known as 'atlas', as shown in Fig 3.3. The most sought after fabric of all was the 'baghmal' or silk Ikat velvet, made towards the end of the 19th century, only in Bokhara, as illustrated in Fig 3.4. It was extremely expensive and highly valued. All these fabrics were sold either by the metre or piece[51].

Fig 3.5 illustrates one larger type of silk Ikat fabric that was produced in Bokhara in the latter part of the 19th century[52]. The method by which it was produced can be observed.

Sketch Map of Turkestan

Fig 3.1

Adrass

Construction Details

Warp	:	125.9 epc filament silk. Resist dyed indigo, red, yellow, overdyed red and blue.
Weft	:	15.7 ppc cotton fibre.
Length	:	123 cm.
Weave	:	Warp Repp.

Fig 3.2

Atlas

Fig 3.3

Baghmal

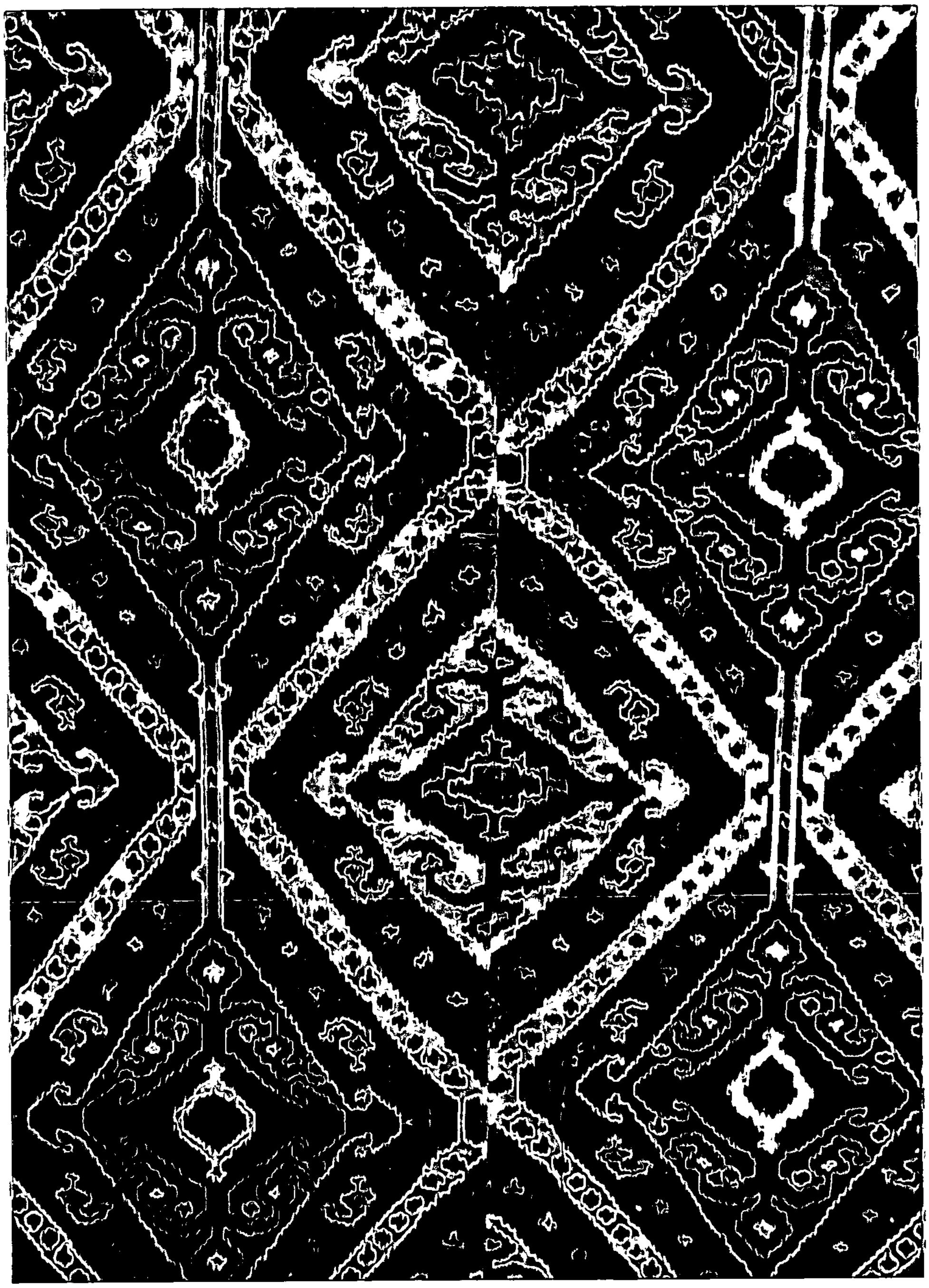
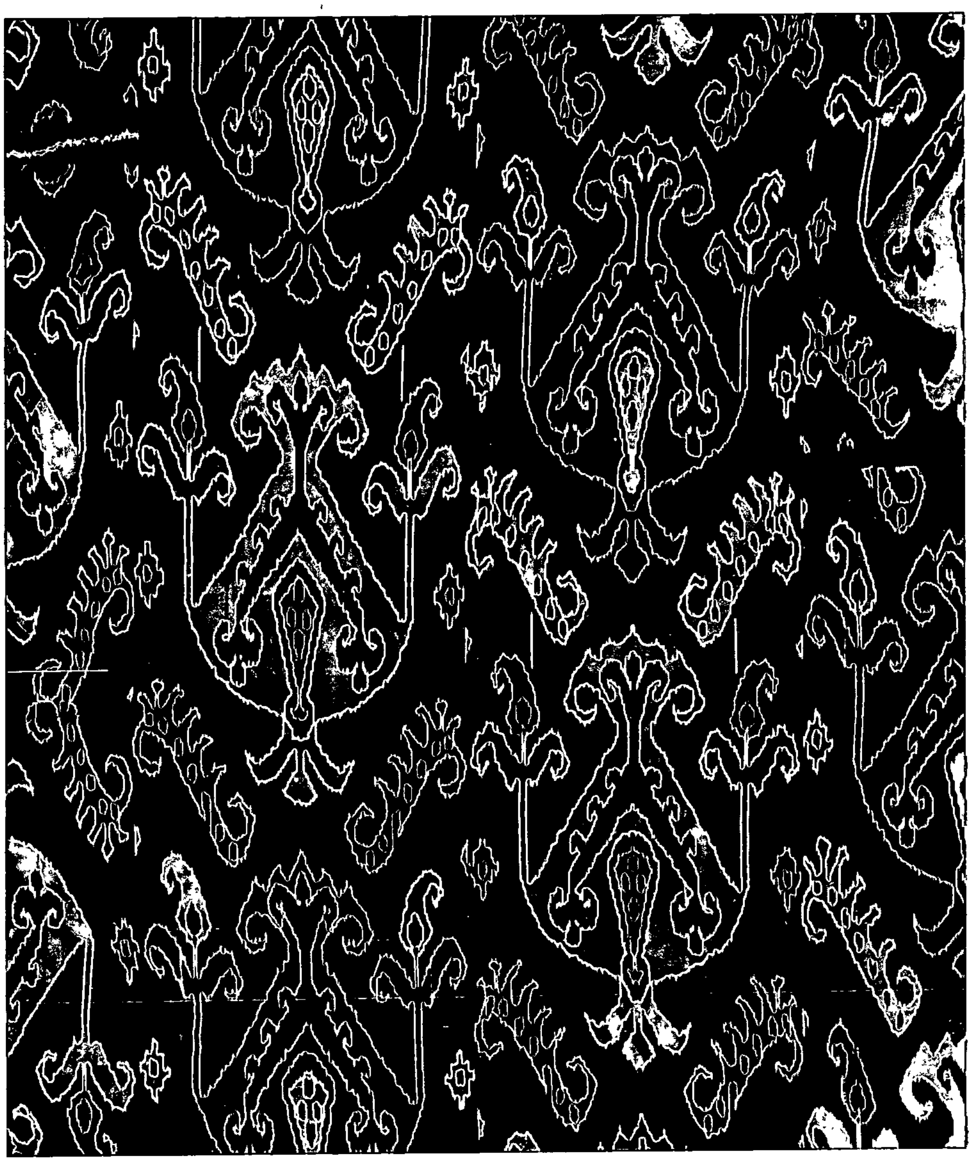


Fig 3.4

Silk Warp Ikat Fabric



Construction Details

Warp	:	81.8 epc filament silk. Resist dyed indigo, red and yellow.
Weft	:	50.3 ppc red filament silk.
Size	:	214 x 146 cm.
Weave	:	Plain.

Fig 3.5

3.3 Methods of Manufacture

In Bokhara, Ikat production was very much a well organised commercial concern, and was exclusively carried out by men. Each part of the process was designated to a specialist, whereas in the smaller towns, production was carried out in one workshop usually a family business[53].

Following the commercial method, the silk, usually undyed, but sometimes dyed pale shades of yellow or pink, was taken in bundles of sixty threads to an Ikat specialist, by a merchant or weaver. The bundles were unrolled between two wooden rollers, which were placed horizontally, on a support. The groups of threads were then arranged according to the design required. Marks were drawn on the stretched and ordered yarn, which the apprentice, who tied the resists, used as a design guide[54].

The tying of the resists complete, the yarn was sent to a dyer, who would begin dyeing the lightest colour first, and ending with the darkest. Referring to Fig 3.5 all the areas except those to be dyed yellow were reserved. Upon completion of the yellow dyeing and the subsequent drying of the yarn, resists to reserve the yellow were applied, and the resists covering what were to be red areas were untied. This process was continued until finally the background of the indigo was applied, the preceding colours being reserved with new resists.

During the 19th century natural dyestuffs were used. In the larger towns, the dyeing was usually carried out by Jews who could be recognised by their dyestained hands[55].

Table 3.1 indicates the sources of dyestuffs used[56,57,58]. To obtain tones of colour, dyes were mixed together in varying quantities. This is known as overdyeing, and was achieved by dyeing the same area twice, each a different colour to achieve a third colour. The popular colour aubergine was produced in this way.

Towards the end of the 19th century, chemical dyestuffs began to be imported from Europe via India, and gradually these superseded the natural dyes, until the latter were abandoned almost altogether.

With dyeing complete, the yarn was sent to another specialist, who was responsible for arranging it on the loom in the required design sequence, in preparation for weaving[59]. The fabric was woven by a professional weaver, whose horizontal loom (which was not dissimilar from the Indian pit loom) consisted of four poles driven into the ground vertically, with a rope tied tightly above to keep equal tension. The breast beam and warp beam were hung in rollers very close to one another, so minimal fabric was visible[60].

The weaver as shown in Fig 3.6 remained in a hollowed pit, passing the shuttle through the rear shed at the opposite side of the reed from where he sat[61]. The loom was quite narrow, restricting the width of fabric that could be woven to approximately 40 cm (15½"). Therefore, to produce a fabric of any large width, a series of strips of 40 cm were sewn together along their selvedge edges to form a whole[62]. The example in Fig 3.5 was one such piece.

Sources of Dyestuffs of Turkestan

Colour	Source	Local name
Blue	Indigo	'Nil'
Red	Krapp	'Rujan'
	Madder	-
	Cochineal	'Kyrmisi'
Faded purple	Logwood	
Yellow	Safflor	
	Larkspur	
	Vine leaves	
	Sophora Japonica	'Turkmak'
	Delphinium Sulphureum	'Esparuk'
Greenish-yellow	Mulberry tree	'Turkmak'
	Fungus	
	Indigo/vine leaves mix	
Orange	Henna and Madder	
Brown	Walnut or Oak bark	
Black	Gallnut of the Pistachio tree	'Abuzgunta'

Table 3.1

Turkestan Weavers at their Looms

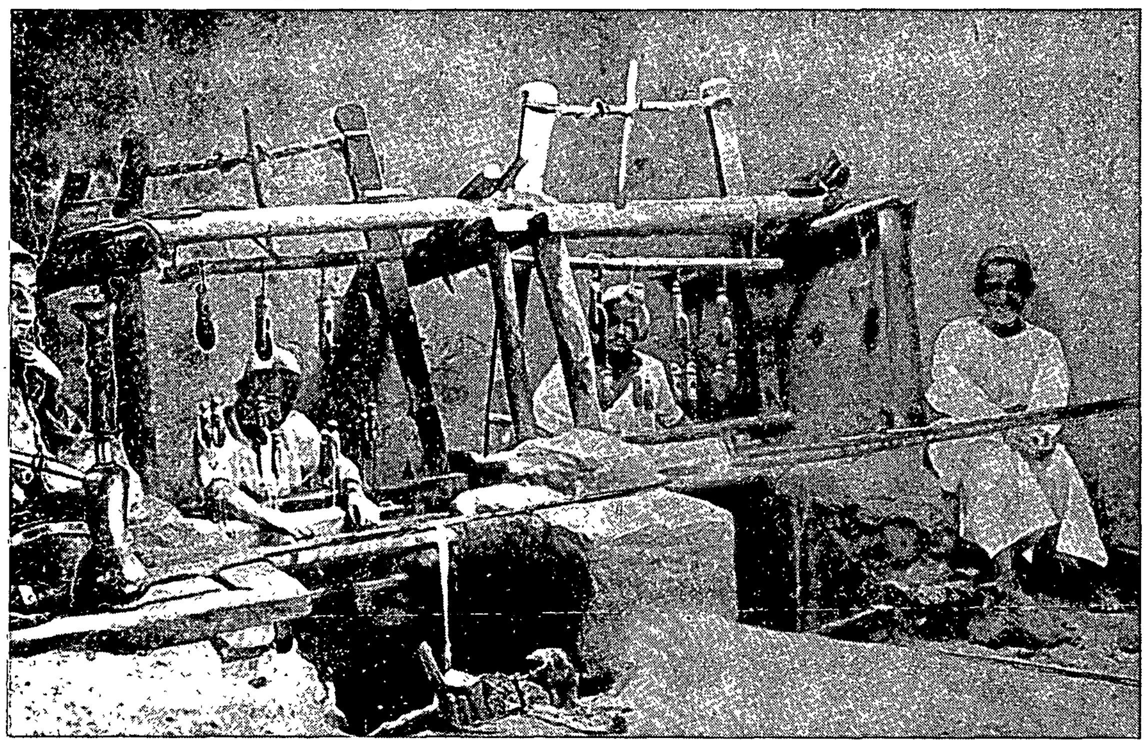


Fig 3.6

When the fabric was finished and removed from the loom, it was sometimes given a finishing process to give it a moiré or watered silk appearance, which added to the prestige of the fabric.

This process was achieved by treating the fabric with a coating of egg white, folding it and wrapping it in layers of cloth, then it was placed on a wooden block and beaten vigorously with a heavy wedge-shaped mallet[63,64].

Very little information is available regarding the manufacture of Ikat velvet fabric, presumably because the method was such a closely guarded secret in the workshops. From observing examples, it can be seen that the pile warp is always silk and very densely sett. It is this pile warp that is always resist dyed, the ground or binding warp being a plain coloured silk.

The length of the pile warp was up to twenty times the length of the ground warp to allow for take up of the pile warp. This greatly lengthened the resist tying procedure, as the designs were as large and complicated as the more usual taffeta Ikat fabric.

The weft yarn was usually plain dyed cotton, although silk was sometimes used.

3.4 End Uses

After the production of the fabric was complete, women were responsible for making it up into trousers, dresses, unlined coats, curtains, hangings, linings for embroideries, and even the scraps were kept carefully for making patchworks[65].

The woman's role played an important part in the general appearance of Ikat fabrics, since the strips of fabric were sewn together in a hap-hazard manner, so that the design on each strip did not correspond or repeat.

By this process, the resulting general effect was one of spectacular confusion of colour and design. This is definitely an indigenous characteristic of the Ikat technique of this area, as there are other Ikat producing countries, that will be discussed later in this thesis where pattern alignment is considered extremely important.

The main items of prestige, however, were the silk and cotton gowns, 'Khalat' or 'Djorma', or 'Chapan' as they were known in the vernacular[66]. It can be seen from the list below, how the yarn types of Khalat differ according to the rank of the wearer[67].

Order of Rank by Khalat in Bokhara:

Parwanatschi (Master of Ceremonies)	Partscha (Gold Brocade)
Toksabashi (Minor Nobleman)	Velvet
Mirzabashi (Head Secretary)	Adrass (Half Silk, Half Cotton)
Karaul Begi (Chief of the Guard)	Imported Silk
Dievazi	Kanaus (Local Silk)
Ischkagazi	Kaschmir Cloth

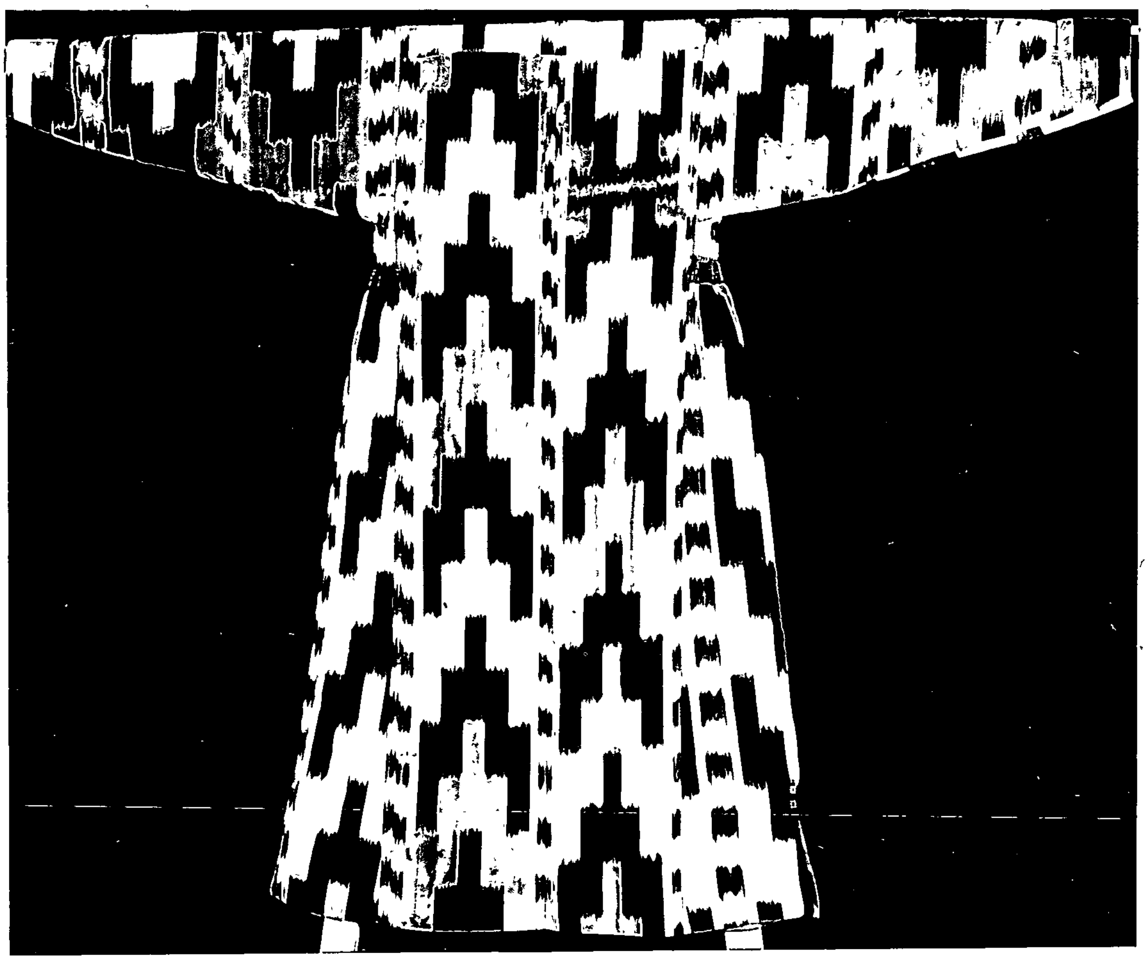
As the list indicates, Khalat were worn by the wealthy citizens, merchants and priests. Sometimes, layers of as many as five coats were worn at once, denoting great wealth and importance. The poorer class would only wear these coats for special occasions[68].

Fig 3.7 shows an example of an "Kanaus" Khalat[69]. These were bought ready made from Khalat sellers at the bazaars[70]. Khalat were lined with a cotton padding and finished with a complete inner lining of printed cotton fabric.

One peculiarity of these garments, was the length of the sleeves, that were rather too long. On the top of the sleeves, approximately five cms from the cuff, there was an embroidered slit, to allow the hands to be withdrawn in accordance with Moslim law, that all parts of the body should be covered. Besides the taffeta Khalat, a similar robe was worn by men, but made from the Ikat velvet, as was illustrated in Fig 3.4. These robes often covered layers of taffeta Khalats and were worn by wealthy or important personages mainly on ceremonial occasions. Since the time and labour involved in making this fabric far exceeded commercial viability it could only be afforded by the affluent and powerful.

Khalats were, in addition, part of a woman's wardrobe, with three different styles being available[71]. Fig 3.8 illustrates one type known as 'Frandjin', a voluminous mantle, giving the wearer a mummified appearance[72]. This garment was placed around the head, on top of a horsehair

'Kanaus' Khalat

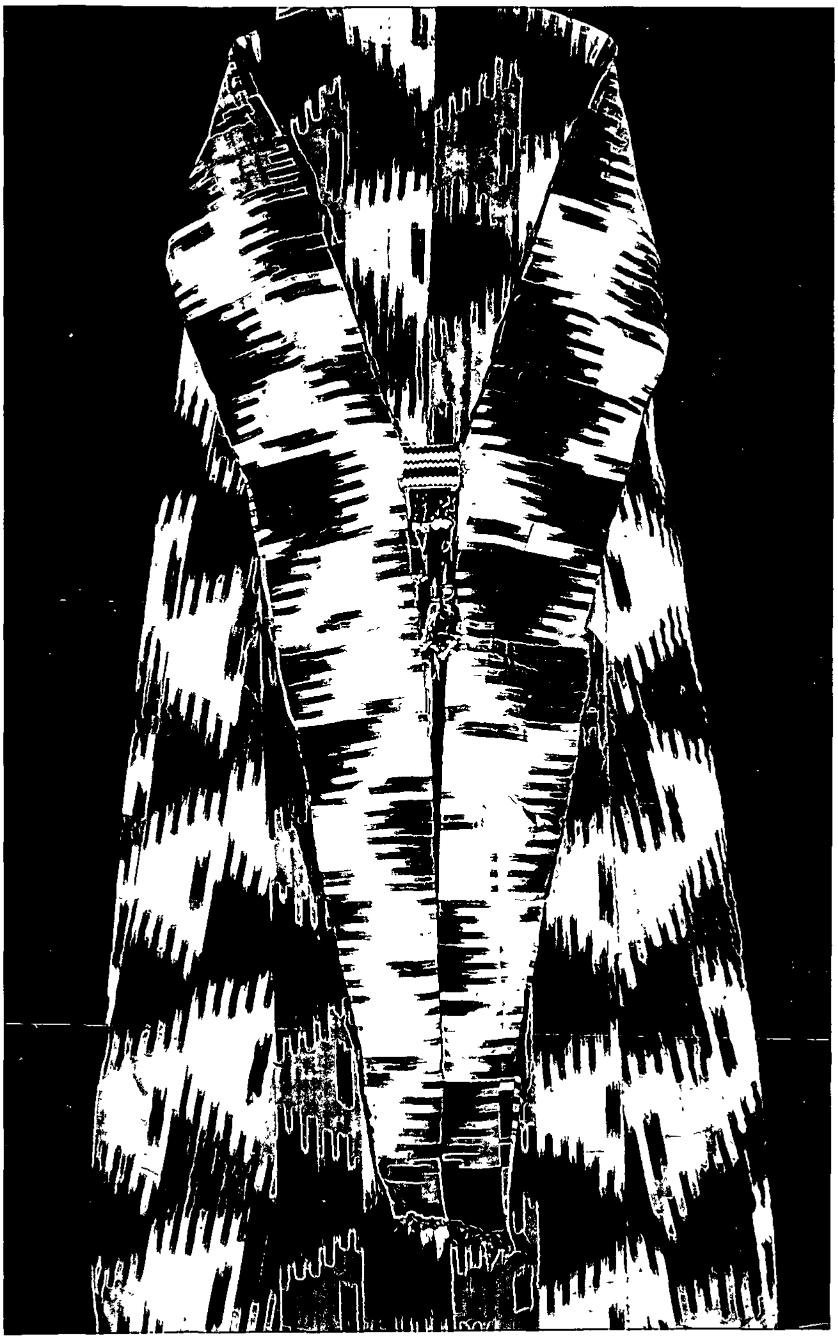


Construction Details

Warp	:	80.3 epc filament silk. Resist dyed indigo, red and yellow.
Weft	:	34.6 ppc red filament silk.
Size	:	125 cm.
Weave	:	Plain.

Fig 3.7

Frandjin Khalat



Construction Details

Warp	:	34.6 epc filament silk. Resist dyed indigo, red and yellow.
Weft	:	37.7 ppc aubergine (indigo and red) filament silk.
Size	:	160 cm.
Weave	:	Plain

Fig 3.8

veil 'Chasband', that hid the face, and hung to the ground, enveloping the wearer completely. Worn as an everyday garment in the streets, it ensured the wearer perfect anonimity[73].

'Frandjin' differed from the man's Khalat by the presence of narrow, elongated sleeves known in Bokhara as 'tails', that were joined together half way down the sleeve with embroidery. They performed no known practical purpose, and were left to dangle at the sides of the garment, having lost their original function[74]. Fig 3.9 illustrates a fine example of a woman's velvet Ikat Khalat, which was part of the ceremonial wardrobe, worn only on special occasions.

The nomadic tribes of the desert, steppe and mountain regions made use of Ikat fabric for decorative purposes[75]. From their herds of sheep, goats and camels they obtained wool to make garments to protect them during the winters. Ikat fabrics were used for lining these items, as well as for ornamenting the interiors of their tents with hangings[76].

3.5 Design Imagery

The design imagery used in Turkestan was, in a sense, a confusion of influences of the varying political and cultural invasions that have occurred[77,78]. By the 19th and early 20th century the tribal symbols of Shamanistic belief, were abandoned and forgotten by the tribes. In the cities, tribal unity no longer had any meaning, and respect

Woman's 'Baghmal' Khalat

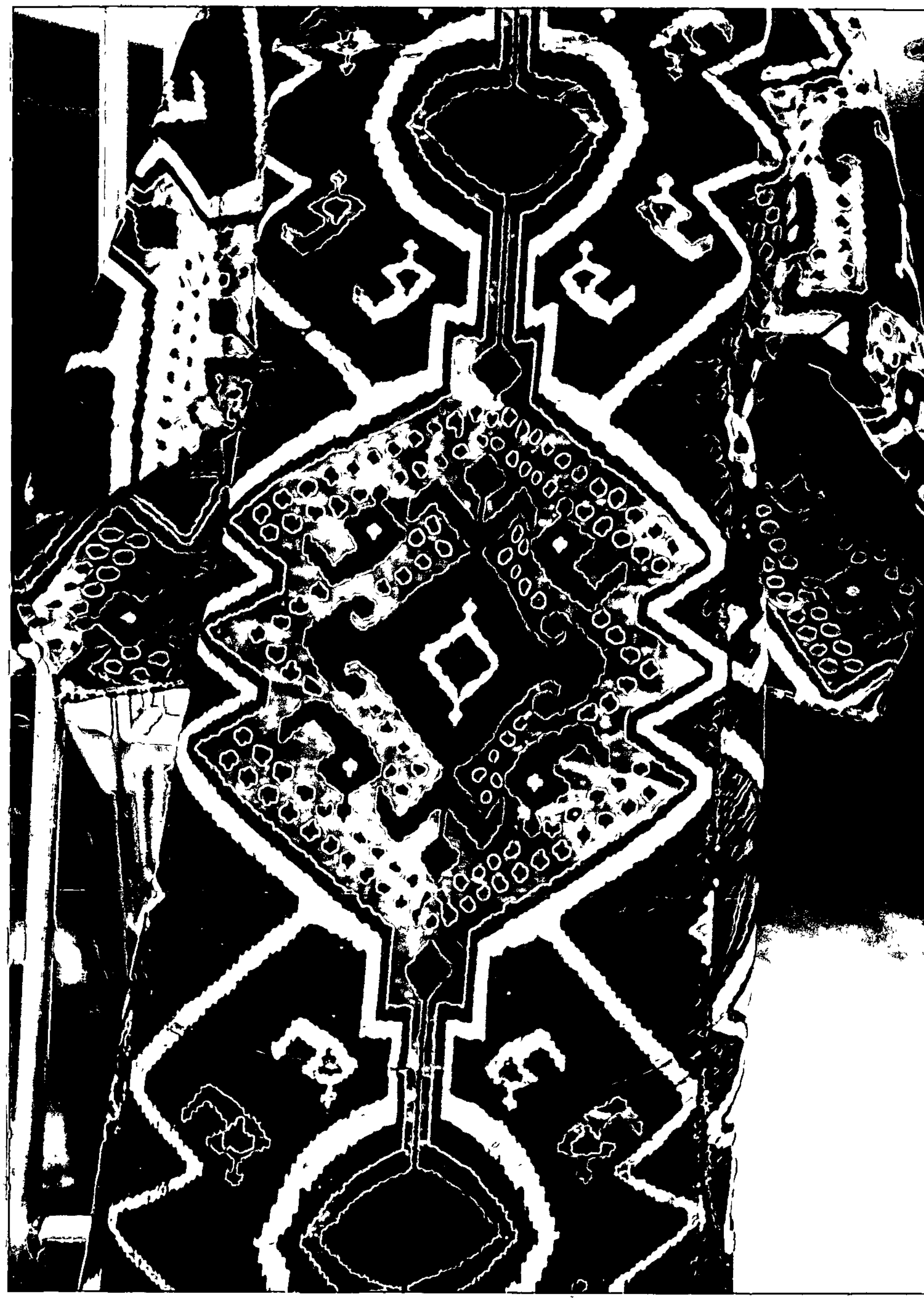


Fig 3.9

was to be shown to the Khan and Islam. Figurative representation was prohibited by Islamic law, therefore design became purely decorative[79]. In addition, with the lack of inherited religious commitment, the ceremonial requirement of Ikat fabric was no longer relevant, so commercial enterprise became the sole reason for its existence.

Fashion played an important part, and designs were changed each year according to demand. Men did not wear the same designs as women, although the colours were similar the imagery was less decorative than those the women wore.

It is known that the motifs were part of a long evolution. Evidence of similar patterning can be traced as far back as the third millenium B.C., on pottery and bronze objects of Namazga III from south Turkmenistan[80], as shown in Fig 3.10.

'Gols' is the general term given to the designs used. It can be translated as 'family' although in this sense it refers generally to 'flowers'[81]. These shapes can be identified as twigs, bushes, the Tree of Life, rams' horns, almonds, pommegranates (see Fig 3.11), bouquets of flowers, plates, lamps, combs, drums, cyprus trees and stylised bird motifs. In addition, geometric forms are included; broken lines, chevrons, spirals, rosettes, S shapes (see Fig 3.11), dovetailing and arrowheads[82].

Today, the manufacture of Ikat fabrics in Margelan and the imitation of Ikat designs printed on womenswear fabrics in parts of the Soviet Union is a continuing trade[83]. In

Pottery and Bronze Objects of the Third Millenium BC

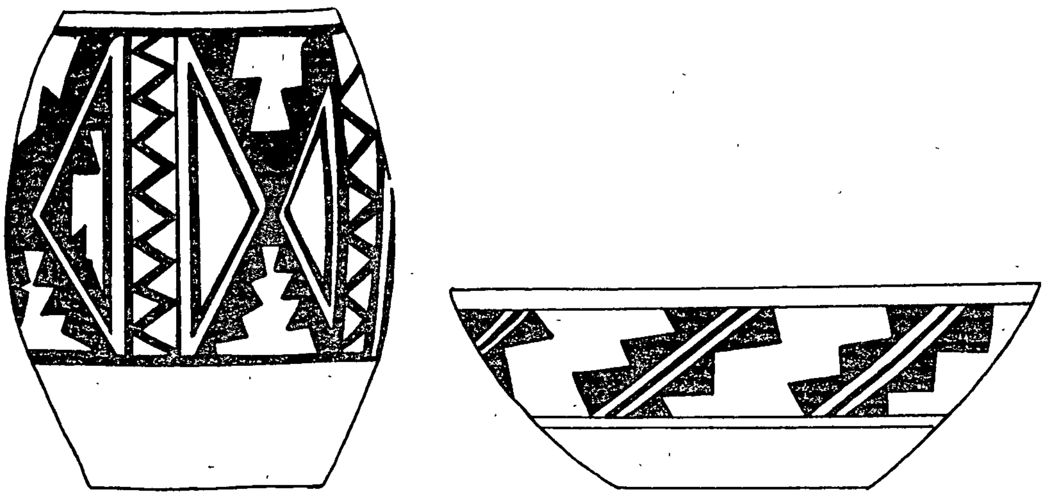


Fig 3.10

S Shape and Pommegranates

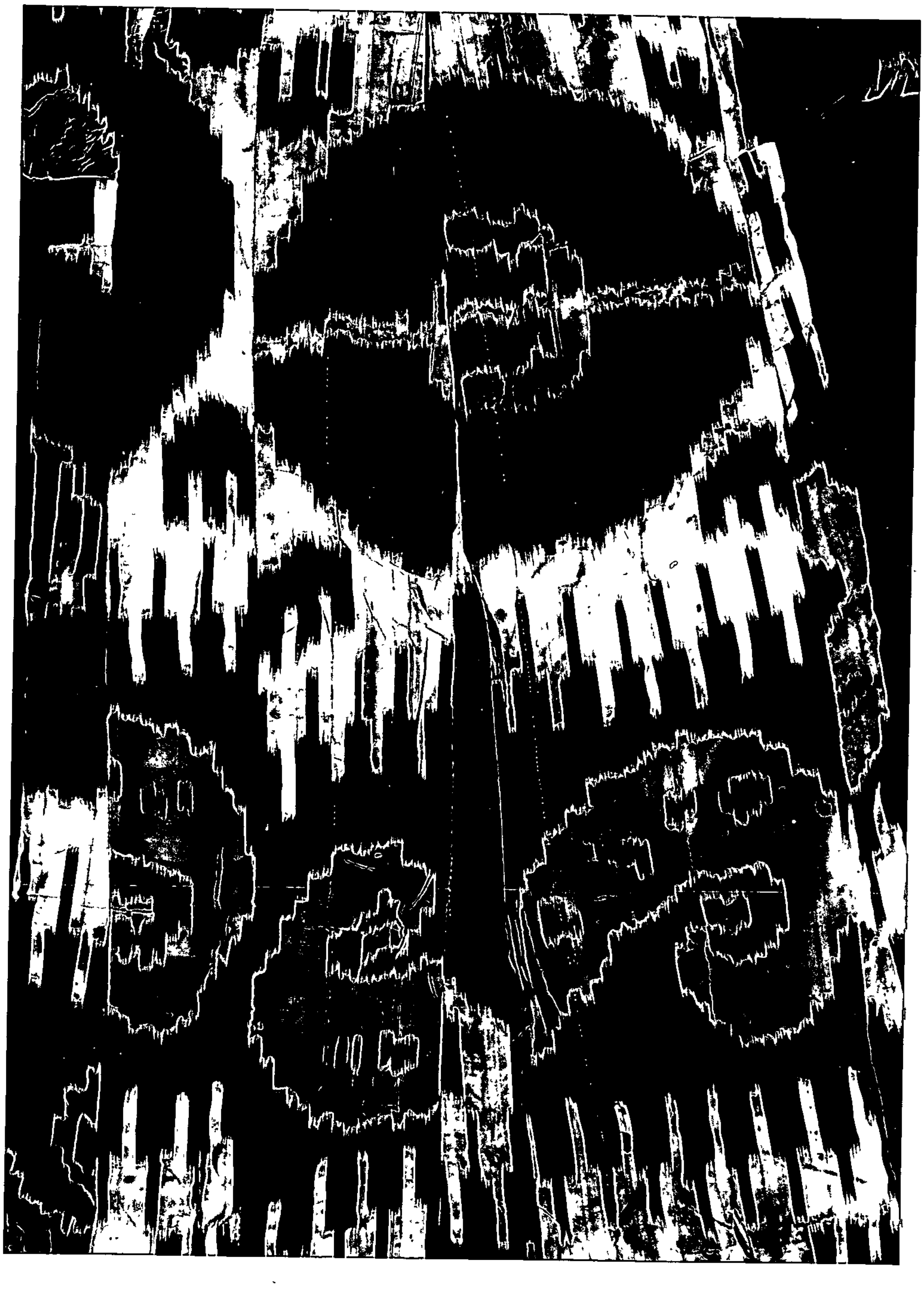


Fig 3.11

Margelan traditional designs are being continued, but the repeats have increased in size, some being as large as 240 cm (7' 8¾"). The lengthy dyeing process has been abandoned, so the fabrics are resist dyed with only one colour. The width of the fabric has been increased to 54 cm (21¼"), and the predominent weave used is satin or 'atlas'[84].

3.6 Conclusion

It is of great interest that the warp Ikats produced in both Chile and Turkestan should have obscure similarities. Although the two countries are sited across the world from one another, the Araucanians were the only tribe to practise Shamanistic beliefs in the Americas, a doctrine definitely indigenous to Siberia. The imagery used in both countries, although not exactly similar, have an overall flavour that perhaps stems from those early Shamanistic beliefs. Perhaps on the other hand the similarity is purely co-incidental.

In addition, it appears that exact proportional symmetry of design is not that important or necessary, which in comparison with Ikat fabrics from most other areas, is unusual.

CHAPTER 4 WEFT IKAT OF BALI, INDONESIA

4.1 Introduction

In contrast to the commercial austerity of Central Asian Ikat production, the weft Ikat fabrics of South East Asia were part of a sacred tradition.

On the island of Bali, in Indonesia, see Fig 4.1, the production of weft Ikat fabrics has continued since the 14th and 15th centuries, when it is believed the technique was introduced by Indian and Arab Moslem traders from the Indian subcontinent[85,86].

Made generally from silk, these fabrics could be distinguished immediately by their brilliant red colouring as seen in Fig 4.2, adding rich and shimmering effects to Balinese ceremonial life[87].

Traditionally, silk weft Ikat manufacture was restricted to areas surrounding royal palaces as the resulting fabric was costly and its existence depended upon rich patronage. The villages of Bubunan[88] and Singarada[89] in the north west and Gianjar[90] and Klungkung[91] in the south east were the main centres. "Endek" is the local word that describes the Ikat process and two types of weft Ikat fabric existed. The first, plain weft Ikat fabric with no additions, as illustrated in Fig 4.2; the second "Endek" and "Songket" a mixture of weft Ikat and supplementary weft as shown in Fig 4.3. The thread used in "Songket" was always metallic, either gold or silver and was imported together with the

The Island of Bali

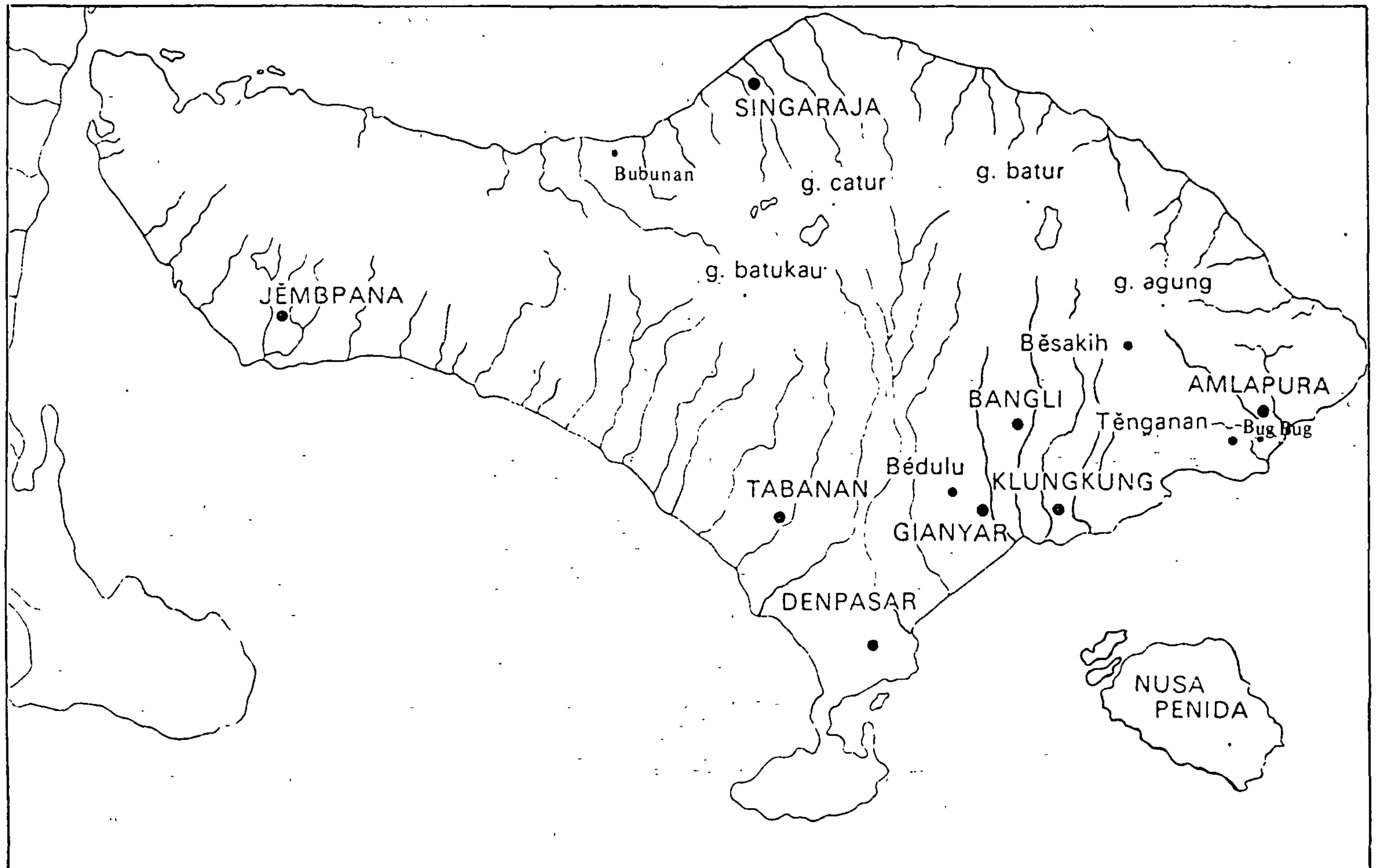
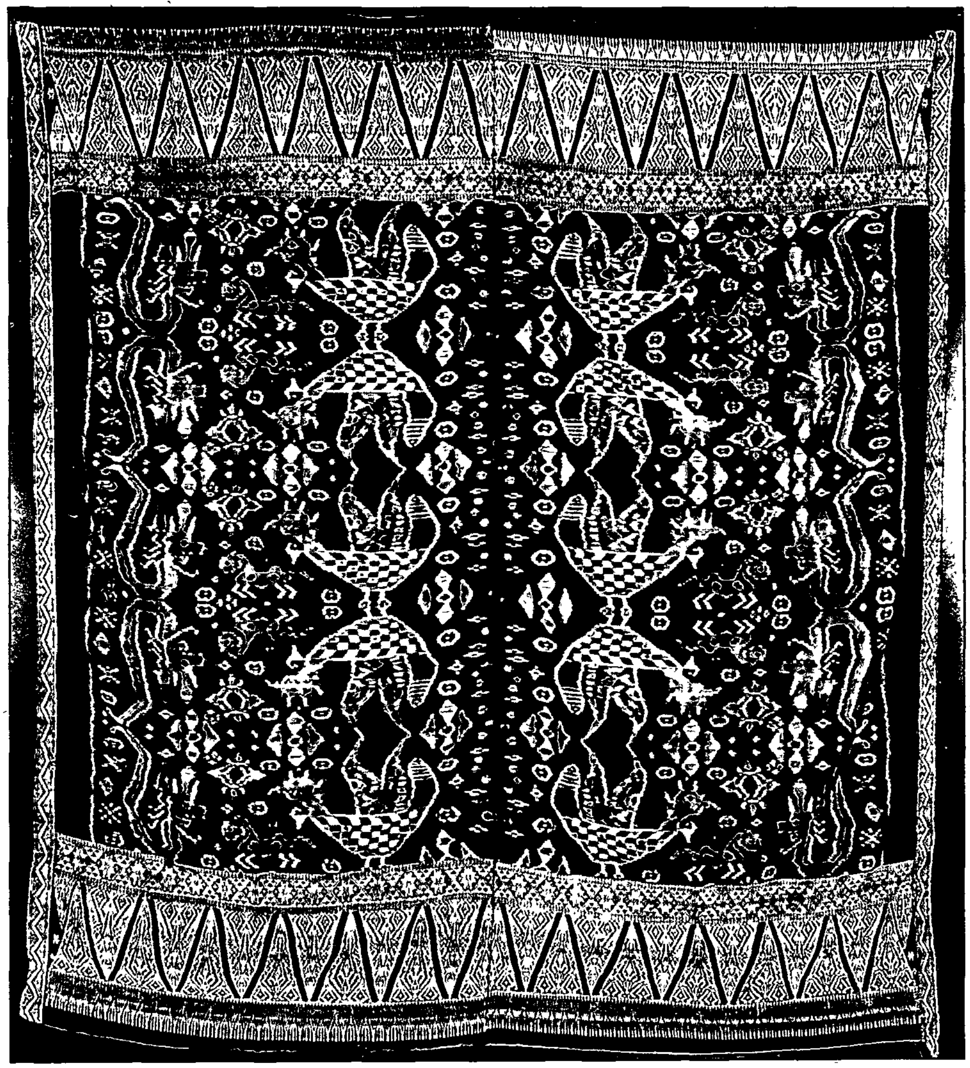


Fig 4.1

A Ceremonial Sarong

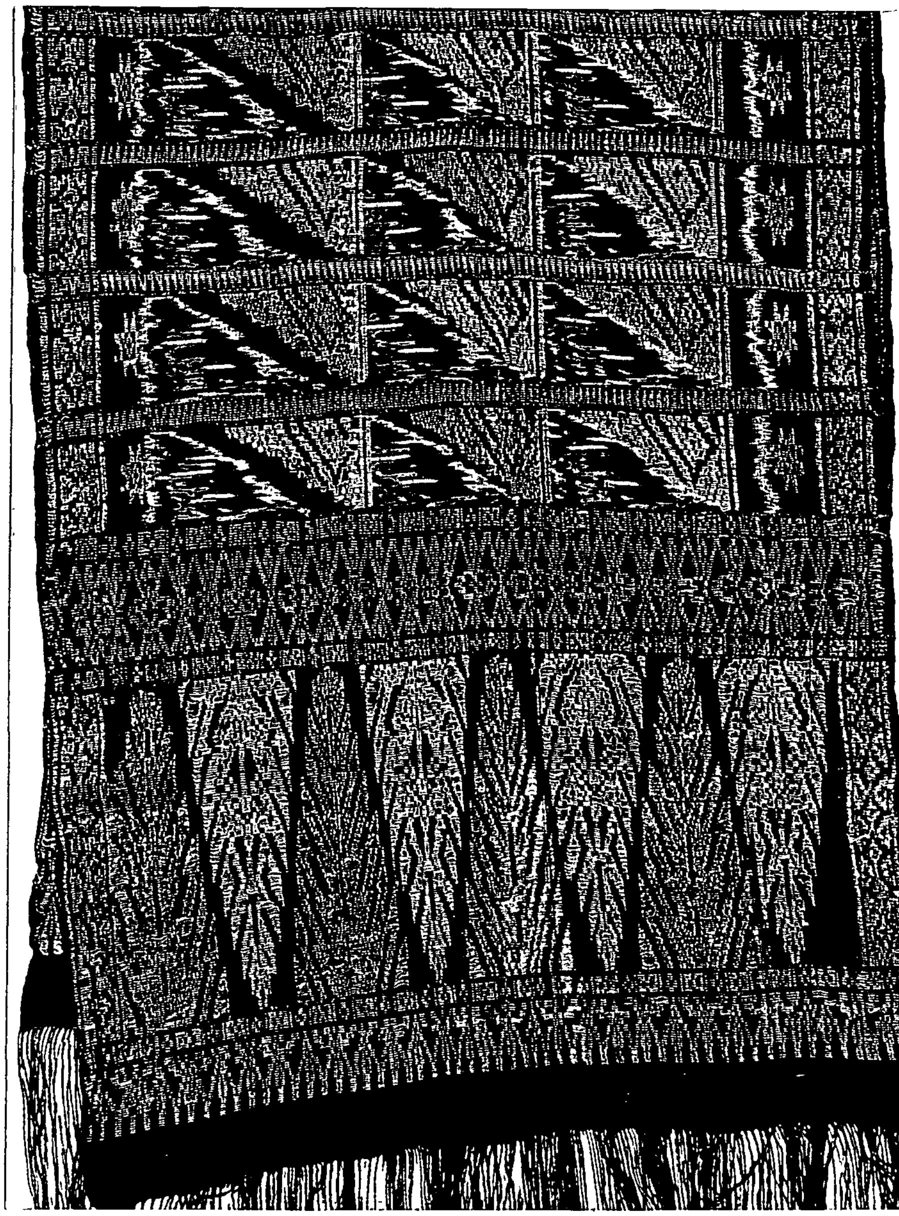


Construction Details

Warp	:	25.5 epc red filament silk.
Weft	:	26.3 ppc filament silk. Resist dyed turkey red, yellow and indigo
Size	:	147 x 132 cm.
Weave	:	Plain.

Fig 4.2

Endek and Songket - Ceremonial Breast Wrapper



Construction Details

Warp : 25.9 epc red filament silk.
Weft : 22 ppc filament silk. Resist dyed turkey red, yellow and indigo in parts.
Size : 300 x 38 cm.
Weave : Plain.

Fig 4.3

silk from India, China and Thailand[92].

4.2 Fibres

It is alleged that in ancient times it was the Chinese maritime trade that brought silk to Sumatra, Java and Bali as a raw material[93], sericulture not being indigenous to Indonesia[94]. Indeed sericulture is not practiced today except for one small village in Java. Cotton was the main fibre employed in Bali for creating Ikat fabrics. A fibre whose indeterminate introduction to Indonesia predates that of silk, but is known to be the first fibre to be cultivated and used extensively by the Indonesians[95]. In most cases the cotton fibre was plied after being spun to give added strength to the yarn making it easier to work with during the many stages of the production process[96].
In general, machine-made cotton is imported and readily available today, but some tribes continue to produce small quantities of homespun cotton which is used to produce special fabrics for ceremonial occasions such as burials[97].

4.3 Methods of Manufacture

The following describes a method of weft Ikat production recorded in the 1930's in the south eastern part of the island[98].
Four bobbins were wound with uncoloured silk and placed in a bobbin frame, ready for weft winding. The apparatus that the weft threads were mounted upon consisted of a simple frame the width of the fabric required. It was hung from

part of the house, or a tree or a wooden stand, where it could be rotated freely by hand as shown in Fig 4.4. The four threads from the bobbins running as one were wound on to the frame. Two rotations in the same place formed bundles of 16 threads and this was repeated across the frame until it was complete.

The sections thus formed were marked with contrasting fibre and it was upon these units that the resists were applied. Bast fibres from either the banana or palm tree were used as resist material. At this stage to save tying time, enough yarn was prepared for two or three identical fabrics.

The perimeter of the design was tied first; the central areas being left until last as the pattern was usually more complex there and a soot marking line was required for guidance.

At this stage also, the yarn was tied with a small resist at each edge of the frame, which would remain there throughout the dyeing procedure. Ultimately, this formed an identifying white dot on each weft thread, to facilitate placement of the yarn during weaving.

The red background colour of all Balinese silk weft Ikats was obtained from the age old and lengthy process of Turkey red dyeing. This demanded special preparation of the yarn prior to dyeing that consisted of sprinkling and kneading the yarn with a mixture of ash-lye, curcuma juice and coconut oil[99].

Because of the time involved to achieve the desired colour, Weft Resist Tying Frame

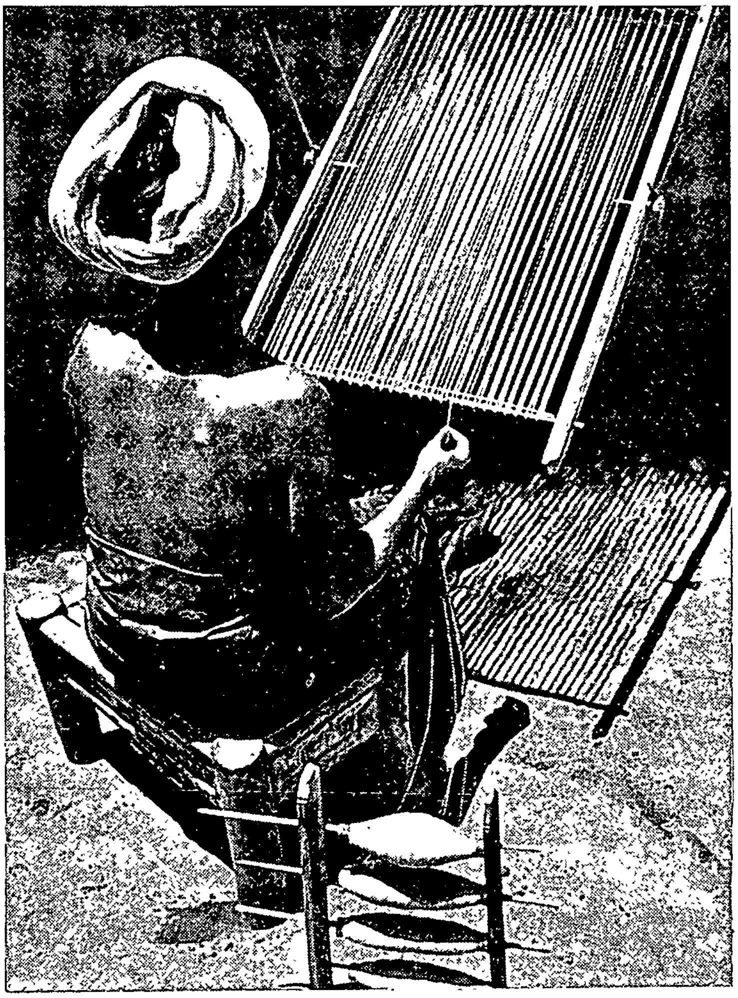


Fig 4.4

the background shade of weft Ikats was completed initially, which differs to the order of dyeing in Turkestan. Therefore, for the first immersion the yarn was prepared with resists covering all areas that were not to be dyed red. Upon completion of the resist tying the yarn was removed from the frame and dyed. When the desired shade of red had been achieved, the dried yarn was remounted on the tying frame. New resists to protect the red areas were applied and resists for the next colour were removed with the aid of a special knife[100]. This procedure was repeated for each colour. Therefore, the yarn used in Fig 4.2 passed through seven separate resist tying and dyeing stages.

The sources of natural dyestuff used are given in Table 4.1[101,102,103,104].

It seems that two methods of dyeing the yarn existed:

i. the yarn was taken from the frame dyed in hanks; or

ii. the yarn was left on the frame, and the whole apparatus was submerged in the dyestuff.

In addition to this, if tiny expanses of colour were required, the dye was applied by hand with the aid of two small sticks while the yarn was under tension on the tying frame, eliminating the necessity for resists[105,106].

Much superstition surrounded the dyeing process. Men were not tolerated anywhere near the site. Dye pots were protected from evil spirits by bunches of feathers suspended above them[107] or a pandanus leaf placed on top of

The Sources of Natural Dyestuffs Used in Bali

Mordant dyes

Colour	Origin	Name
Red	Root of Morinda Citrofolia tree Lac.shield-house	Mengkudu
Blue	Indigo	Indigofera Tinctoria
Black	Bark of wild mango tree, leaves of local plant, and ferrunginous mud	

Direct dyes

Colour	Origin	Name
Red	Annatta Barks of Caesalpinia and Dudrania trees	Bixa Orellana
Yellow	Turmeric Safflower	Curcuma Carthamus Tinctorius

Colours such as green, orange, violet and brown were obtained by combinations of the above.

Table 4.1

the dye pot as illustrated in Fig 4.5[108].

Upon completion the dyed bundles of yarn were mounted once more upon the tying frame and the remaining resists removed. Each individual thread, wound onto the bobbin in preparation for weaving, would form a single repeat of a weft Ikat motif[109].

The silk yarn used for the warp was of a finer count than that used for the weft and was also dyed red. As the fabrics were woven with a weft faced weave this allowed the maximum weft to be visible, exposing the pattern yarn to its best advantage. The warp itself was made on a simple apparatus consisting of three pegs that protruded vertically from ground level[110] as shown in Fig 4.6.

A form of backstrap loom where the weaver's body controls the tension of the warp yarn, was employed in weaving weft Ikat fabric, as illustrated in Fig 4.7[111].

Since many fabrics were woven from one warp the warp excess was wound around a wooden plank that became the warp beam or roller. It was held secure by being placed between two posts in the ground. The difference between this loom and other types of loom in Bali was the inclusion of a reed which facilitated the exposure of the patterned weft[112].

Again ancient rites and superstitions were observed. A warp could only be mounted on the loom on the day of a full moon and a high tide or else the yarn would break[113].

In comparison with the yarn and dye preparations, the weaving of weft Ikats was relatively quick and straight forward. As mentioned previously, the yarn was resist tied

Pandanus Leaf Placed on Dye Pot Protecting It From Evil Spirits

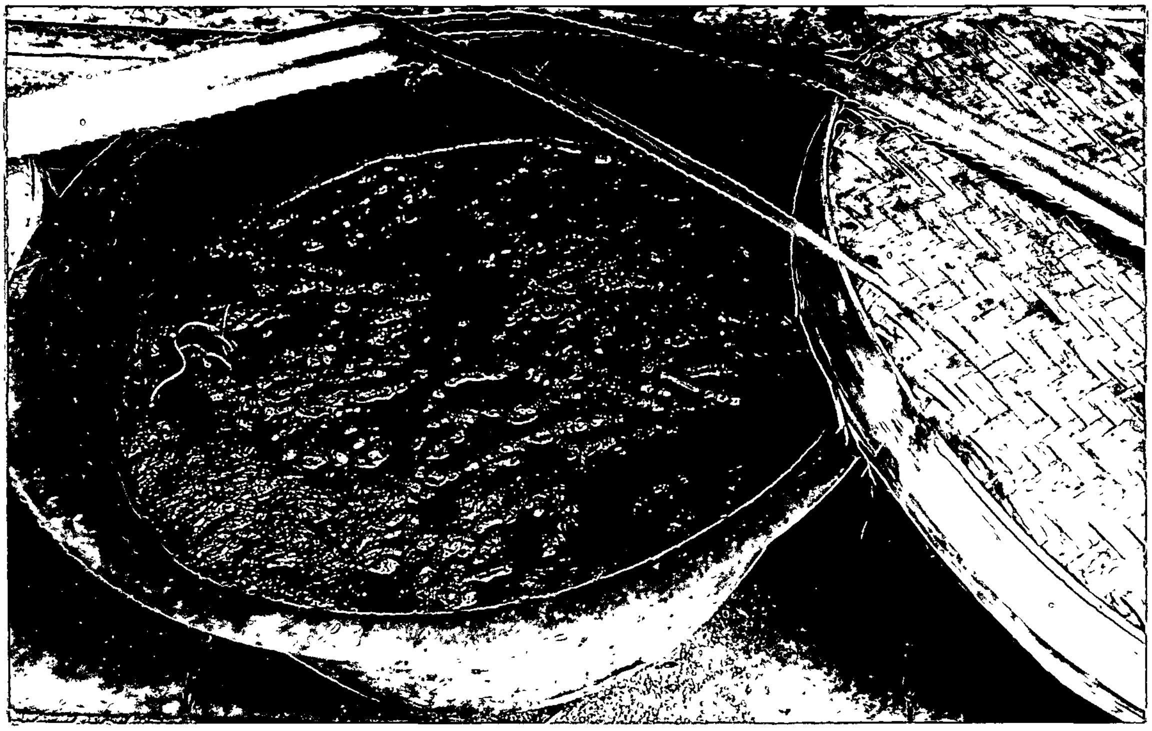


Fig 4.5

Balinese Warping Pegs

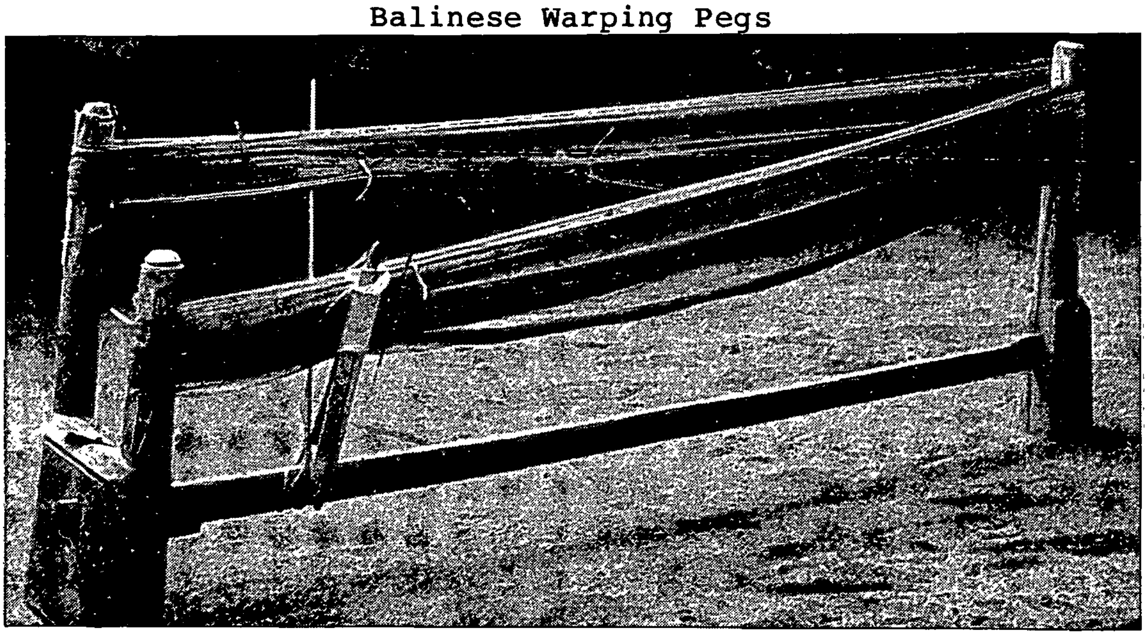
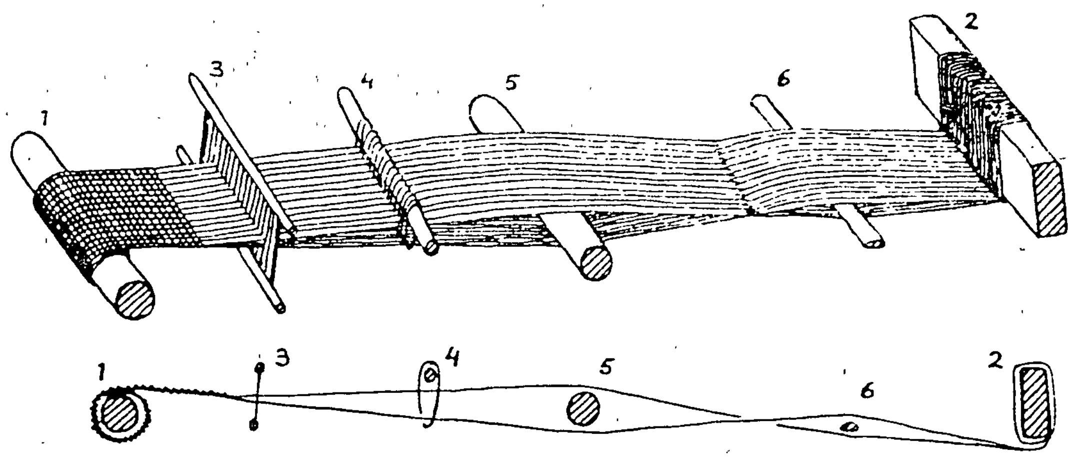


Fig 4.6

Weft Ikat Backstrap Loom



Plan of a loom of type A (RITA BOLLAND)

1. cloth-beam
2. warp-beam
3. reed
4. heddle
5. shed-stick
6. laze-rod

Fig 4.7

to give an identifying "dot" which acted as a marker. Each pick inserted into the shed was matched up with the preceding "dot" and in this way the weft pattern emerged exactly as it was tied. Any misplacement of the pattern that did occur was corrected by careful manipulation.

On the night preceding the weaving, prayers were recited and the filled bobbins awaiting use, were "put to sleep" on mats, and sand was sprinkled over them[114].

4.4 Design Imagery

The designs of the resulting fabrics contained a mixture of motifs from Hindu mythology and the bronze age, as well as figurative representations from their own daily life.

Bali was and still is the only Hindu island left in the Indonesian archaepelago and patterns could be identified with scenes from the Ramayana and other Hindu myths that had travelled from the Indian sub-continent [115,116].

In addition, geometric shapes could be related to the bronze age or Dongson period of 7th century - 1st century B.C., which was an artistic culture that spread southwards from North Indo-China and southern China[117,118].

The sarong illustrated in Fig 4.2 included roosters, snakes, horses and geometric shapes as well as the tumpal "songket" patterning at each edge of the fabric.

The list below outlines the significance of these motifs.

Rooster

A symbol of the sun as it crowed at sunrise. It also represented force, courage and fertility and continually played important roles in cockfighting and sacrificial rites[119].

Snake

The snake was a regular motif used in Hindu-Indonesian art, and was often depicted "crowned" as Fig 4.2 illustrated. It symbolised female representation, the underworld, and the water[120].

Horse

The horse represented two ideas. One as a symbol of power and wealth; the other as a symbol of transporting a deceased person's soul to heaven. In Fig 4.2 they appeared as a secondary motif indicating their value in daily life[121].

Tumpal

The "tumpal" border shown in Fig 4.2, consisted of a row of isosceles triangles filled with tendril designs. This motif is similar to patterning found on prehistoric kettle drums from West Java[122]. It was a widely used motif throughout southeast Asia, in some forms it symbolised the Tree of Life[123].

The three main geometric shapes collectively known as "Bandji" consisted of a meander, a swastika and a hook or key design[124].

The motifs were used frequently as decorative infil patterns for centre fields and borders. The swastika was the most notable, symbolising the rotation of celestial bodies as well as the sun. It was considered a lucky sign[125].

The meander and the swastika were also combined to form a "hook" or "key" design, a rectangular pattern, especially appropriate for "songket" weaving, as the supplementary weft formed conspicuous twilling lines[126].

The human body, another figurative motif of constant use and importance, represented protection against evil, and depiction of ancestors. To the primitive mind whoever, or whatever, was presented upon a fabric bestowed protection by magical power[127].

4.5 End Uses

The resulting weft Ikat fabrics of Bali were looked upon as both clothing and costume. Loom widths were of a rectangular shape and it was customary for two or more identical loom widths to be sewn together along their selvedge edges as well as their weaving edges to form a narrow tubular fabric.

These tubular sarongs were worn by women for everyday use and were secured by being folded or knotted above the breast. In addition, the women wore unjoined rectangular sarongs wrapped closely around the hips.

Everyday wear for men comprised a garment called the 'kaunben', a single rectangle secured around the waist reaching to below the knee.

For ceremonial purposes, women wore a further garment known as the 'kaunben cerik', a long narrow fabric used to cover the shoulders and breasts. Often this piece was ornately decorated with 'songket', the metalic thread as the example in Fig 4.3 illustrated.

In addition to apparel uses, weft Ikat fabrics were employed as temple decorations and there is a small, less well-known group called the "Bebali" which were completely sacred in function.

This latter group were, however, not of silk but of a loosely woven gauze-like plain weave cotton. The weft Ikat colouring was of pastel shades of blue, pink or brown. It is thought that these textiles were used as "offering cloths" at death ceremonies, or formed part of the clothing of one of the Gods[128]. They were in effect token fabrics with no everyday use.

CHAPTER 5 DOUBLE IKAT OF TENGANAN, BALI, INDONESIA

5.1 Religious Significance

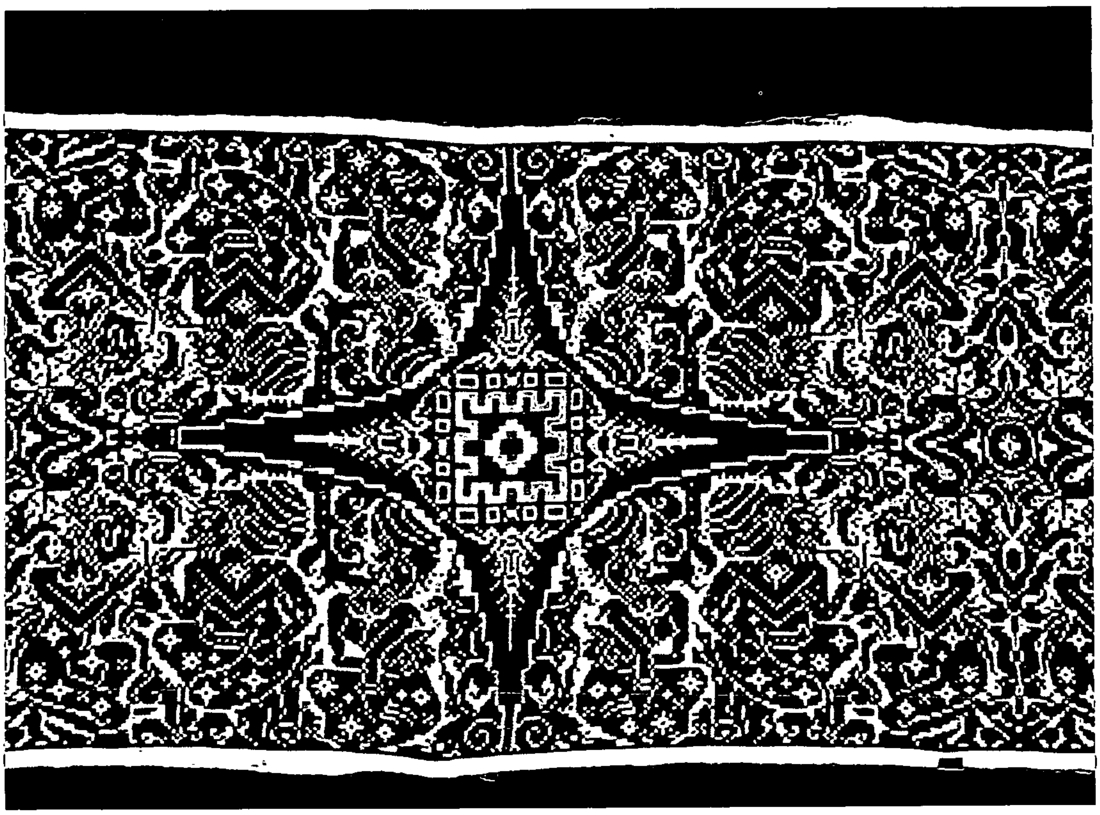
In addition to producing silk weft Ikat fabrics, Bali has gained recognition for producing the double Ikat, or "Gringsing", as shown in Fig 5.1.

Originally discovered at the beginning of this century, the Gringsing fabrics were considered to possess great spiritual and magical powers, and their manufacture was exclusively the work of women[129]. The methods by which they were produced were far more elaborate in the preparation of the yarn, the dyeing, the weaving and the ritualistic observance of prayer, than any other type of Ikat fabric.

'Gringsing' were made in the village of Tenganan Pagringsingan (see Fig 4.1), which was one of three places in the world that produced this method of Ikat, the other two being in India and Japan.

Tenganan was one of the several villages on the island inhabited by the Bali Aga tribe, or "pure Balinese", whose history predates the introduction of Hinduism in the 11th century[130,131]. A community who practiced a type of Hinduism, with overtones of animism and pre-Hindu custom, they remained intentionally separate from the other islanders[132]. This helps to explain the presence of religious ceremony which was so much a part of Gringsing manufacture.

Gringsing 'Weyang Kebo'



Construction Details

Warp	:	Twisted cotton. Resist dyed indigo and red.
Weft	:	Twisted cotton. Resist dyed indigo and red.
Size	:	232 x 52.5 cm.
Weave	:	Plain.

Fig 5.1

The word 'Gringsing' is of sanskrit origin, 'gring' meaning sickness and 'sing' meaning 'not' or 'sickness averting'[133,134], which accounts for the reason why these fabrics were so highly prized and sought after. Furthermore, they were believed to avert evil spirits amongst many other functions both of a ceremonial and practical nature[135].

Children were covered with them when their hair was first cut; they were placed underneath the participant's head in tooth filing ceremonies; they formed part of the marriage rites at weddings; and they enshrouded dead bodies as well as hanging as complete textiles from cremation towers and temples. In addition they were part of the costume worn by men and women on festive occasions[136,137,138].

A distinguishing feature of these fabrics, to be discussed in more detail later, was the continuous warp structure upon which these fabrics were woven[139]. The finished article was removed from the loom in a tubular form, with a small section of warp threads unwoven, as illustrated in Fig 5.2. These unwoven threads were cut as part of the ritual during religious ceremonies, resulting in open fringed fabrics. The 'cutting of Gringsing threads never took place in Tenganan, but frequently occurred in ceremonies on other parts of the island[140].

5.2 Methods of Manufacture

'Gringsing' was made entirely from locally grown cotton, which underwent the same preparatory process prior to

Unwoven Warp Threads of the Uncut 'Weyang Kebo'

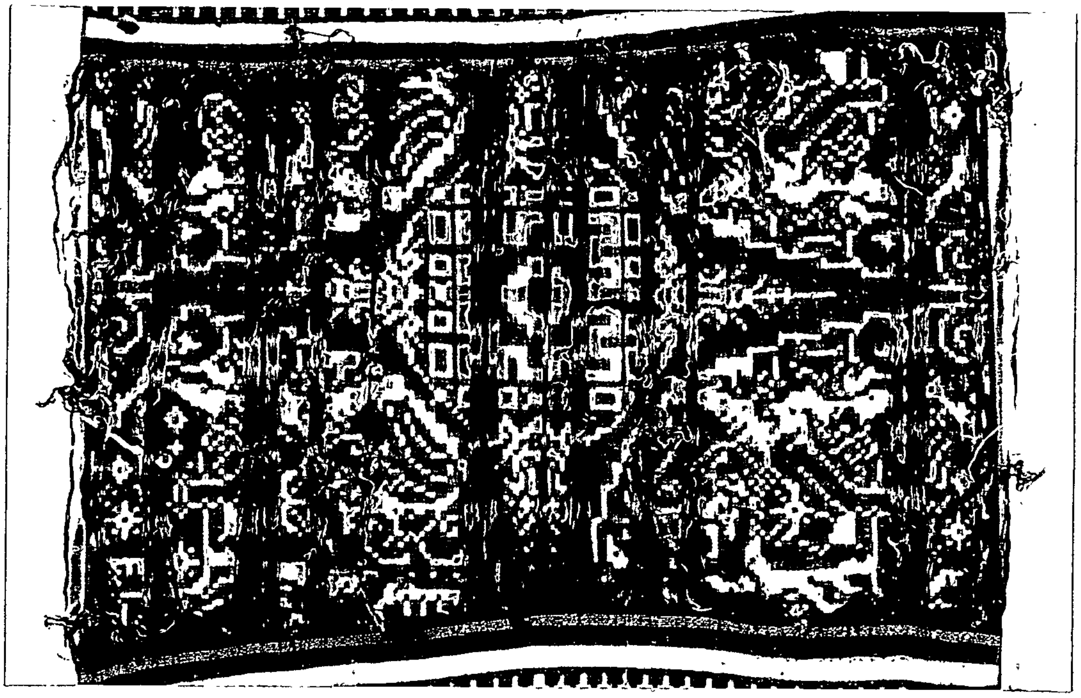


Fig 5.2

Warping and Warp Resist Tying Frame

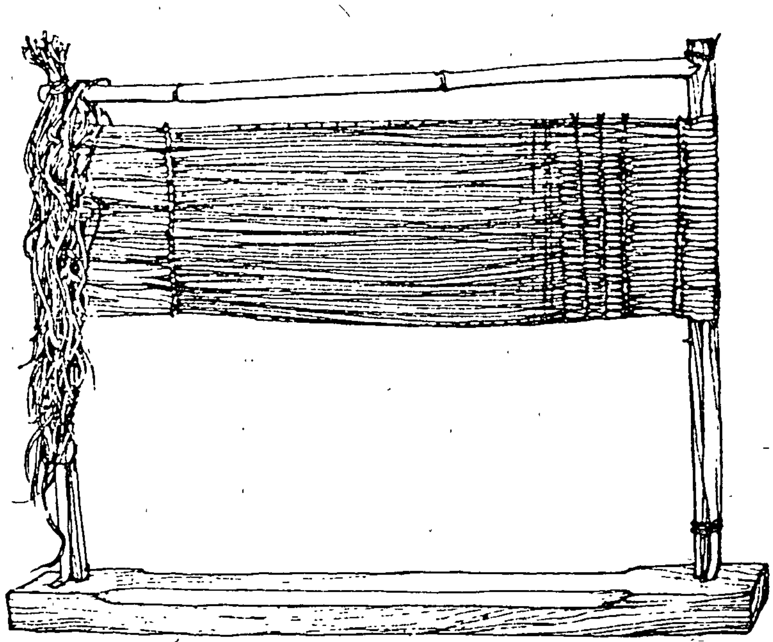


Fig 5.3

resist tying and dyeing, as did the yarn used in the manufacture of silk weft Ikats[141]. The yarn was treated with a mixture of oil and ashes for a number of days and nights, in preparation for the red dyestuff[142,143]. This altered the areas that were to remain natural coloured to a beige tone.

The prepared warp yarn was wound directly onto an upright frame that acted jointly as a warping mill and resist tying frame as illustrated in Fig 5.3.

The yarn was warped in a sequence of seven sections containing some 1400 ends over-all, which was enough to produce five identical fabrics[144]. The seven sections were subdivided into ten sections each, equalling twenty ends per subdivision, and were kept separate with bast fibre[145]. The shed was picked out and secured with special knots of bast fibre.

Each of the ten subdivisions was divided into four equal bundles of 5 ends each. The bundles were arranged in a criss-cross or web formation, forming four sets of yarn, a bundle of each subdivision being included into one of the four sets.

When the warp had been completed there were twenty eight sets of yarn, and it was to these sets that the resists were applied. Thus, in each of the seven original sections, ten identically patterned strips were produced[146].

To facilitate the resist tying procedure perpendicular lines of charcoal were drawn across the prepared yarn to keep the pattern in symmetry. Generally patterns were reproduced from memory, but occasionally a finished Gringsing was required for reference, as Fig 5.4 illustrates.

The method of producing weft Ikat for Gringsing frabics was essentially similar to the weft Ikat method discussed in the preceding chapter, although variations did exist.

Enough weft yarn required for weaving a number of weft repeats was mounted onto individual bobbins, and as before, the yarn from these was wound as one thread, around a simple width-adjustable frame. A marking fibre was threaded in and out of each completed circle to make the sections to be bound with resists[147,148].

The frame, thus loaded with yarn, was placed within a larger, more rigid frame, for the tying of the resists, as Fig 5.5 shows. Tension was achieved by looping bast fibre between outside edges of each frame[149].

Likewise, with the resist tying of the Gringsing warp threads, the weft threads were marked with a charcoal guideline, to give accurate reproduction of the design. This was extremely important, as perfect alignment of warp and weft threads was required to give the necessary integration of design, another characteristic of these special fabrics[150].

Palm leaf bast was the material used for resist tying both the warp and weft yarns, and those areas that were to remain natural were bound first, followed by the areas designated to be dyed red[151].

Gringsing Used as Guide to Reproduce Pattern

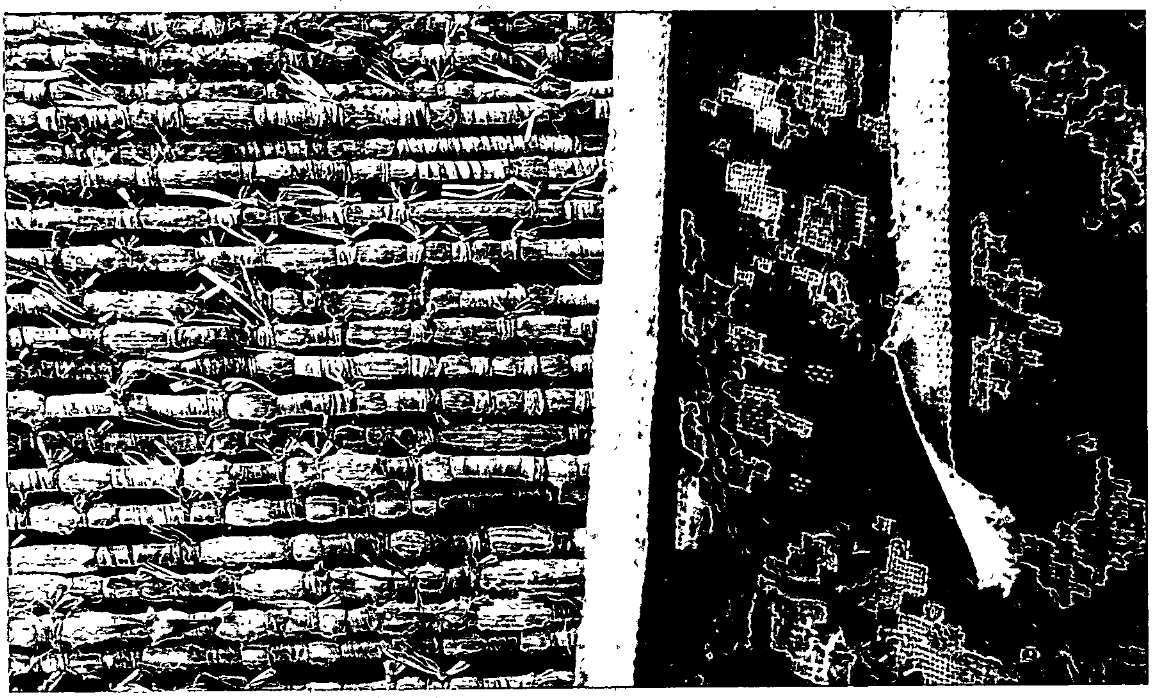


Fig 5.4

Weft Resist Tying Frame

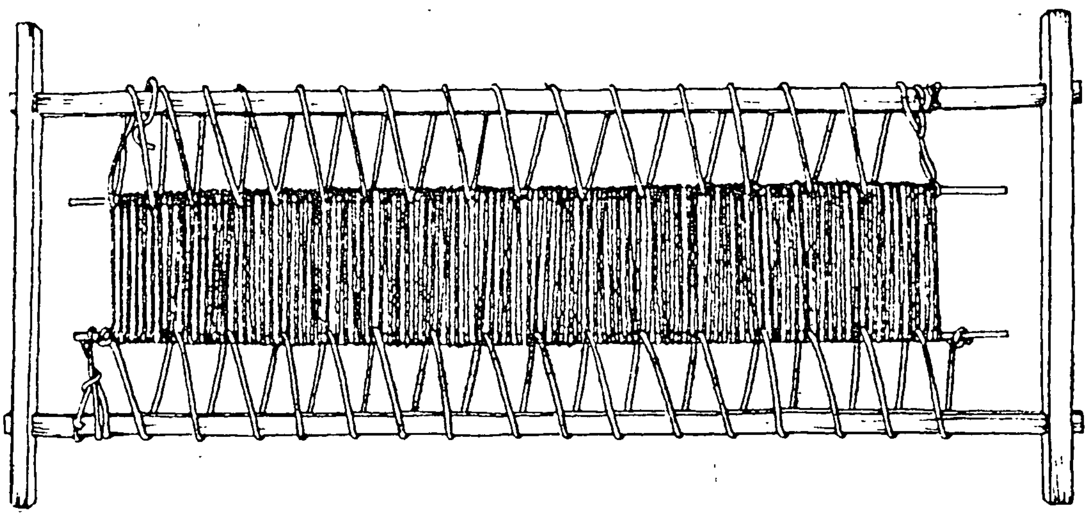


Fig 5.5

Two dyestuffs only were required to achieve the subtle and intrinsic colours of the Gringsing:

i. Blue Indigo

ii. Red Mengkudu, Root of Morinda Citrofolia tree

Indigo was the initial colour to be dyed and since indigo dyeing was by custom prohibited in Tenganan, the procedure was completed in the neighbouring village of Bug Bug[152,153]. The dyed yarn was returned to Tenganan for red dyeing and the relevant resists were removed in preparation. Additional resists to preserve the newly dyed blue areas were not applied. Thus, overdyeing of the blue areas with red is another characteristic of Gringsing.

Red dyeing generally continued on and off with the same batch of yarn for up to eight years, as the dyestuff 'Mengkudu' had to be obtained in small quantities from the neighbouring island of Nusa Penida[154]. In addition, great care was taken to achieve a red tone that simulated that of dried blood[155], a substance reputed to have been used originally to good effect[156].

When the dyeing procedure was complete, the warp and weft yarns were returned to their respective frames, and the remaining resists masking the natural areas were removed. The warp yarns were rearranged into their correct sequence for weaving and the yarns for each fabric were separated[157]. The yarn of one fabric was placed onto the poles of the backstrap loom and assembled for weaving. Each weft thread was wound individually onto bobbins in preparation for use.

The loom used for weaving the sacred Gringsing varied from the weft Ikat loom of Bubunan. Fig 5.6 indicates the difference. Gringsing fabrics were a continuous warp structure, the length of warp was twice the distance between the front beam and warp beam, and the length of fabric was restricted accordingly. In addition, although no reed featured in this loom, the weft Ikat was not affected by the lack of one. Furthermore, instead of lease rods, a coil rod was employed behind the shed stick, around which the yarn passed in a loop[158] as can be seen in Fig 5.7.

The resulting structure of the fabric provided a loose gauze-like web, allowing both warp and weft threads to be seen to advantage. The weaving of Gringsing demanded special concentration to align the warp and weft threads exactly, and it took many years of practice to become an accomplished weaver of such fabrics.

Additionally, Gringsing were often decorated partially with gold and silver metallic threads embroidered around the ends of the fabric.

5.3 Design Imagery

Approximately twenty different design variations existed, and these could be identified in three main groups:

i. figurative motifs;

ii. geometric outlines based on a square; and

iii. floral motifs;

Yarns and colours were similar in each group, though fabric

Gringsing Backstrap Loom

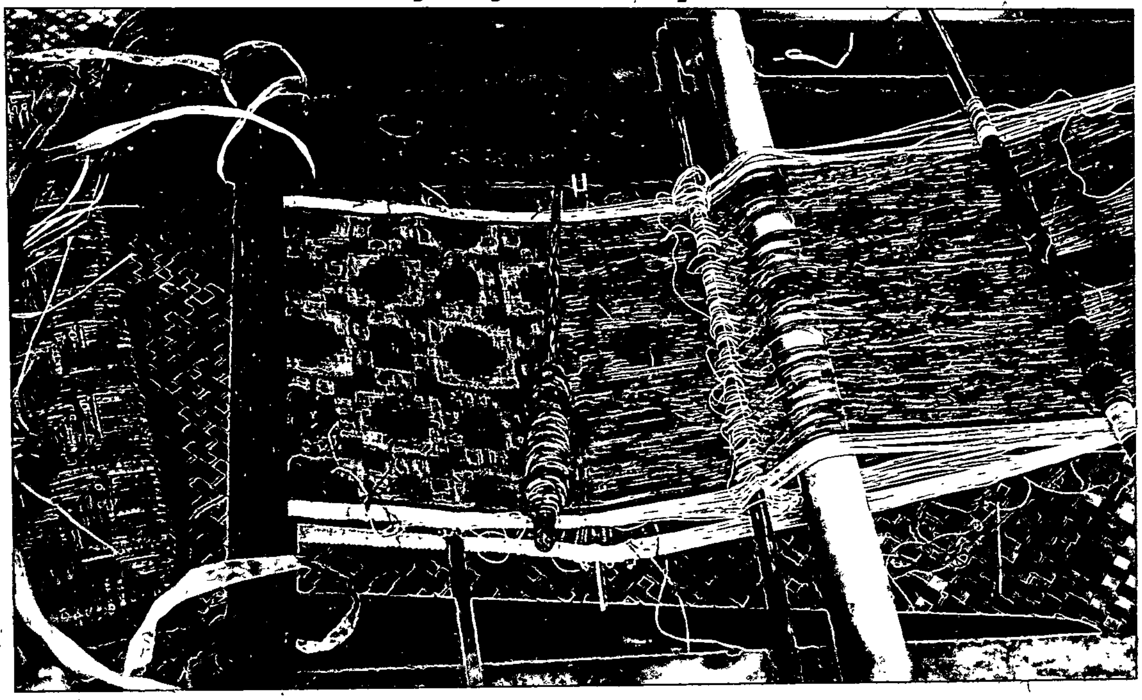
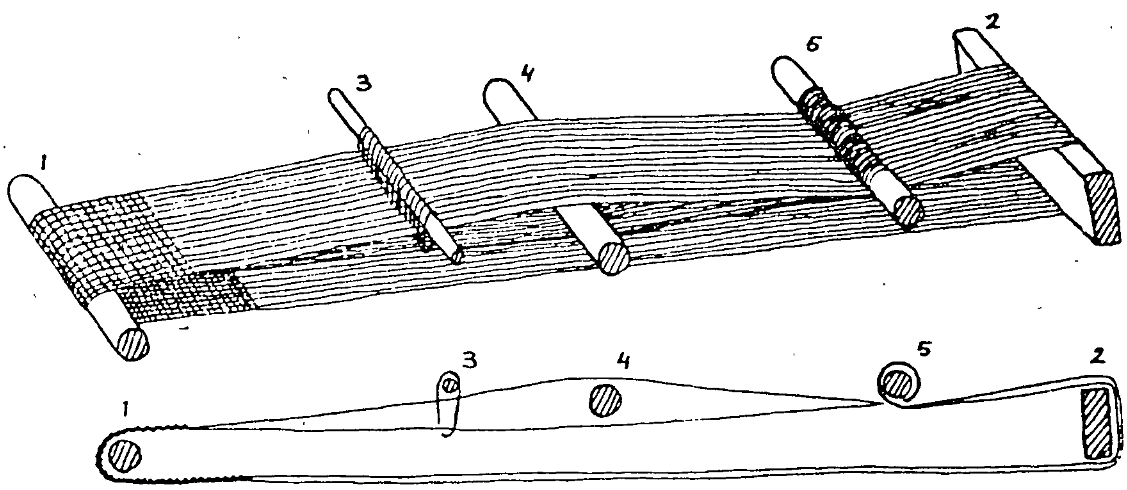


Fig 5.6

Gringsing Loom Coil Rod



Plan of a loom of type B (RITA BOLLAND).

1. cloth-beam
2. warp-beam
3. heddle
4. shed-stick
5. coil-rod

Fig 5.7

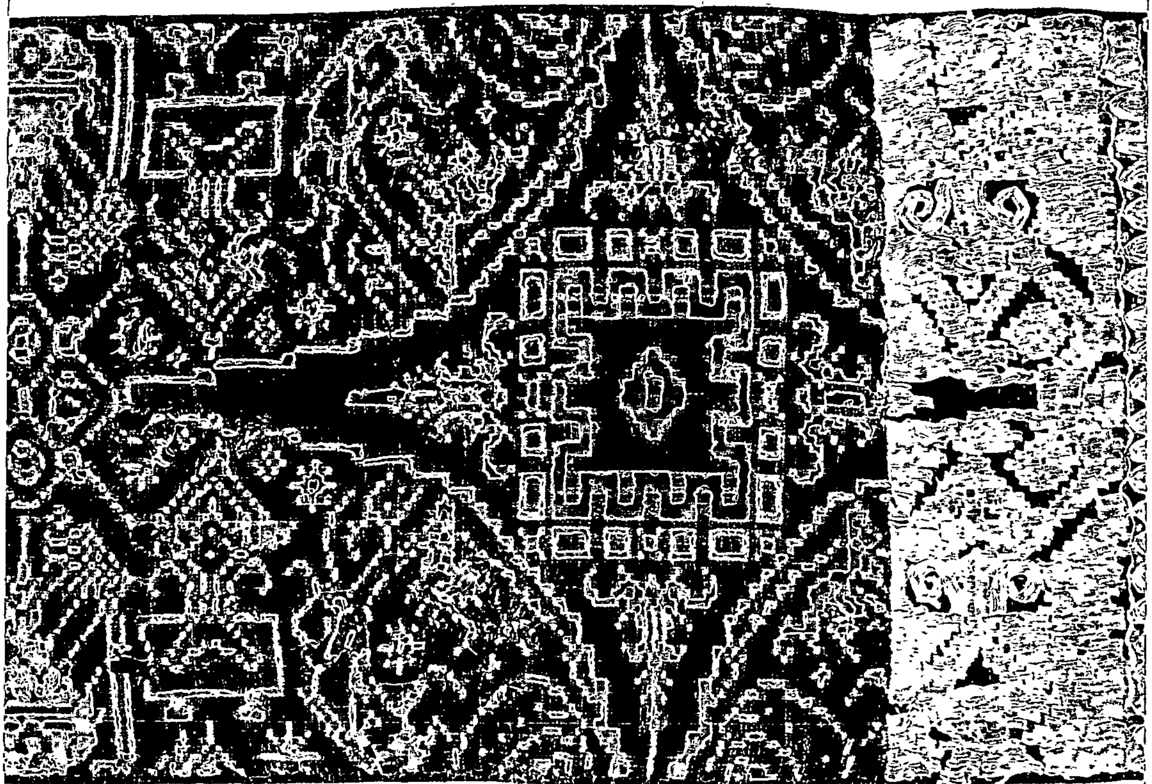
widths varied between 22 cm (9") and 58 cm (24").

A typical figurative design was the "Weyang Kebo" illustrated in Fig 5.1 in which the pattern consisted of a central four pointed star, flanked by groupings of three people. These groups were mirrored at the central horizontal axis, therefore revealing six figures, indicating male representation. Little is known of the significance of the figures, although upon close inspection, a priest and two companions can be identified. Their arrangement and decorative forms have been compared with the 13th century East Javanese temple relief sculptures as well as the "Weyang Kulit" the Javanese shadow puppets[159].

Many forms of the geometric Gringsing existed and they were all attributed with different names. Fig 5.8 is one such fabric. It was bought in Tenganan in 1977 as a "Weyan Putri Isi" or four figured fabric, indicating female representation. It is, however, a "Weyang Patlikur Isi"[160,161]. The front facing figure is crowned with a headdress very similar to those worn by the "baris tekok jago" dancers, who perform at cremation ceremonies[162]. The geometric Gringsing were extremely influenced in design by the Indian Patola fabrics, which were imported into Indonesia during the 16th century[163,164].

Other themes include a central four pointed star or perhaps a small flower motif flanked with asterisks and stars, or architectural and zoomorphic motifs. The architectural images were related directly to objects found in Javanese

Gringsing 'Weyang Patlikur Isi'



Construction Details

Warp : 13.3 epc twisted cotton. Resist dyed indigo and red.
Weft : 9.4 ppc twisted cotton. Resist dyed indigo and red.
Size : 200 x 40 cm.
Weave : Plain.

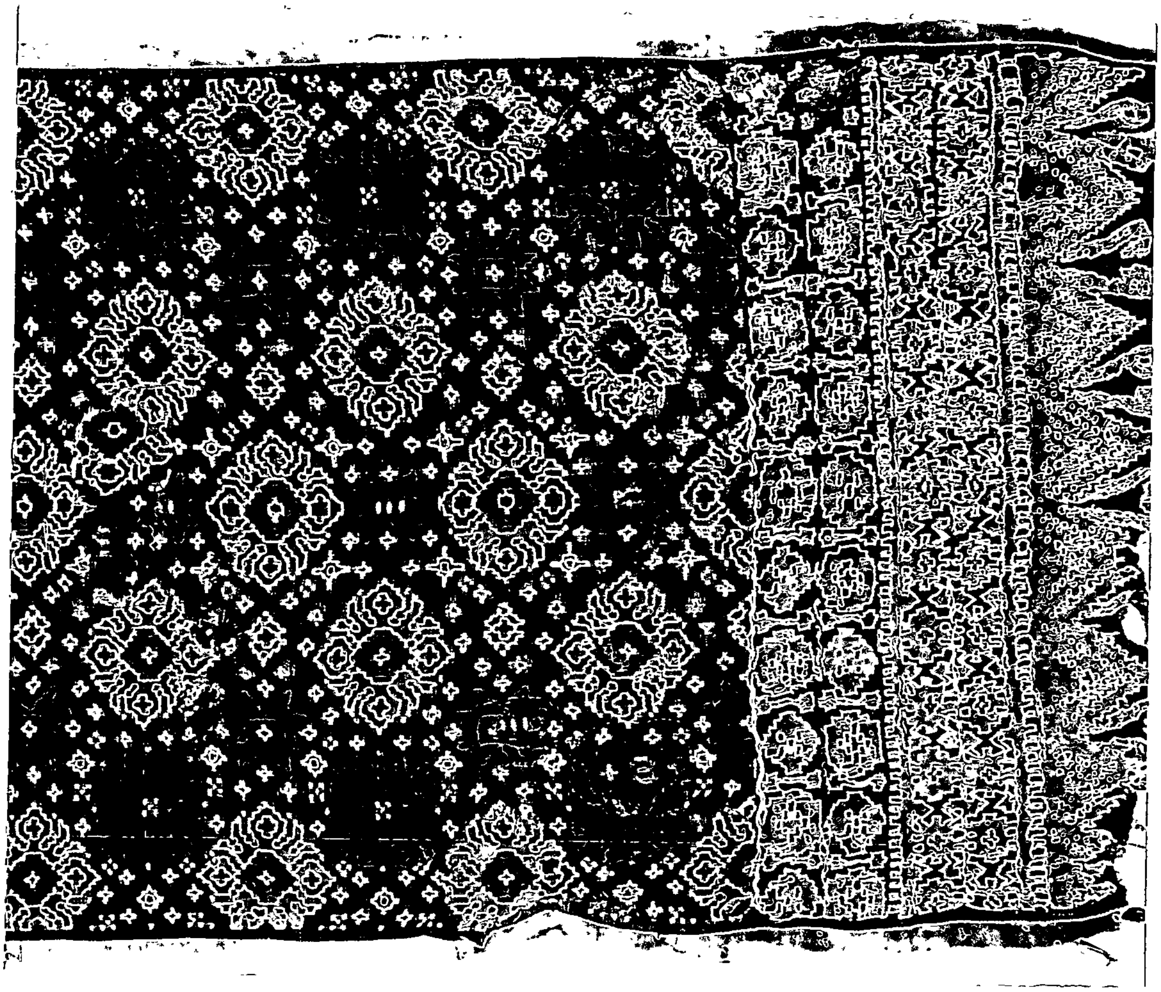
Fig 5.8

temples, such as bronze cult objects used at Buddhist ceremonies and processions. A type of floral Gringsing was the "camplong' illustrated in Fig 5.9. This had a very definite appearance of the Indian Patola, an identical motif, usually a lotus flower, was evenly distributed throughout the fabric surrounded by grid and lozenge patterns[165].

Gringsing fabrics are still produced in Tenganan. The designs in use are simplified versions of the originals, and are used mainly for initiation ceremonies[166].

In addition only three families are involved in producing these fabrics[167]. It is now very difficult to buy complete original examples, although the few pieces that can be found fetch anything up to £800. More usual, however, is to find small fragments approximately 1" square that are bought by the Balinese outside Tenganan, to ward off illness[168].

Gringsing 'Camplong'



Construction Details

Warp	:	15.7 epc twisted cotton. Resist dyed indigo and red.
Weft	:	9.4 ppc twisted cotton. Resist dyed indigo and red.
Size	:	150 x 48.5 cm.
Weave	:	Plain

Fig 5.9

CHAPTER 6 WARP, WEFT AND DOUBLE IKAT OF JAPAN

6.1 Introduction

The methods of colouring yarn in Japan, for the use of creating Ikat fabrics, were more sophisticated and numerous in comparison with similar principle techniques used in other countries.

Japan comprises a string of islands, as Fig 6.1 illustrates, the southernmost of which are known collectively as the Ryukyu Archipelago. This archipelago has consistently maintained a resist dyeing craft quite independently from the rest of Japan.

The local term for Ikat in Japan is 'Kasuri'; in Okinawa, one of the Ryukyu islands, it is known as 'Ichiri'[169].

Many opinions exist as to the origin of the word 'Kasuri' but in all cases it describes the essential characteristics of the Ikat technique; to abrase, graze, blur or mist. 'Kasuri' is probably derived from the verb 'Kasuru' meaning 'in passing touch lightly' or 'lightly brush' or 'stroke along'[170].

Uncertain evidence concerning the introduction of the technique into Japan has led to confusion as to the exact origin of the craft.

As already noted in the introduction, the earliest evidence of the technique was fragments of fabric that were imported from or through China into Japan during the Chinese T'ang dynasty A.D. 618-913.

Japan Mainland

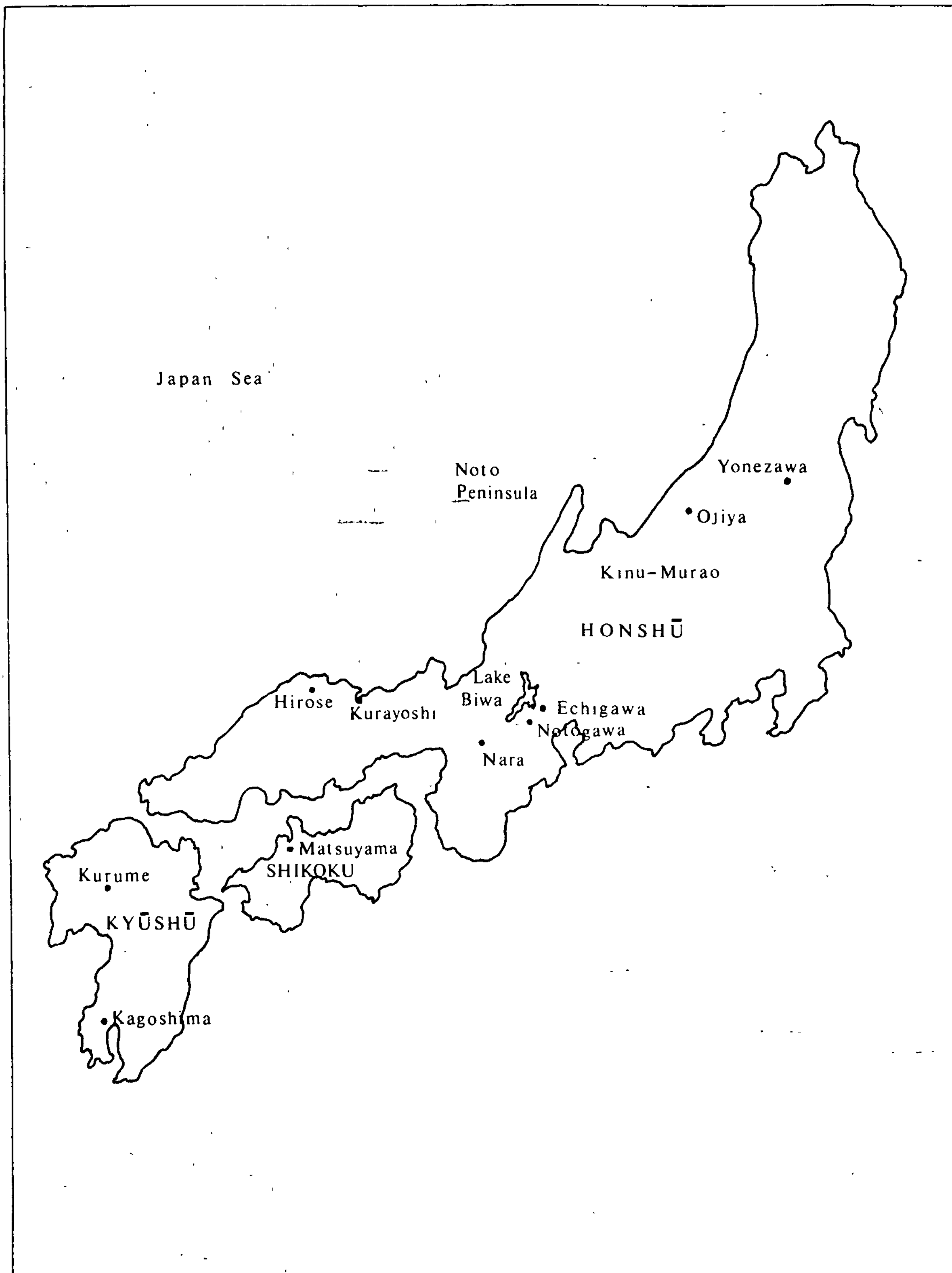


Fig 6.1

Additionally there is evidence from examples of delicately coloured braided cords (Hirao) used for attaching weapons, such as swords to the girdle[171], of a simple Kasuri tradition during the Heian period (794 - 1186) which preceded the pre-Keicho period.

The technique is likely to have become firmly established, however, through imports of textile merchandise from southeast Asia into the Ryukyu archipelago during the pre-Keicho period (pre c. 1600) when trade between these two areas was at its most advanced[172].

By the early 17th century Kasuri weaving was established as a folk art in this region, with the islands of Miyako and Okinawa the main producing centres. The technique spread gradually northwards to the southernmost Japanese island Kyushu, with the town Kurume becoming the forerunner of famous 'Kasuri' centres, that spread eventually to all parts of Japan[173] (see Fig 6.1).

As with Ikat fabrics from other parts of the world, the means of identifying 'Kasuri' depends upon recognition of fibre, technique, colouration, geographical location and design motif. This becomes a more complicated procedure in Japan than the other areas already identified, as within each category numerous derivations or alternative methods exist. Therefore in order to classify and become familiar with 'Kasuri' fabrics it is necessary to include these derivations which are sometimes difficult to recognise once the fabric has been woven. It is not possible to include extensive details of all the methods used in this thesis, but the most common will be outlined.

6.2 Fibres

Since 200 B.C. indigenous bark and stalk bast fibres were employed for creating fabrics[174]. The use of these fibres has continued to the present day with ramie, and hemp the most popular, and banana fibre and orchid fibre utilised to a lesser extent. Cotton fibre did not appear until the early 16th century, but once introduced soon became the most important yarn[175]. Sericulture was established during the Yayoi period 200 B.C. - 250 A.D. Silk fabric was prized highly by the nobility, and constituted a form of currency and tax payment for the common people, before the sumptuary laws were repealed in 1867. After this time sericulture became one of Japan's farming industries with a large export market to America[176]. Thus silk became available to the craft weaver, and was employed extensively to create traditional Kasuri fabrics, a representative example of which is illustrated in Fig 6.2.

6.3 Types of Ikat

The four types of Ikat fabric were produced in Japan, and are referred to as:

Warp Ikat	- Tate-gasuri, shown in Fig 6.3;
Weft Ikat	- Yoko-gasuri, shown in Fig 6.4;
Double Ikat)	Tate - Yoko-gasuri, shown in
Warp and Weft Ikat)	Fig 6.5a and b.

In addition, a common, but famous method of obtaining

A Traditional Silk Kasuri

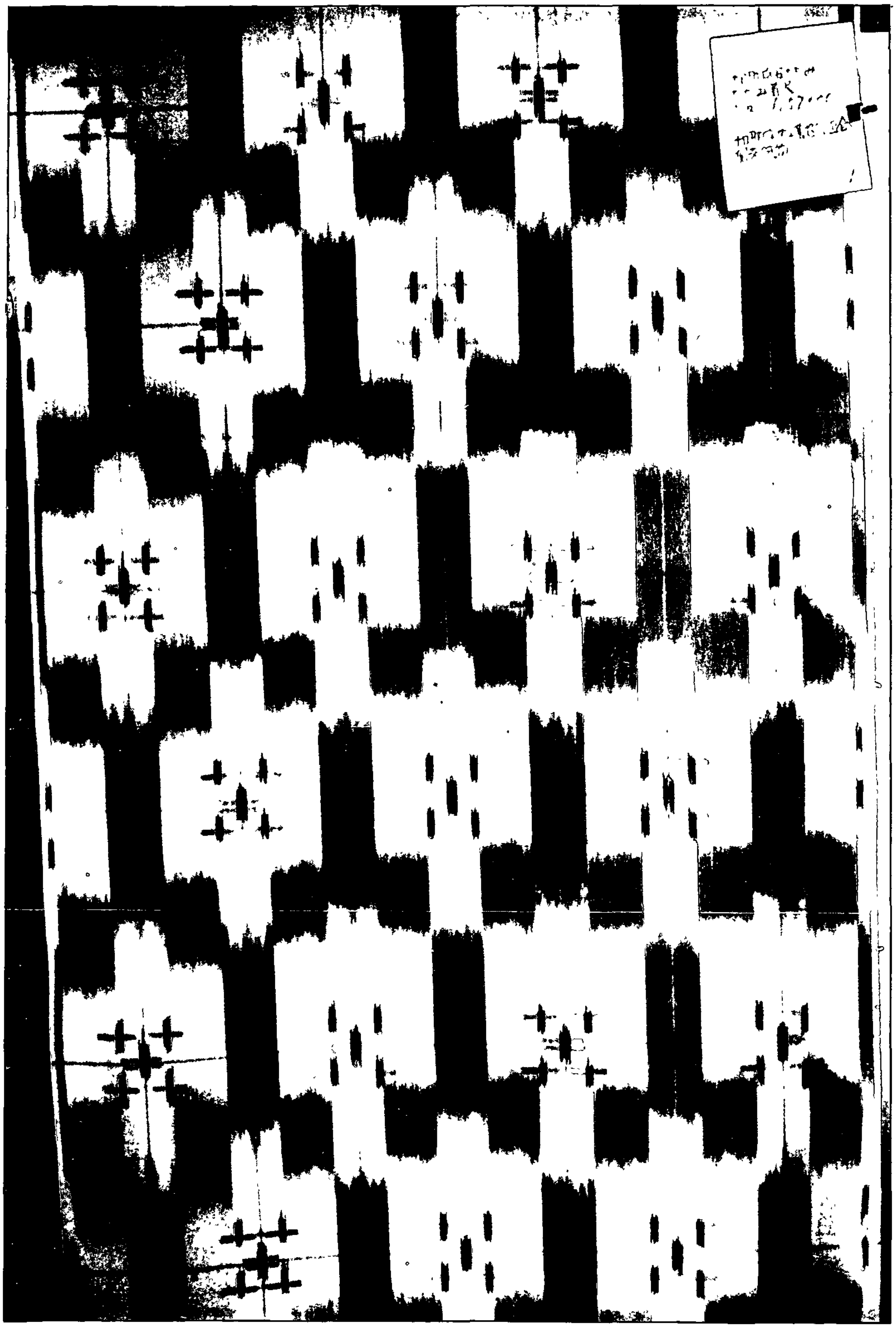


Fig 6.2

Tate-Gasuri

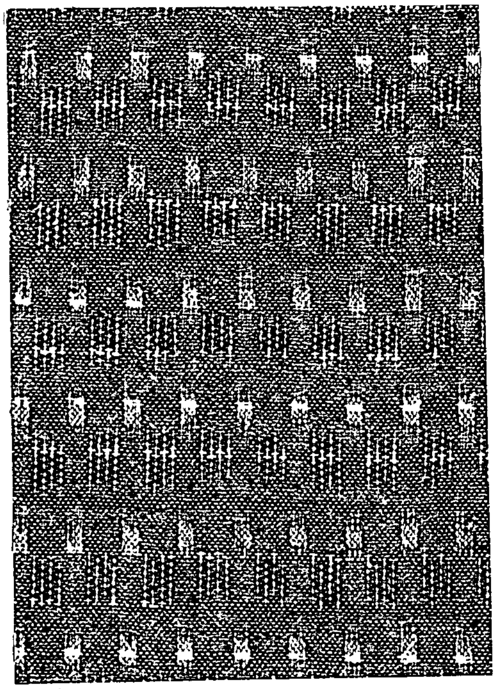


Fig 6.3

Yoko-Gasuri

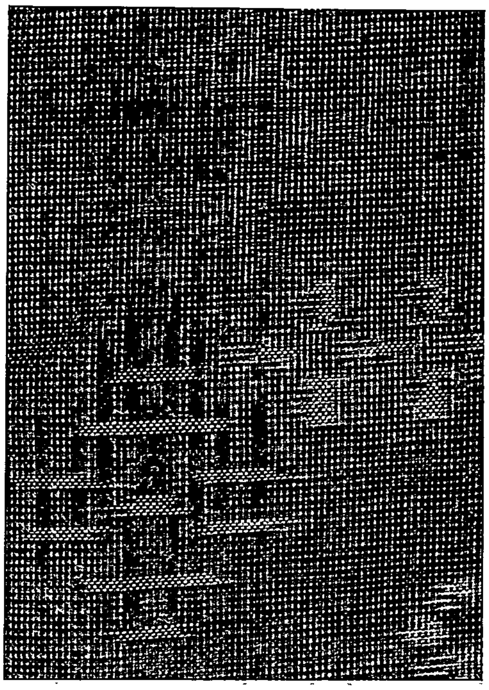
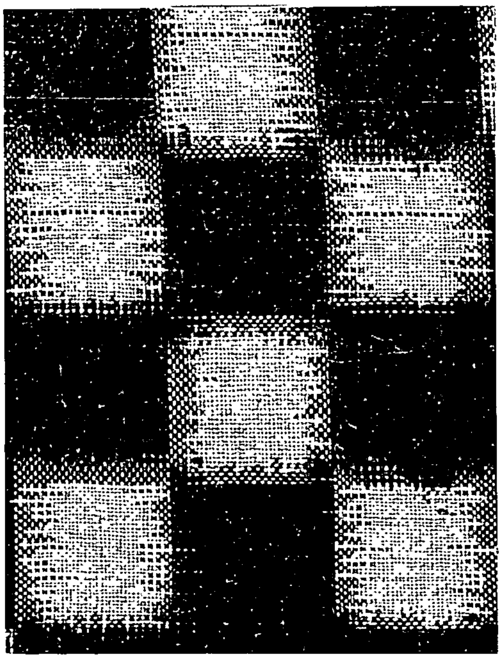


Fig 6.4

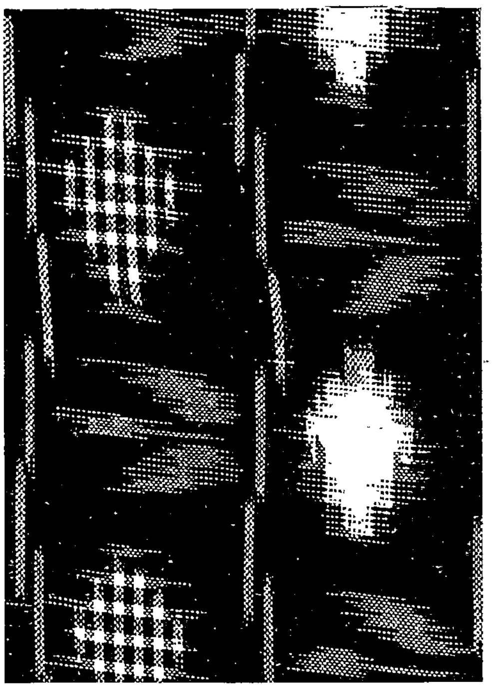
Tate-Yoko-Gasuri

(Double)



a

(Warp and Weft)



b

Fig 6.5

figurative patterns using weft yarn, was known as 'e-gasuri' or 'picture' Kasuri (see Fig 6.6). These techniques have been preserved and continued to the present day.

It should be noted that the indefinite article is used when another word precedes kasuri, in which case the 'k' becomes a 'g'.

6.4 Methods of Manufacture

6.4.1 Techniques

The main techniques employed for resist tying or colouring the yarn are described and illustrated in the following section.

Tegukuri-gasuri

In 'Tegukuri-gasuri' or tying the yarn by hand, two methods were employed:

i. the bundle of yarn was knotted tightly at regular intervals as shown in Fig 6.7[177], and

ii. the bundle of yarn was resist tied in the normal manner, see Fig 6.7[178].

'Araso', a raw fibre of a type of Japanese hemp, was used as the binding material, which shrank on contact with moisture[179].

Before the resists were tied, a single yarn was wound horizontally around parallel bamboo combs contained in a rigid frame known as an 'Ezudai' (see Fig 6.8). The combs were set the required distance apart to give an exact repeat of the pattern[180]. The purpose of the 'ezudai' was

E - Gasuri

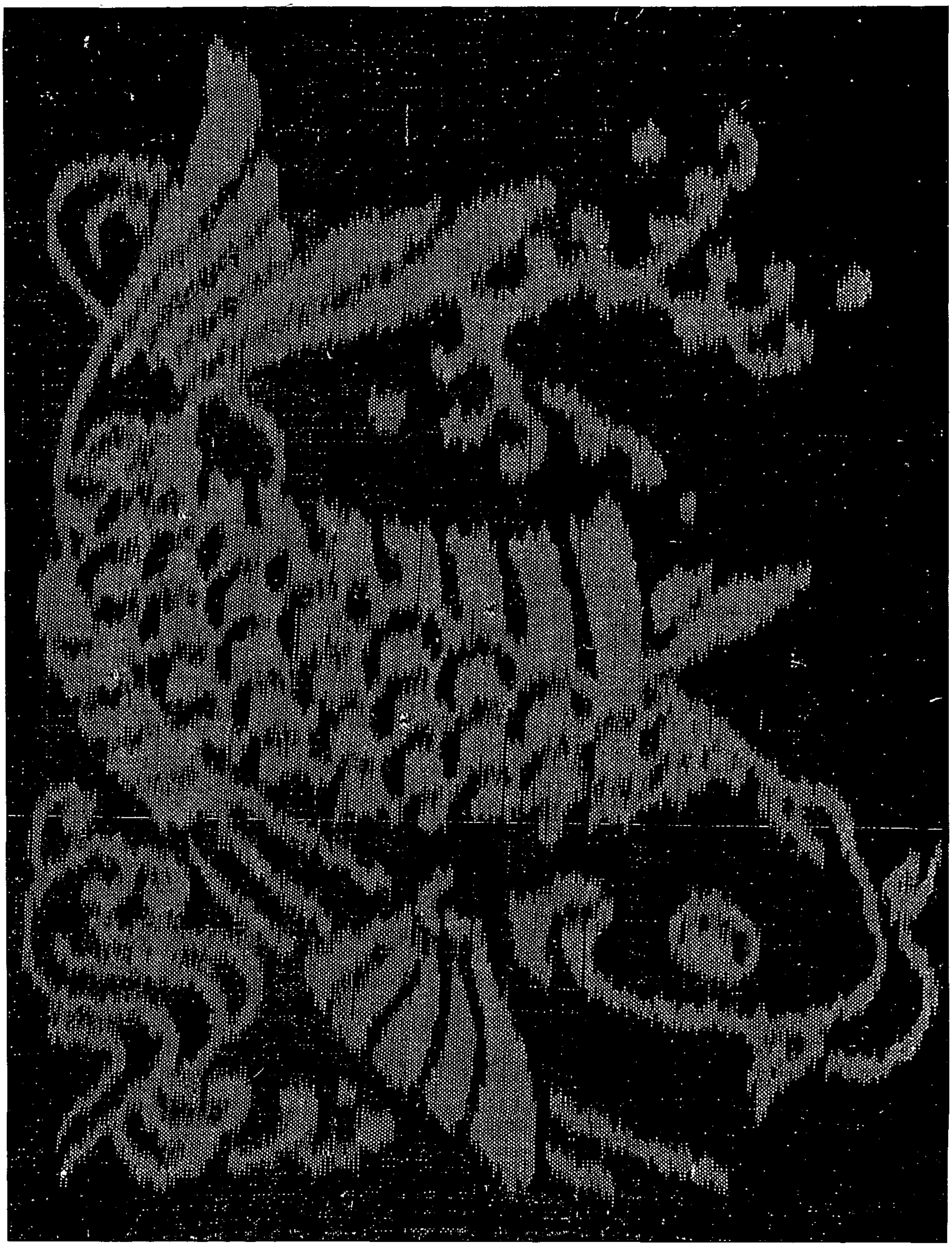
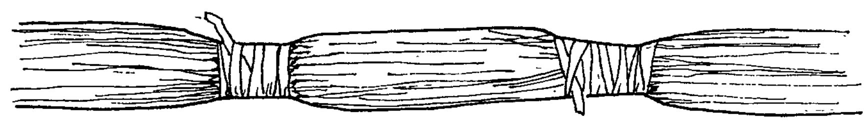


Fig 6.6

Tegukuri-Gasuri

(a)



(b)

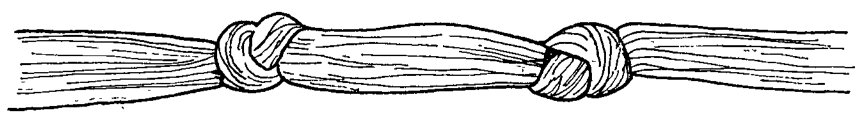


Fig 6.7

Tying Frame or 'Ezudai'

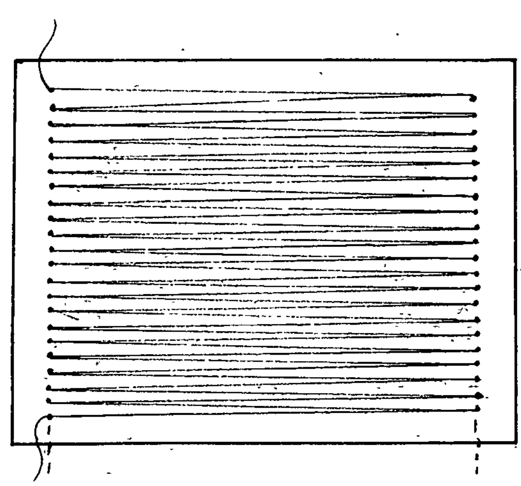


Fig 6.8

to form a solid support to enable the design to be marked upon the single thread which acted as a pattern guide during the resist tying procedure.

Usually the 'ezudai' was used for weft kasuri patterning, in particular for the 'e-gasuri' or 'picture' kasuri, but yarn or warp and double kasuri was sometimes prepared upon this apparatus. At times, instead of tying resists, the pattern was applied by painting the yarn with a brush using a paper stencil for guidance[181].

Surikomi-gasuri

A hand method of colouring bundles of yarn with a spatula (6.9a and b[182]), often used to achieve iro-gasuri ('coloured' Kasuri).

Kashiri-gasuri

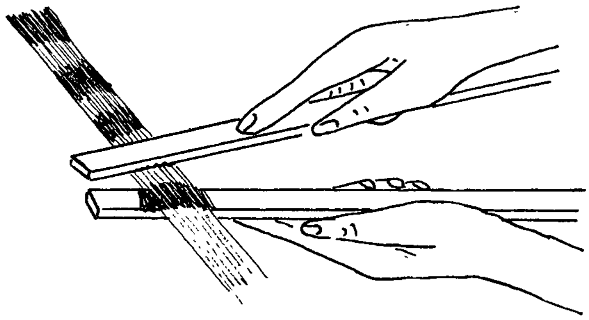
A hand method of rubbing the dyestuff carefully into predetermined sections of single ends of yarn while it was stretched out to its full length. This technique continues today in Echigo, Niigata prefecture, and in Yaeyama in the Ryukyus[183].

Itajime-gasuri

This technique employed a series of carved-out wooden blocks and clamps. The yarn was placed between two blocks partially in relief. Up to as many as 150 blocks were clamped together with yarn between at one time. The whole assembly was submerged in the dyebath. The areas of yarn

Surikomi-Gasuri

(a)



(b)

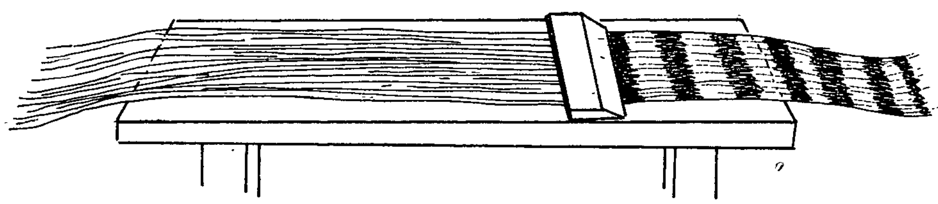


Fig 6.9

Itajime-Gasuri

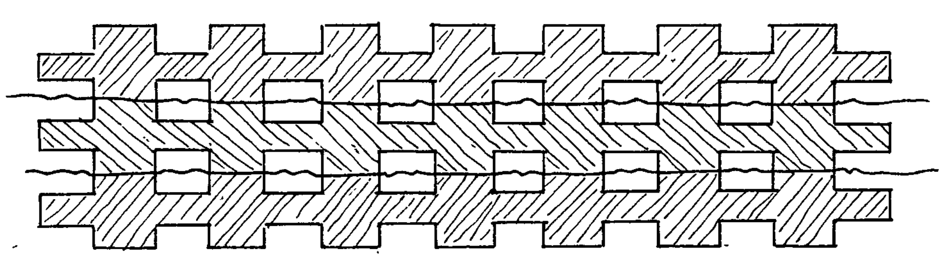


Fig 6.10

that were highly pressurised, resisted the dyestuff, whereas the yarn became coloured in the relief areas, see Fig 6.10[184].

Orijime-gasuri

This method of resist dyeing requires a fabric to be made with what later becomes a disposable coarse warp and bundles of very fine yarn which will form the tie-dyed picks of the weft as Fig 6.11 illustrates. Thus, after tightly weaving the coarse warp and fine bundles the resulting fabric is dyed and then the piece is unravelled. The coarse warp which acted as the resist is discarded, leaving the fine bundles of weft covered in a tiny speckled pattern[185]. The resist dyed bundles are unwound as single threads onto bobbins ready for weaving. 'Tsumugi' fabric is always made by this technique. The final effect of the technique can be seen illustrated later in Figs 6.18 and 6.28. Apart from these traditional techniques of resist tying the yarn there are many other imitations of 'Kasuri' which time has not permitted a full investigation and thus cannot be included in this thesis.

6.4.2 Colouration

It was customary to give the colouring of the fabric, particularly cotton or hemp, a name and the following list indicates the combinations that were used:

i. dark blue ground/white patterning = Kon(blue)-gasuri;

ii. white ground/dark blue patterns = shiro(white)-gasuri;

Orijime - Gasuri

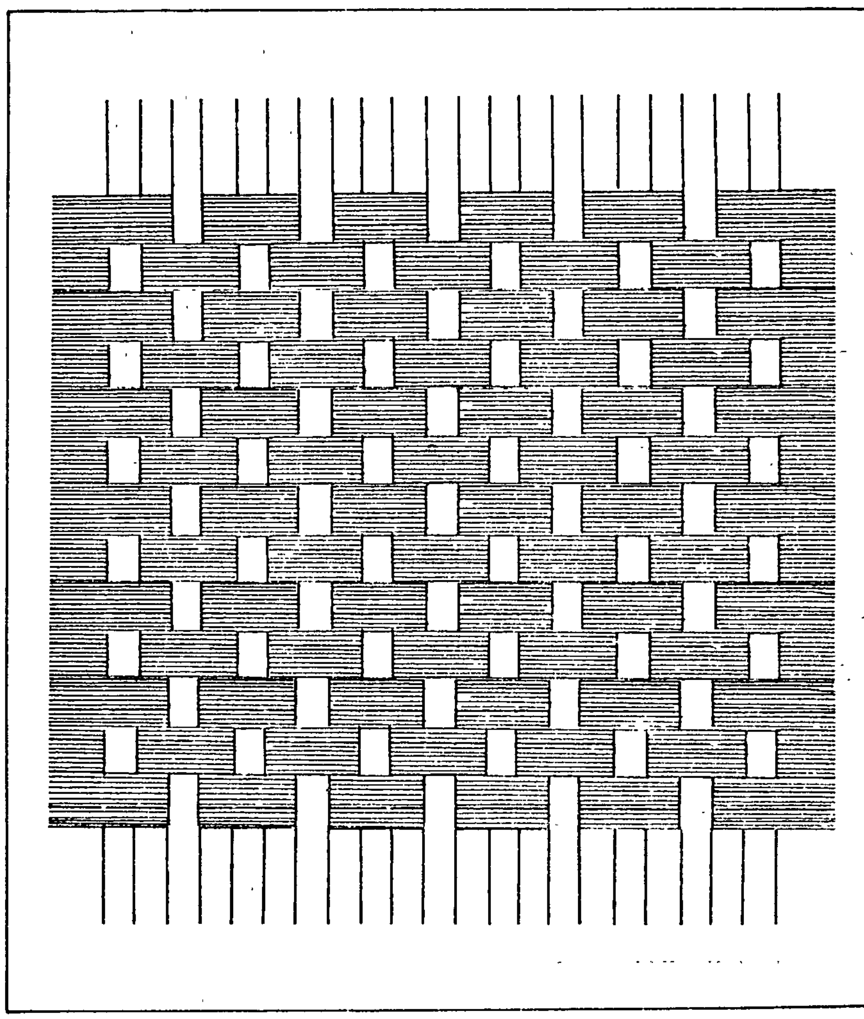


Fig 6.11

iii. brown ground/white patterns = chya(brown)-gasuri;

iv. black ground/white patterns = kuro(black)-gasuri; and

v. coloured patterns = iro-gasuri[186].

A further colour type was Basho-fu, a light, cool summer-weight kasuri fabric made from banana fibre as shown in Fig 6.17. This type of fabric is indigenous to Okinawa in the Ryukyus. Basho-fu can be identified by the natural background colour of the banana fibre, as well as its quality which cannot be compared with any other in Japan.

In addition to cotton or hempen fabrics the production of silk kasuri was of great importance.

In most cases the quantity of different colours used for one piece of fabric varied greatly in comparison with the cotton or hempen examples. Sometimes as many as eight or ten contrasting colours can be observed. Not only was silk kasuri highly esteemed, but it was also extremely expensive and the poorer classes sometimes only acquired one good piece in their lifetime.

The most common of all these variations was the cotton kon-gasuri, used by the farming communities as working garments[187] as Fig 6.12 illustrates. Nowadays kon-gasuri is worn by municipal workers in rural areas and is considered equivalent to the western boiler suit or working overalls[188].

Table 6.1 indicates the most important dyestuffs used by the old time colourists[189]. Indigo was a preferential colour for the farming communities as it left a particular odour in the fabric which they believed protected them from

Kon-Gasuri. Cotton Working Garments

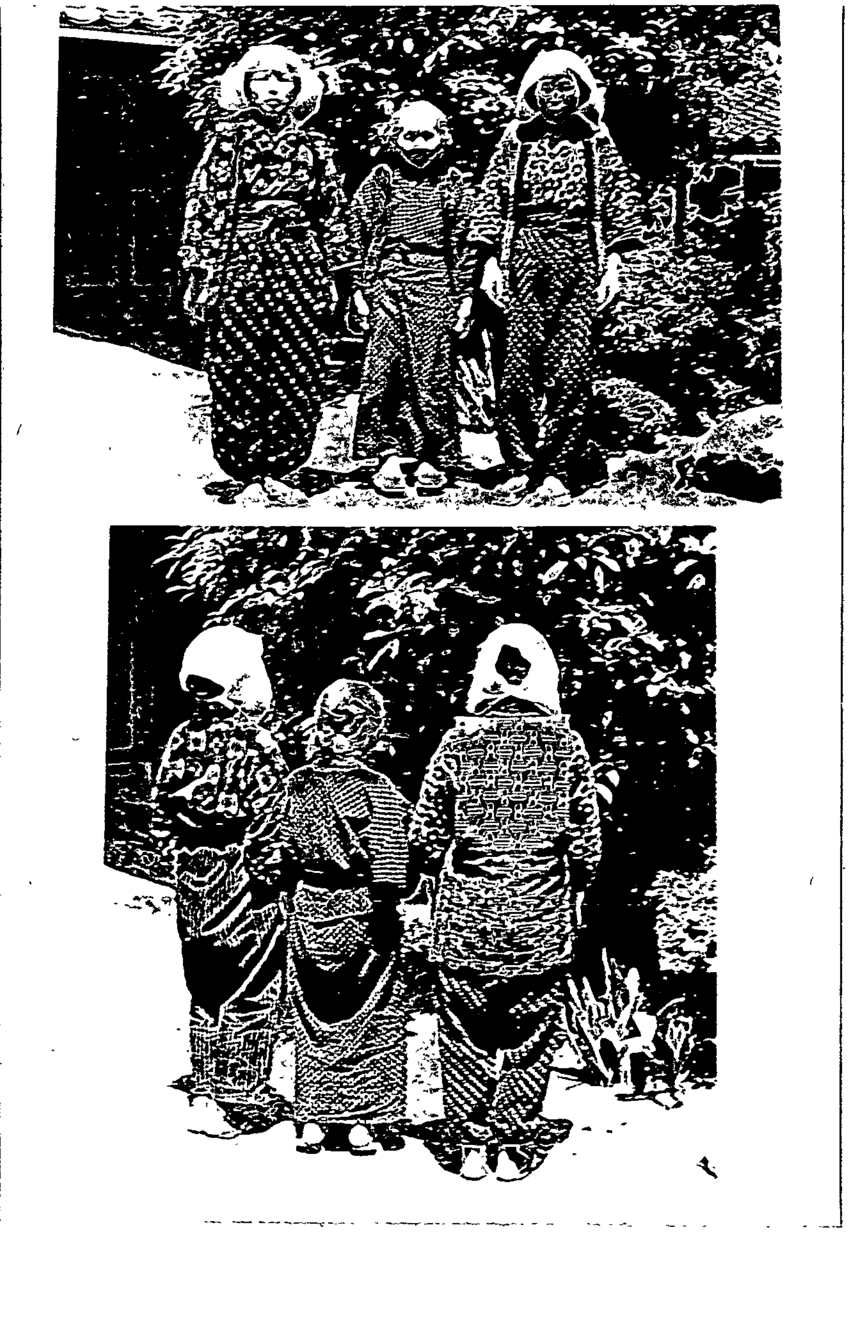


Fig 6.12

Dye Plants of Japan

(Most important natural dyes used by old time colourists)

Japanese	Botanical name	Parts used	Shades name obtained
Ai	Polygonum Tinctorium	Stalk & leaves	Blue & indigo
Yamamamo	Myrica Rubra	Rind & leaves	Yellowish-brown khaki
Jurumi	Juglans Sieboldiana	Bark & leaves	Yellowish-brown kahaki
Kuri	Castanea Crenata	Bark	Greyish-Brown khaki
Kiwada	Phellodendron Amurense	Rind	Khaki
Sharimbai	Raphiolepis Umbellata	Rind	Brown
Binroji	Areca Catechu	Fruit	Greyish-black
Suwo	Caesalpinia Sapan	Heart-wood	Red-purple
Benibana	Carthamus Tinctorius	Flower	Red
Murasaki	Lithospermum Officinale	Root	Purple
Akane	Rubia Cordifolia	Root	Red
Kuru	Diosorea Rhipogoniodes	Root	Red-brown
Kariyasu	Miscanthus Tinctorius	Stalk & leaves	Yellow
Kobunagusa	Arthraxon Ciliaris	Stalk & leaves	Yellow
Asenyaku	Acacia Catechu	Bark	Brown
Madami	Machilus Thunbergii	Bark	Brown
Shii	Pasaniopsis Sieboldii	Bark	Greyish-brown khaki
Hannoki	Alnus Japonica	Bark	Greyish-brown khaki
Yashabushi	Alnus Firma	Nut	Khaki brown
Hazenoki	Rhus Succedanea	Bark	Greyish-brown khaki
Tangara	Bruguiera Gymnorrhiza	Bark	Brown

Table 6.1

snake bites while they worked in the paddy fields[190,191]. Indigo dyeing was exlusively carried out by men, and the earthernware dyepots were sunk in the floor and kept at the correct temperature in the cold season by charcoal fires[192].

6.4.3 Loom Types

When the dyeing process was complete the yarn was arranged on the loom in preparation for weaving by the women. The type of loom used initially was a backstrap and the weaver crouching, inched her way forward. This procedure was a method used by the Ainu tribe of Japan.

Subsequently, two types of horizontal loom came into use.

i. The 'jibata' or backstrap 'low loom' whereby the warp yarn was attached to the warp beam and stretched with a belt around the weaver's body, (see Fig 6.13a), involved the shed being opened with a single foot operated harness[193,194] as shown in Fig 6.13b. This loom is also known as 'Izaribata' or Fusebata'.

ii. The 'takahata' or 'high loom', the most recent type of traditional loom. It has a raised seat similar to carpet looms used in the Near East and China, and was operated by a number of shafts[195] (see Fig 6.14).

The 'jibata' was used primarily for weaving plain bast-fibre and silk fabrics and is still utilised today in Echigo, Etchu, Noto and Omi, Hachijojima, Yuki and Okinawa. The 'takahata' was employed more to weave figured fabrics of cotton and silk[196].

Jibata or Backstrap 'Low Loom'

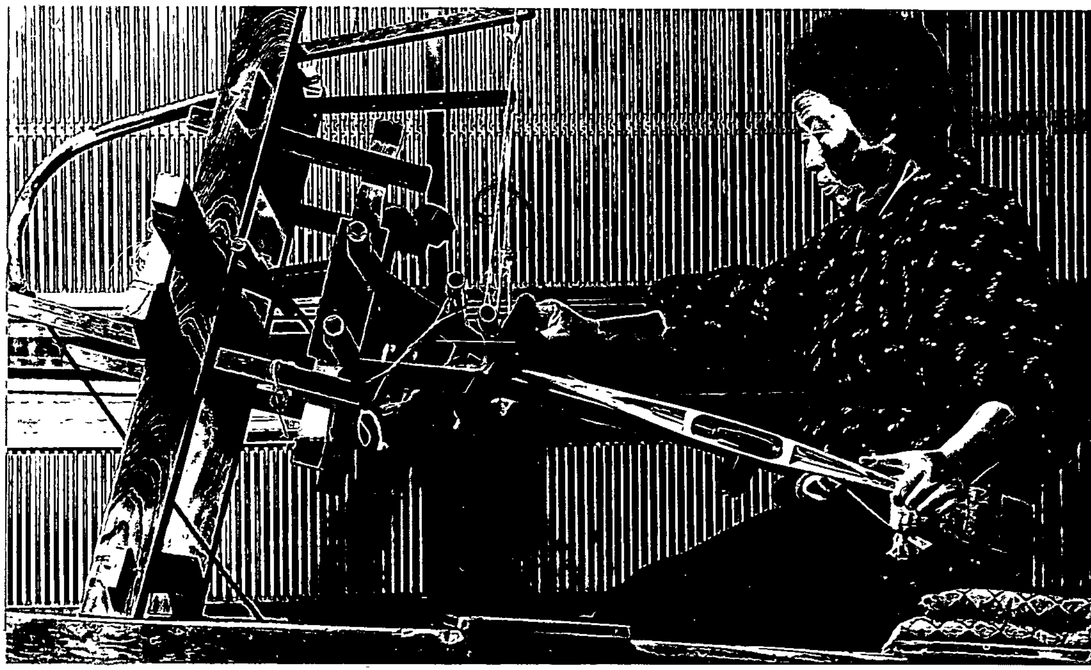


Fig 6.13a

Jibata Shedding System

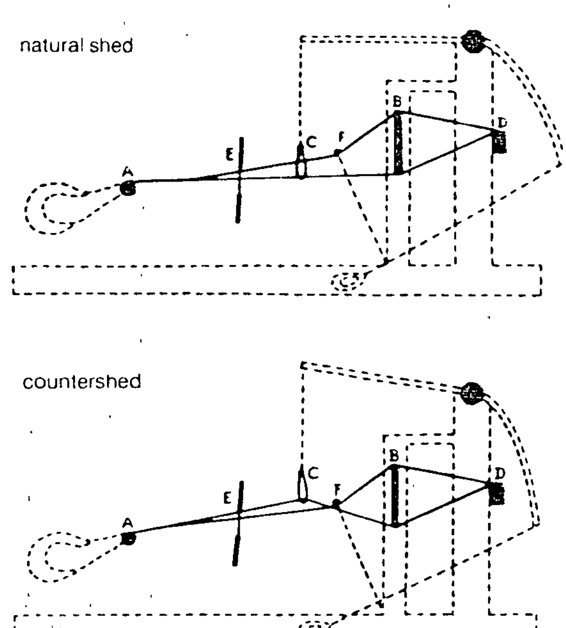


Fig 6.13b

Takahata or 'High Loom'

Fig 6.14

6.4.4 Constructions

The primary construction of kasuri cotton and silk fabrics was plain weave, which not only required the most elementary shedding procedure, but also assured tight interlacing of the warp and weft giving strength and durability to the subsequent garments. Additionally plain weave assisted the visual effect of the kasuri patterning. Silk kasuri fabrics were often woven with many different types of construction, but they were all based upon modifications or combinations of plain weave and occasionally twill and satin.

Traditional Japanese fabric has always been woven to the standard width which measures approximately 33 cm[197]. This standard applies to all types of woven fabrics, and is known in Japan as one Shaku.

6.5 End Uses

There were many uses for kasuri fabric, but two main functions predominated. Firstly, as already mentioned, kon-gasuri formed a large proportion of the farmers and workers wardrobe. Secondly, many widths of kon-gasuri were sewn together at the selvedges to form a large piece of fabric. These were mainly made into futon covers, being a highly prized part of every bride's trousseau[198]. Furthermore, silk kasuri fabric was woven specifically for kimonos and it is still made for that purpose today but more often, however, by machine.

6.6 Geographical Distribution

6.6.1 Kasuri Manufacturing Centres

As mentioned in the introduction to this chapter the knowledge of the kasuri technique spread to all parts of Japan. Various regions and towns became centres for certain types of kasuri fabrics and in some places this tradition has carried on to the present day. Outlined below are the most important kasuri producing centres of the past and the present.

6.6.2 Ryukyu Islands

Miyako

Situated in the southerly part of the Ryukyu Archipelago, Miyako is known for its fine quality hemp fabrics 'Miyako-jofu' (see Fig 6.15). This type of kasuri patterning is of a delicate subtle nature which is achieved by the Orijime technique. The colours of Miyako-jofu are mainly indigos and greens although browns and yellows are sometimes incorporated. In addition, Miyako is known for its plain striped hempen fabrics of which some comprise narrow widths of tegukuri-gasuri within the same structure[199,200].

Okinawa

To the north of Miyako lies the island of Okinawa famous for its long history of kasuri production. Ramie, hemp and banana fibres comprised the main yarns used for weaving in the past, with cotton and silk used to a lesser extent. Okinawan designs are predominantly geometric and the method

Ryukyu Islands

Miyako Jofu

Fig 6.15

Okinawa Kon-Gasuri

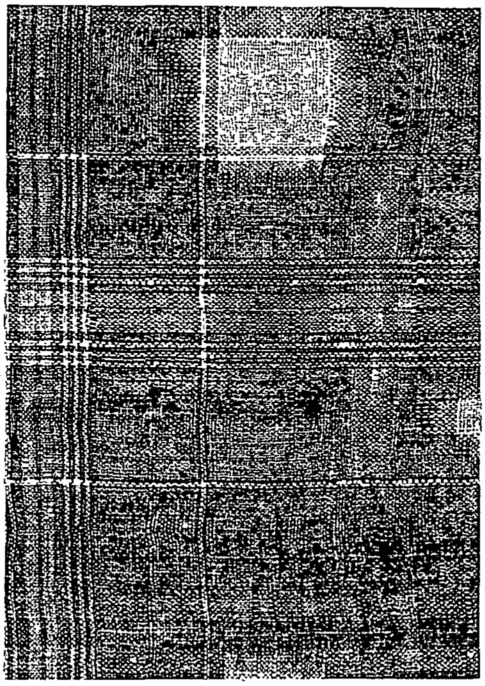


Fig 6.16

Okinawa Basho-Fu

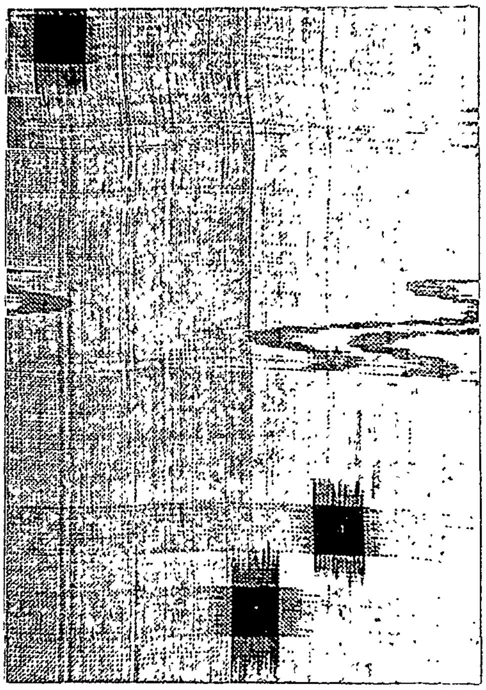


Fig 6.17

Amami-Oshima Tsumugi

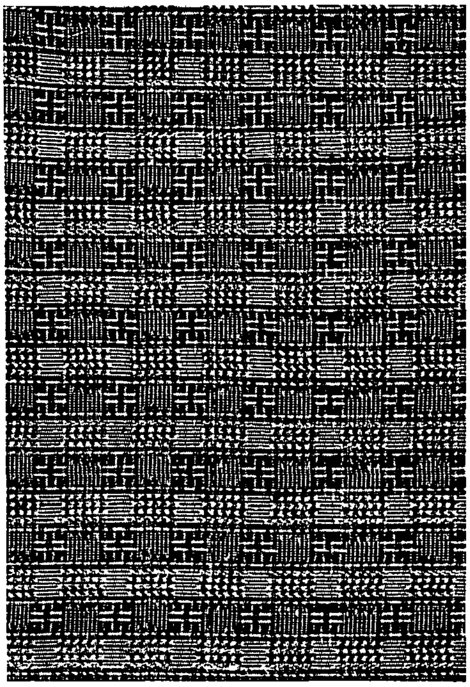


Fig 6.18

used was by the tegukuri-gasuri technique. What differentiates Okinawan fabrics from other kasuri fabrics is the wide variety of bright colours used within one design, which include reds, yellows, browns, blues, greens, greys and black as Fig 6.16 illustrates[201,202]. In addition, Basho-fu, the summerweight fabric made from banana fibre, and indigenous only to Okinawa, comprises design and technique similarities, but can be distinguished apart by its tactile qualities and colour (see Fig 6.17)[203].

Amami-Oshima

This is an island that lies to the north of the Ryukyu Archipelago and is famous for 'Amami-Oshima tsumugi'. This is a luxury fabric and very popular with the upper class Japanese women who use it for springtime kimonos[204]. It is made of a fine quality silk and the kasuri patterning is produced by the Orijime technique, thus giving it a similar overall appearance to the fabrics of Miyako. Amami-Oshima tsumugi designs are small, either geometric or figurative, and repeat continuously across the fabric (see Fig 6.18). In addition, they can be distinguished by their colour, which is either chya (brown)-gasuri or kuro (black)-gasuri with white, blue, gentle red or yellow patterning[205,206]. Usually only the warp threads are pattern dyed, the weft being a plain black. Since Amami-Oshima tsumugi is a luxury fabric it is not made to the standard size of one shaku as previously discussed, but is made 35 cm wide, and a 'tan' or length, may exceed 12 metres.

6.6.3 Japanese Mainland

Kurume

Kurume is situated in the north west of the southernmost Japanese island Kyushu, and has a long standing history of kasuri weaving. In contrast to the areas already described Kurume is known for its cotton kon (blue)-gasuri, the working apparel of the Japanese[207]. The designs are bold and vary in size and most are intense and repeat regularly (see Fig 6.19)[208,209]. Kurume gasuri was produced by the tegukuri technique, but nowadays these patterns are made by machine tying procedures.

In addition to the apparel fabrics, Kurume is famous for its cotton blue and white e-gasuri (picture kasuri) which is woven in standard widths and sewn together to form futon covers as illustrated in Fig 6.20. The designs are either wholly figurative or part figurative, part geometric. Some kon-gasuri geometric patterns are produced by the Itajime technique.

Iyo

Iyo is situated on the west coast of Shikoku, the island that lies between Kyushu and Honshu. Iyo gasuri is of a very similar type to kurume gasuri and sometimes it is difficult to differentiate between them. The designs of Iyo fabrics are either geometric or figurative or a combination of the two. It can be seen in Fig 6.21 that

Kurume Kon-Gasuri

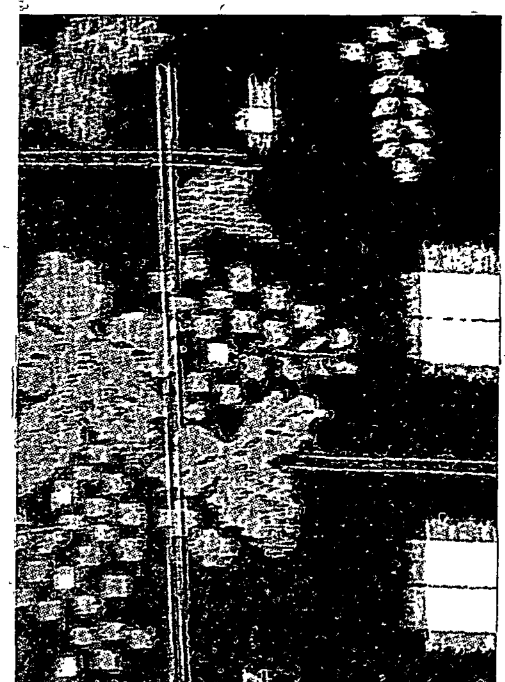


Fig 6.19

Kurume E-Gasuri

Fig 6.20

Iyo Kon-Gasuri

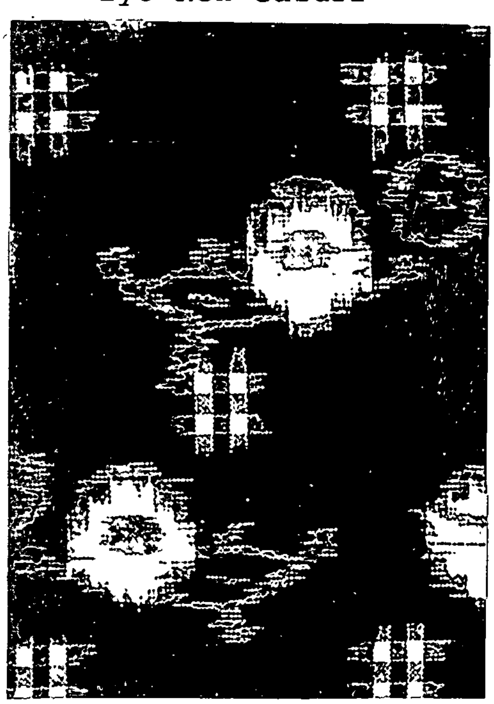


Fig 6.21

Hirose/Kurayoshi E-Gasuri

Fig 6.22

the repeats of some Iyo designs are more openly spaced than those of Kurume. In addition, soft bright colours sometimes highlight small areas within the repeat such as pinks and yellows[210].

Hirose/Kurayoshi

Hirose and Kurayoshi are towns situated in the northern part of Southwest Honshu. During the middle of the 19th century kasuri weaving became famous in these areas producing cotton or hemp kon-gasuri fabrics by the Tegukuri-gasuri technique[211]. To a large extent Hirose and Kurayoshi fabrics were utilised as futon covers. In general, the design motifs can be seen to be more openly spaced than the kurume kon-gasuri, and often the e-gasuri patterning is linear instead of solid as Fig 6.22 illustrates. Additionally, narrow plain coloured brown or pale yellow stripes are included both in the warp and the weft.

Yamoto Province, Nara

The province of Yamoto is situated in the central part of western Honshu. It is a region known for its production of cotton or hemp shira (white)-gasuri, the coloured geometric patterns repeating regularly on the white or natural coloured ground[212] (see Fig 6.23). This type of kasuri is similar in appearance to that of Echigo and is comparatively rare. The kasuri patterning of Yamoto is either black or brown and is achieved by the Tegukuri-

Yamoto Province
Shira-Gasuri

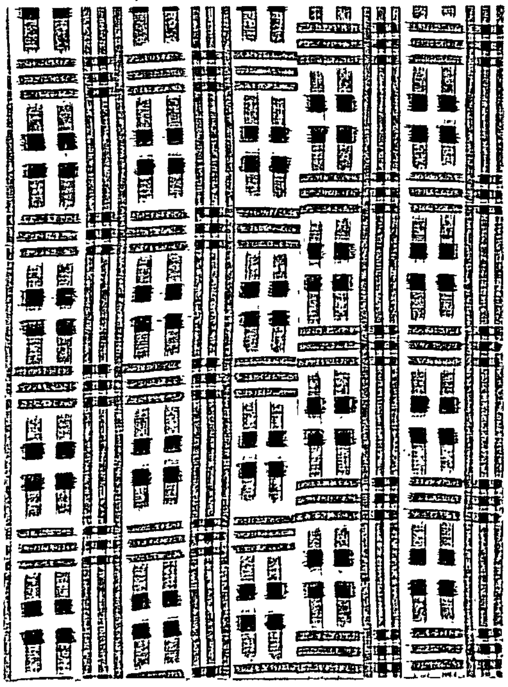


Fig 6.23

Omi
Omi-Jofu

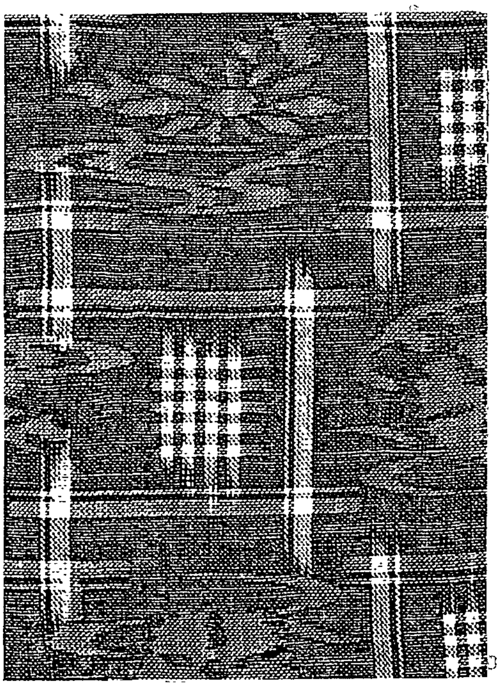


Fig 6.24

Noto Peninsula
Noto-Jofu

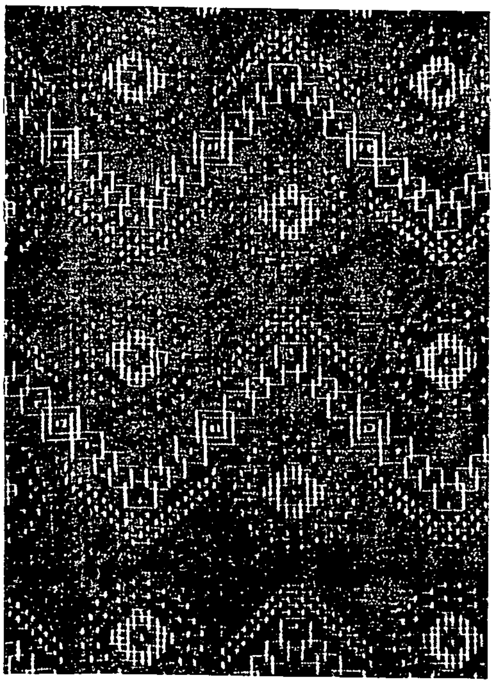


Fig 6.25

Ojiya
Ojiya-Gasuri(or Echigo-Jofu)

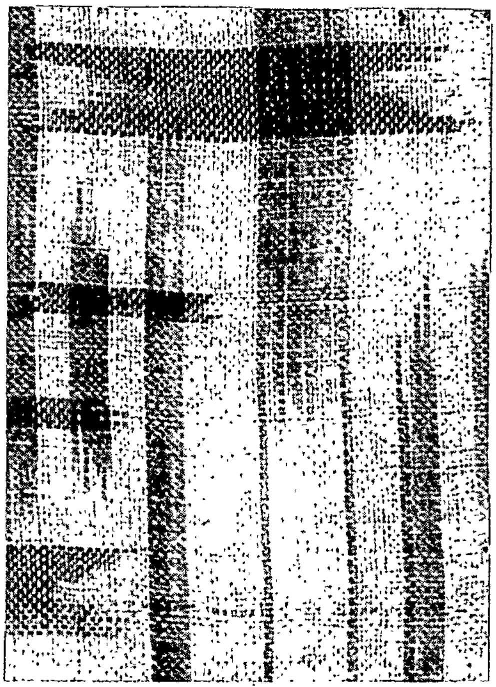


Fig 6.26

gasuri technique.

Omi

Omi is a small town situated close to the eastern shores of Japan's largest lake, Lake Biwa in central Honshu. The fabric from this town and the surrounding districts is referred to as Omi-jofu which describes a fine quality hempen textile, a popular summerweight fabric for women's kimonos which can be seen in Fig 6.24[213]. Additionally, it represents a further example of kon-gasuri. In this case, however, the design motifs vary from very small to medium sized and are intensely decorative[214]. They are either geometric, or figurative, or a mixture of both. A characteristic design feature of Omi-jofu is the small warp and weft stripes superimposed upon one another to form a grid which is repeated regularly to add to the intensity of the pattern[215]. A further distinction of Omi-jofu is the subtlety of the indigo blue ground which is far softer in tone than Kurume or Iyo gasuri.

The production of Omi-jofu declined at the beginning of the century and today is an art no longer practised. The method by which it was produced was the Itajime technique[216].

Noto

The Noto peninsula juts northwards into the Japan sea from central Honshu, and is the home of a hempen kasuri fabric known as Noto-jofu. It is favoured by the older generation as a summerweight fabric as the characteristic designs are very small with white or natural coloured patterning[217]. Noto-jofu continues to be made today.

Ojiya gasuri or Echigo-jofu

The town of Ojiya is situated in the old Echigo province, the present Niigata prefecture in the northeast of Honshu. It is here that rare shira (white)-gasuri was made, a fabric comparable to that from the Yamoto province, Nara. It can be seen in Fig 6.26 that Echigo-jofu is made from hemp and incorporates small kasuri designs of pale indigo or pale vermillion on the white ground[218]. The motifs themselves comprise simple geometrics such as arrow heads which repeat continuously. A particular finishing process known as 'chijimi' is sometimes given to kasuri fabrics from Ojiya. The fabric is woven with heavily twisted yarn after which it is placed in very hot water and trampled upon. This procedure gives a wrinkled appearance to the finished article[219].

Yonezawa

Yonezawa is a small town in the locality of Nagai, in the Yamagata prefecture, northern Honshu, known for its silk and rayon fabrics[220]. Kasuri weaving in this region dates back to the beginning of the 19th century when Yozan Uesugi, the local landowner, took interest in the craft and aided its development[221]. The kasuri fabric from this area is silk and known as Yonezawa-ryukyu-tsumugi. It is thought that perhaps there was originally some connection between Yonezawa fabrics and those of the Ryukyu islands as the kasuri crafts of the Ryukyus and Japan are seldom interrelated[222].

The patterning of Yonezawa fabrics is reserved in white (natural) upon a dark indigo ground and is achieved by the Orijime technique (see Fig 6.27). In most cases the design motifs are very small in type and both warp and weft yarns are resist dyed. It is thus a favoured fabric with the older generation.

Yuki

Yuki is a small town situated in the Tochigi prefecture approximately 25 miles north of Tokyo. The surrounding area including the local towns of Ashikaga, Kiryi, Isezaki and Maebashi, Gumma prefecture, are all known for silk weaving which is a flourishing industry today and has a history dating back to the 8th century[223].

The kasuri fabric of Yuki is known as Yuki-tsumugi and it is made from locally grown silk. As the method of production is accomplished by the Orijime technique the overall effect of the finished fabric is very similar to Miyako and Amami-Oshima tsumugi from the Ryukyu islands. The designs vary from bold motifs to tiny speckles of either geometric or figurative character as Fig 6.28 shows. Often Yuki-tsumugi contains many colours which include red, yellow, green, blue and natural sometimes all incorporated on a dark indigo ground. Yuki fabric can be identified

Yonezawa

Yonezawa-Ryukyu-Tsumugi

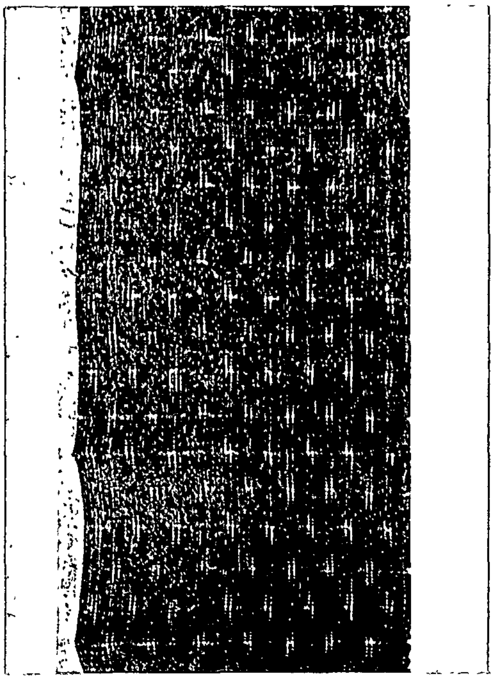


Fig 6.27

Yuki

Yuki-Tsumugi

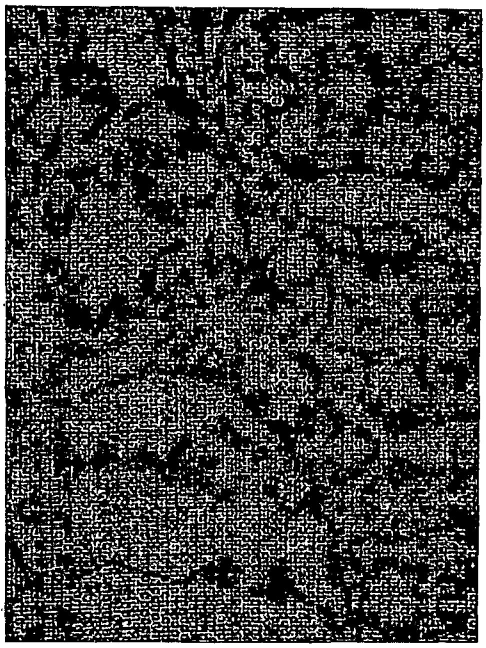


Fig 6.28

simply by the complexity of design combined with great subtlety of colour, and like the tsumugi fabric of the Ryukyus it is one of the most expensive textiles of Japan[224,225].

6.7 Design Imagery

6.7.1 Size

The use of decorative motifs on kasuri fabrics was of great importance to the Japanese and formed an integral part of the textile as a whole. Hundreds of different designs existed both in the Ryukyu Islands and Japan, and the size of the design itself was an identifying feature. Large patterns were known as 'o-gasuri' (o = large), while small patterns were known as 'ko-gasuri' (k = small)[226]. As noted previously, it was customary for the older generation to wear fabrics with the small patterns.

6.7.2 Motifs

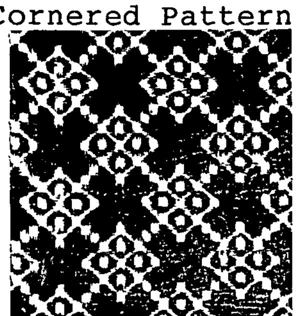
Kasuri motifs in general can be classified into four main groups namely geometric, figurative, floral and zoological. The most common, being the easiest to achieve, is the geometric group. Tables 6.2 - 6.5 illustrate some of the most representative motifs belonging to each group.

Table 6.2 identifies the geometric group, most of which are compositions of straight lines. The pattern direction of most geometric imagery is either warpways or warp and weftways (double).

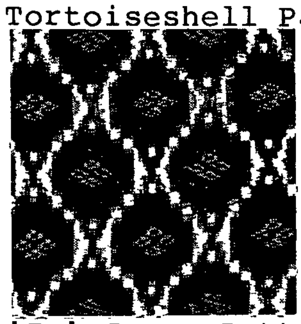
Table 6.3 illustrates the figurative group of motifs which

Geometric Pattern Group

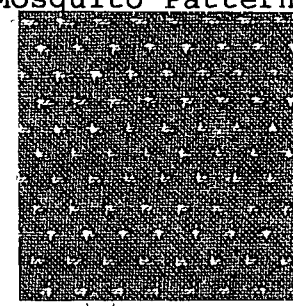
Four Cornered Pattern



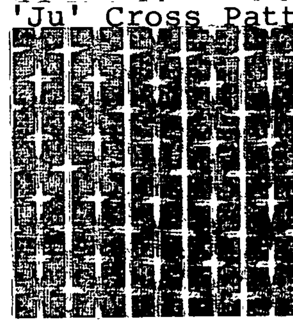
Tortoiseshell Pattern



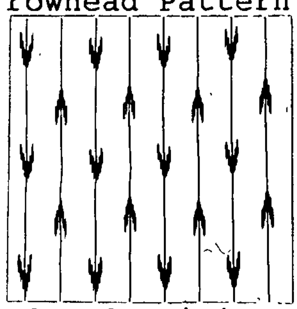
Mosquito Pattern



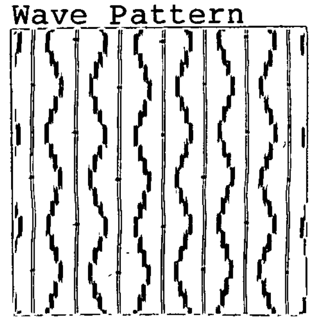
'Ju' Cross Pattern



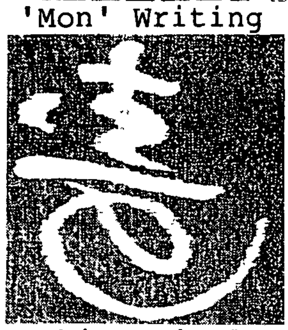
Arrowhead Pattern



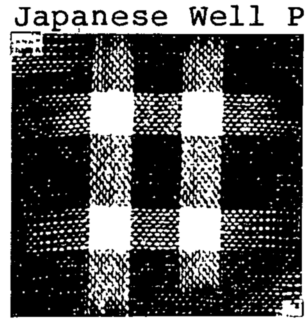
Wave Pattern



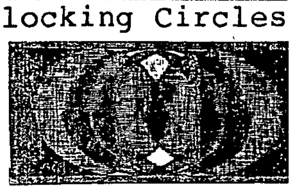
'Mon' Writing



Japanese Well Pattern



Interlocking Circles



3 Comma Motif

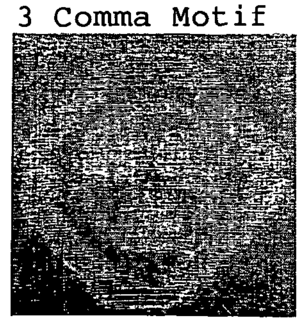
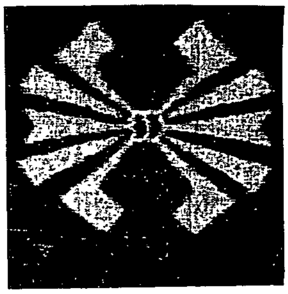


Table 6.2

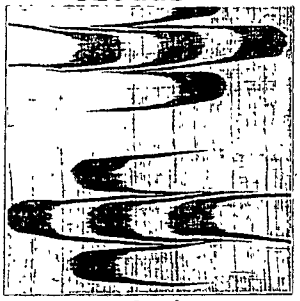
Figurative Pattern Group

Noshi

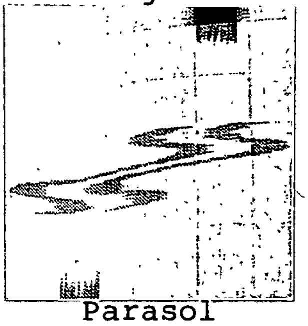


Chinese Character

Clouds

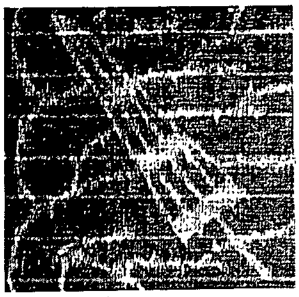


Flowing Water



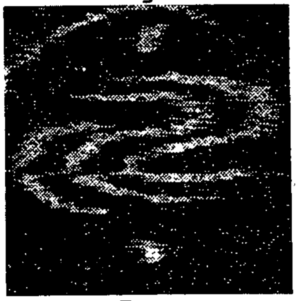
Trellis

Parasol



Flowing Water

Flowing Water



Hand Drum

Bag

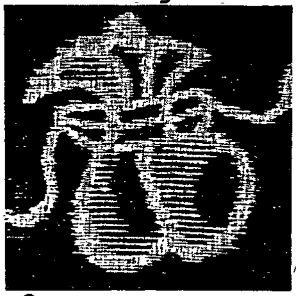
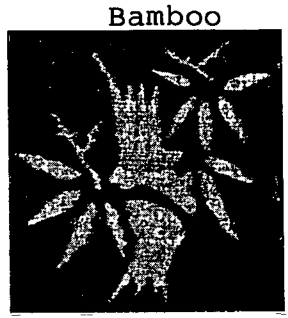


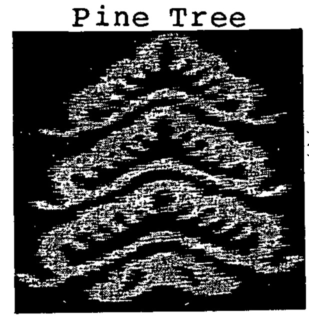
Table 6.3

Floral Pattern Group

Bamboo



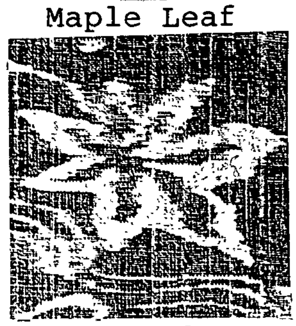
Pine Tree



Chrysanthemum

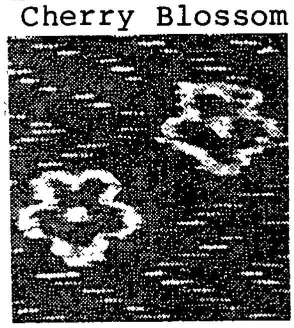
Quince & Chinese Flower

Maple Leaf

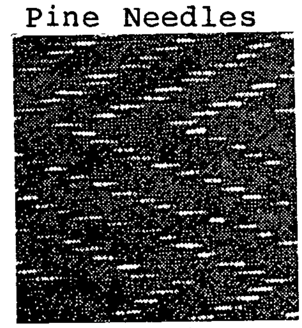


Gentian

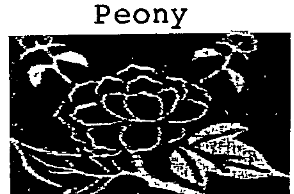
Cherry Blossom



Pine Needles



Peony



Pawlonia

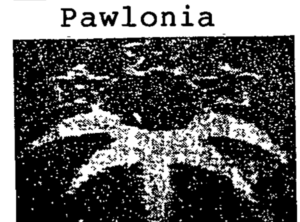
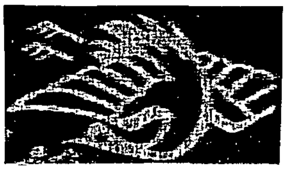


Table 6.4

Zoological Pattern Group

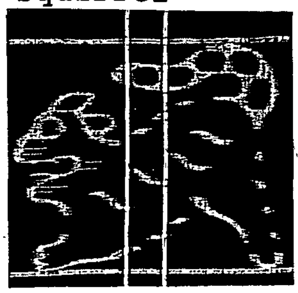
Crane



Butterfly

Eagle

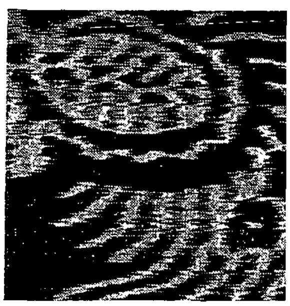
Squirrel



Tiger

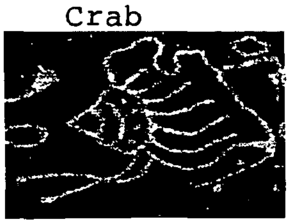
Lion

Tortoise



Fish

Crab



Shell

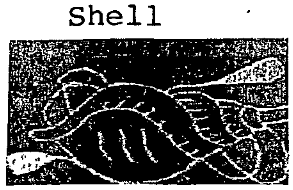


Table 6.5

either represent items from every day life or mythological characters from Chinese legend. In most cases figurative imagery is created in the weft only.

Table 6.4 represents the floral group. Most floral imagery comprises specific plants presented in a stylised form. The pattern lies generally in the weft only.

Finally, Table 6.5 identifies the zoological pattern group. In most cases the imagery is representative of everyday life and some animals have become highly stylised, for example the lion (from Chinese legend), the crane and the tortoise. Again the patterning is in the weft only.

6.7.3 Symbols

In all the pattern groups certain motifs have important symbolic meanings, and when they appear upon fabrics such as those included in a bride's trousseau it is for a specific purpose. For example, a crane and a tortoise, two of the most commonly combined motifs, become a longevity symbol as it was thought that the crane lived 1,000 years and the tortoise 10,000 years[227]. For this purpose Table 6.6 briefly outlines the symbolic meanings of some of the more common motifs.

A characteristic feature of any kasuri fabrics is the combination of geometric and figurative designs on one fabric. This combination is used generally upon large expanses of fabric which can incorporate bolder designs. Most blue and white cotton futon covers are thus decorated, as well as some silk apparel fabrics.

Symbolic Meanings of Common Design Motifs

Type	Symbolic representation
Animal	
Crane	Longevity
Tortoise	Longevity
Eagles and birds of prey	Power
Tiger	Power. Symbol for 3rd year of the oriental zodiac. Chinese influence.
Lion	Guardian of sacred rights and protector against evil influence.
Carp (Kao)	Strength and success.
Floral	
Peony	Emblem of summer
Evergreen pine	Longevity
Bamboo	Moral uprightness and security.
Plum blossom	Harmony
Other	
Cross (Jin)	Longevity
Water motifs: waves, waterfalls falling water	Refreshing and enriching power, fluid motion.
Combined Motifs	
Lion and Peony	Survival of the most deserving.
Evergreen pine, bamboo and plum blossom	Happiness and good fortune.
Crane and tortoise	Longevity

Table 6.6

6.7.4 Geometric Motifs

For the smaller geometric and floral motifs other decorative shapes are formed to create different patterns of a geometric nature. For example, small floral motifs are positioned together to form a lozenge shape[228]. Further decorative shapes include squares, hexagonal or octagonal outlines which together form repeating grids, circles and stripes which can be closely related to Persian ornamentation[229].

6.7.5 Non-Religious Images

A further observation of kasuri patterning is the lack of religious influence in its creation. As already outlined in the preceding chapters in some cases the connection between design imagery and religion is very strong. In Japan, however, this is not the case, although it is possible that at some stage the Shinto and Buddhist cults have indeed contributed subtleties to the appearance of Japanese kasuri designs.

To complete this chapter it was felt necessary to include Table 6.7 which summarises the foregoing identification of the Japanese methods of Ikat production including location, technique, fibre, colouration and design.

Identification of Methods of Ikat Production in Japan

Ryukyu Islands

Island	Town or Locality	Local Name	Technique	Fibre	Colour
Miyako		Miyako-Jofu	Orijime	Hemp	Indigo/green
Okinawa		Ichiri Basho-fu	Tegukuri Surikomi	Ramie, Hemp Banana	Blue + white Indigo + colours
Amami-Oshima		Amami-Oshima Tsumugi	Orijime	Silk	Brown + white Black + white

Table 6.7a

Identification of Methods of Ikat Production in Japan

Japan Mainland

Island	Town or Locality	Local Name	Technique	Fibre	Colour
Kyushu	Kurume	Kurume-gasuri	Tegukuri+ Itajime	Cotton	Blue + white
Shikoku	Iyo	Iyo-gasuri	Tegukuri	Cotton	Blue + white
Honshu	Hirose Kurayoshi	Hirose-gasuri Kurayoshi-gasuri	Tegukuri	Cotton	Blue + white
Honshu	Yamato Province, Nara		Tegukuri	Cotton	Blue + white
Honshu	Omi	Omi-jofu	Itajime	Hemp	Blue + white
Honshu	Noto	Noto-jofu	Tegukuri + Itajime	Hemp	Black + white
Honshu	Ojiya, Echigo Province	Ojiya-gasuri Echigo-jofu	Tegukuri	Hemp	White + Blue White + red
Honshu	Yonezawa	Yonezawa Ryukyu Tsumugi	Orijime	Silk	Indigo + white
Honshu	Yuki	Yuki-Tsumugi	Orijime	Silk	Indigo + colours

Table 6.7b

CHAPTER 7 DISCUSSION OF CLASSIFICATION OF IKAT FABRICS

7.1 Introduction

From the findings discussed in the preceding chapters, the necessity arose to view the resulting facts in a simplified and condensed form. The following Tables 7.1 - 7.6 were therefore developed to represent these findings, and indicate the similarities and differences of the production of Ikat fabrics in the particular geographical regions discussed.

7.2 Classification

7.2.1 The Principles Used

The principle criteria have been classified by sequence of development, under geographical denomination.

Table 7.1 identifies the relevant Ikat producing tribe, their terminology for the technique, and their religion.

Table 7.2 indicates the types of yarn employed, their preparation and weaving.

Table 7.3 outlines the manufacturing procedure and idiosyncratic customs that persist.

Table 7.4 illustrates the types of warping, resist tying and weaving apparatus employed.

Table 7.5 illustrates general design and colour differences.

In addition to the identification of the principle criteria, Table 7.6 lists further general groupings of

Classification of the Tribe, the Religion and the Local Terminology for the Technique

Geographical location	South America	Southern Russia	Indonesia		Japan
Name of tribe or community	Mapuche	Uzbeks	Local Balinese	Bali Aga	Local Ryukyuians & Japanese
Religion and /or religious influences	Shamanism	Originally Shamanism but converted to Islam	Hindu	Type of Hinduism Animism & Pre-Hindu	Shinto Buddhist
Local term for the Ikat process	"Trarican" "Trarin" = to tie, bind	"Abr" = cloud	"Endek" = short dwarf?	Unknown	Okinawa = "Ichiri" Japan = "Kasuri" = in passing touch lightly

Table 7.1

Classification of the Types of Yarn Used, Their Preparation and Their Weaving

Geographical Location	South America	Southern Russia	Indonesia		Japan
Yarn Spun Filament	Sheep's Wool	Cotton silk	Mainly silk but cotton also	Cotton	Cotton, silk ramie banana fibre hemp orchid fibre silk
Yarn prepared for tying by	Women	Men	Women	Women	Women
Yarn dyed by	Women	Men	Women	Women	Men only
Yarn warped & woven by	Women	Men	Women	Women	Women
Use of resulting fabrics	Ponchos Blankets	Garments Hangings Scraps used for patchworks	Sarongs Breast wrappers Temple decorations	Ceremonial uses Sarongs	Working garments Futon covers Kimonos
Made up by	Women	Women	Women	Women	Women

Table 7.2

Classification of the Manufacturing Process and Idiosyncratic Customs

Geographical location	South America	Southern Russia	Indonesia		Japan
Direction of Ikat patterning	Warpways	Warpways	Weftways	Warp & weftways	Warpways Weftways Warp & weft ways
Construction of fabric	Warp repp	Plain weave Warp repp Satin Warp velvet	Plain weave	Plain weave	Plain weave Satin Twill
Percent of irregularity of image profile	None	Some to none	None	None	Low to none
Use of religious custom during manufacture	None	None	Some	A lot	Some
Design imagery	Geometric	Geometric Anthropomorphic Zoomorphic	Geometric Figurative Floral	Geometric Figurative Floral	Geometric Figurative Floral Zoological
Order of colouring yarn	Dark to light	Light to dark (overdyeing used)	Dark to light (overdyeing used)	Dark to light (overdyeing used)	Dark to light
Shape of finished fabric	Rectangle	Narrow strips	Tubular or rectangle or length	Tubular rectangle	Narrow strip

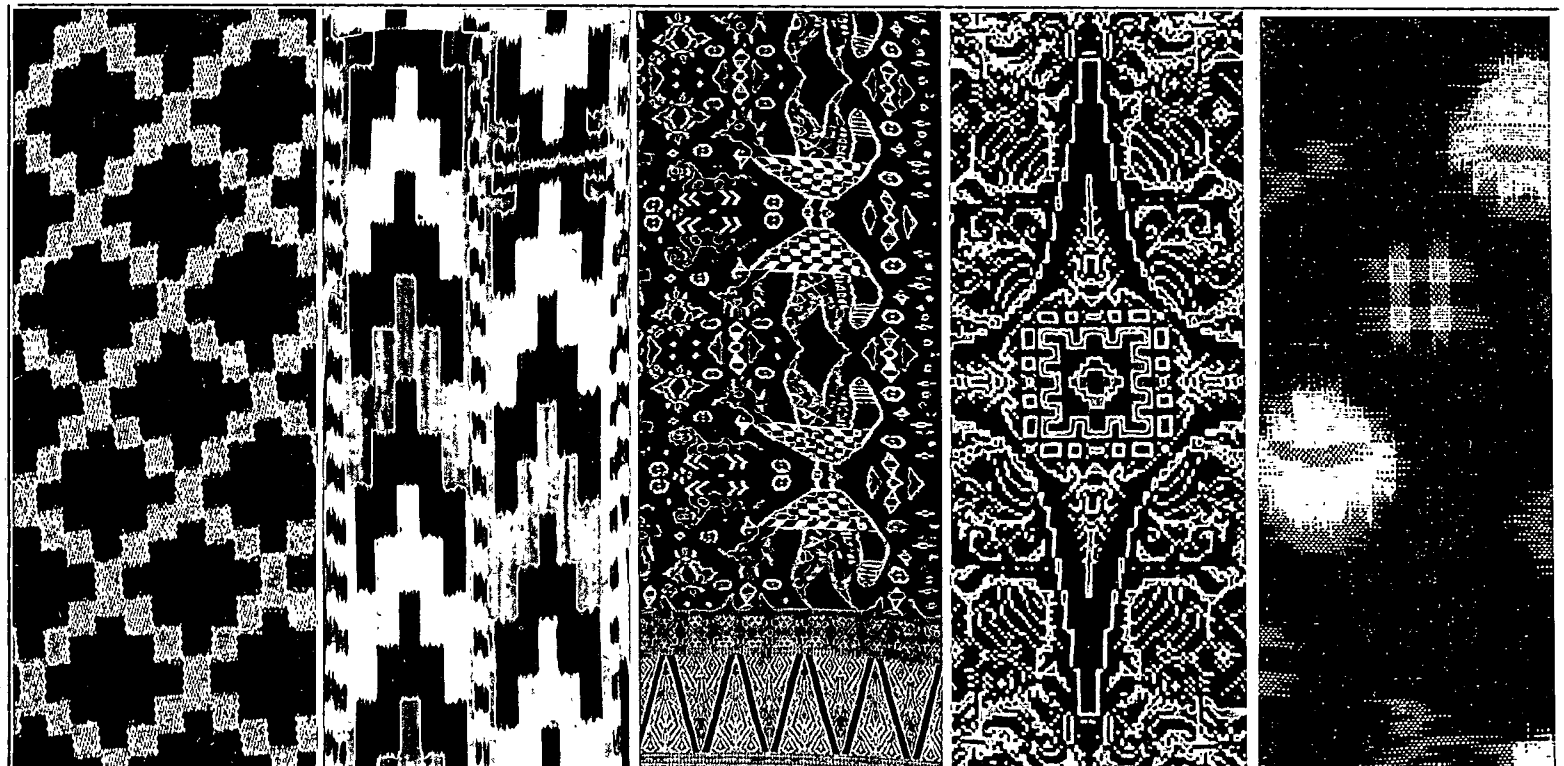
Table 7.3

Classification of Warping, Resist Tying and Weaving Apparatus

Geographical Location	South America	Southern Russia	Indonesia		Japan
			Weft Ikat	Gringsing	
Warping frame or apparatus	Poles placed vertically in ground	Poles positioned horizontally on a raised surface	Vertical pegs placed in ground	Vertical pegs placed in ground	Board
Resist tying frame (if different from above)	"	"	Suspended rotating frame	Upright poles on stand	Board clamps
Loom type	Freestanding upright	Freestanding upright	Backstrap	Backstrap	Backstrap Freestanding upright

Table 7.4

Typical Ikat Examples Indicating General Design and Colour Differences That Distinguish Each Regional Group Apart



Araucanian	Uzbek	Local Balinese	Bali-Aga	Local Japanese

Table 7.5

General Groupings of the Similarities and Differences of Ikat Manufacture

Similarities	Differences
Religion and Layout. For example Shamanistic believing areas similar design layout.	Colour. Use of colour combinations.
Precision of Image Profile. Important to preserve perfect alignment of pattern in most cases.	Design Motifs. Particular use of certain design motifs.
Geometric Motifs. General use of design motifs mostly based on a square.	Fibre.
Social Status of Weaver. Fabrics manufactured by native or local communities. Not an upperclass persuit.	Construction. Satin and velvets.
Constructions. Predominantly plain weave.	Use. End use of finished fabric.
Weight of Fabrics. Majority of cotton and silk fabrics of a light weight even those used in severely cold climates.	Finishing. Sometimes finishing procedures given moiré, chijimi.
Looms. Mainly backstrap in type.	Dyeing. Varying dyeing procedures.
Sexual Dicotomy. Generally work was carried out by women.	Looms. Varying details to facilitate certain aspects of manufacture.
Pattern Preparation. In all cases predetermined design preparation.	Warping and Resist Tying. Varying warping and resist tying procedures according to country.
	Religion. Use of religious practices during manufacture.
	Skill of Weaver. Variation with different qualities of yarn and resulting fabric.
	Time Scale. Some fabrics take 7 years to produce.

Table 7.6

similarities and differences that have become evident from the historical analysis.

7.2.2 Common Factors

Thorough examination of these tables revealed five common factors some of which were considered of importance as a basis of new work.

These are:

i. the use of three main fibres, wool; cotton and silk;

ii. the preparation, dyeing and weaving of the yarn was generally a woman's task;

iii. plain weave was the main construction favoured, with the additional use of its derivative warp repp;

iv. very little irregularity within the image profile was permitted in most areas; and

v. geometric designs featured more strongly than figurative.

7.2.3 Fibres

All these criteria may be explained simply. The types of yarns employed for traditional Ikat weaving entirely depended upon availability of fibre which was relative to the climatical and geographical location and conditions of the particular area. The world map illustrated in Fig 7.1 defines the type of fibre common to the particular Ikat producing countries and regions identified.

For example in Southern Chile, the area inhabited by the Araucanian Indians, warp Ikat fabric was woven from the

World Distribution of Fibre Common to Particular

Ikat Producing Countries

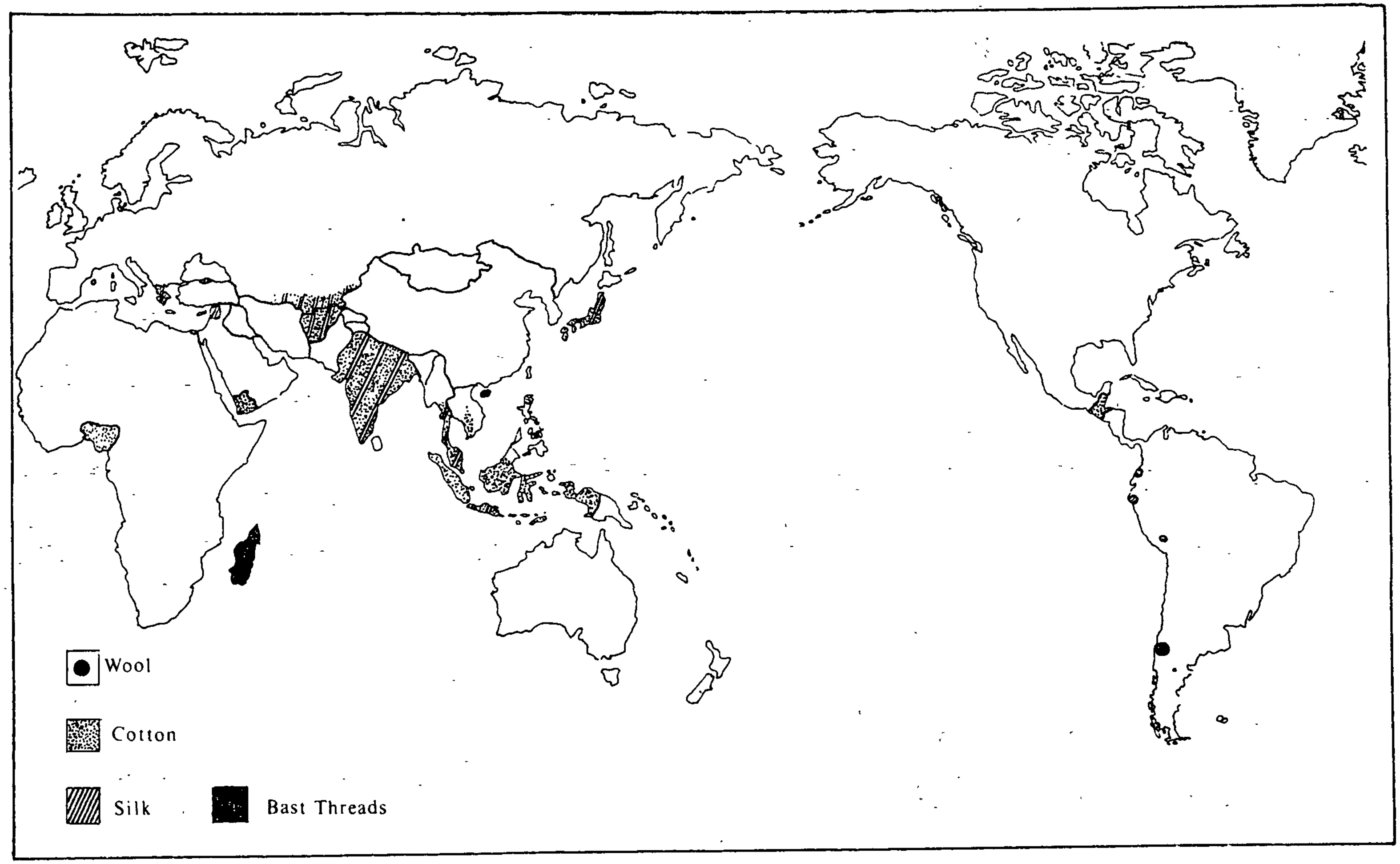


Fig 7.1

wool of the sheep that they raised. As described, this fabric constituted a dense repp construction "shedding water like a roof", an important factor when excessive rainfalls and intense cold dominated the winter months. Silk and cotton fibre on the other hand could not be cultivated locally, thus cotton fabric was imported ready made and used for clothing. It may be observed that the distribution of the use of cotton fibre was widespread particularly in the east where the climate necessitated a cool, lightweight fabric. Some cotton yarn was imported, for example into Indonesia, and some was cultivated locally, for example in India and Japan. Cotton fibre has in many instances become an alternative fibre to silk being readily available and inexpensive in comparison. Being a fine yarn and manageable it lends itself well to the Ikat technique and provides the necessary requirements as far as durability and weight are concerned.

Although the use of cotton is widespread it can be seen from Fig 7.1 that silk is additionally a well utilized fibre for Ikat manufacture. The Ikat technique itself is complicated and time consuming, therefore expensive in man hours and skill. Thus it lends itself best of all to the most expensive and finest fibre, silk. As a result of these factors the finished product is most prized by the affluent such as in Turkestan, and sought after for religious ceremonies such as in Indonesia.

Although there were plentiful supplies of wool from the local sheep, the Ikats from Turkestan were almost entirely made of silk. Firstly to meet the demand made by the wealthy citizens of Bokhara and the like for rare and fine fabrics, and secondly because Turkestan was situated on the silk routes from China from whence came a continual supply. There is however one exception to this, that being the Gringsing fabrics of Bali in Indonesia. Probably the most sacred of all Ikat fabrics Gringsing have always been made of cotton, a particular home cultivated and homespun variety. It is said that homespun cotton was reserved exclusively for special weaving, to be used for sacred or ceremonial purposes[230].

7.2.4 The Woman's Role

As regards the woman's role it may be noted that in most underdeveloped tribes or communities there was a natural sexual dicotomy concerning labour. As the man's role in the community was one of protector and worker, incorporating such tasks as heavy manual labour, wood cutting and animal welfare into his routine, it was thus the tradition that in most cases yarn and fabric production were the woman's responsibility. Sometimes, however, the opposite was true. For example, the Ikat production process in Turkestan was carried out by men until the fabric was completed, whereupon it was passed to the women to be made into garments. Additionally, in Japan it was customary for the men to do the indigo dyeing. In both cases it was not only custom, but also commercial necessity that caused male involvement.

7.2.5 Construction

The main reason for plain weave being the most favoured construction was because of its stability. It was necesary primarily that the ikatted yarn should remain stable and constant, and once woven, ensure clear representation of the pattern, as well as provide a fabric which was suitable for everyday use with durability and drape. In addition, it involved only one manoeuvre to construct plain weave on the simple type of loom used by the traditional weavers.

A further point is perhaps that if a warp faced weave were used, such as a satin or twill, more resist dyed yarn would be necessary and the resulting Ikat imagery would reduce in size from its original and intended shape.

7.2.6 Patterning

The use of geometric patterns in preference to figurative and floral designs was because it was simple to devise symbolic representation from a more complicated pattern. Historically it can be noted that a simple geometric symbol acquired meanings beyond its form and was by far easier to reproduce than a figurative equivalent.

7.2.7 Irregularity of Image Profile

Finally, to understand the difference of irregularity of the image profile it is necessary to analyse the customs, methods and skills indigenous to each of the four areas discussed.

The woollen Ikats of South America show very little irregularity of the image profile because it appears that coarser yarn gives a more indistinct image profile owing to its size and fibrous nature. It can be seen, therefore, the Araucanian weaver required less skill to produce Ikat fabrics than did the other Ikat producing tribes or communities, as the production of the fabric was straight forward with so few ends per centimetre and the geometric motif being a simple one to create. Furthermore, Araucanian Ikats were made for personal rather than commercial purposes therefore it did not matter if the image appeared somewhat crude.

Very fine yarns of silk and cotton are used in Turkestan and thus, in comparison, the image profile was more distinct; as it can be observed, the finer the yarn the more definition of the image profile there is. The range of fabrics produced made up three distinct groups. Firstly, the finest fabrics of all, the silk Ikat velvet; highly prized and extremely expensive demanding great precision on the part of the weaver with no irregularity within the image profile at all.

Secondly, the more common everyday and ceremonial fabric worn by the citizens, of silk, or mixed cotton and silk ("mesru"). This type also demanded skill as many colours were used and the patterns were often extremely complicated. However, the image profile of these fabrics was often quite irregular although the overall shape of the image was maintained. The third group consisted of silk, or the mixed cotton and silk fabric; the Ikat being of low grade quality with few colours, not complimenting one another, poor image alignment, and an irregularity of the image profile indicating the skill of the weaver of this group was not very accomplished. The reason for these distinctions of quality was that Ikat fabric was worn by a cross section of the community encompassing the very rich and the very poor.

The Balinese of Indonesia, on the other hand, produced silk and cotton Ikat fabrics; and for religious reasons exercised great care and skill to ensure extreme accuracy of the image profile with none or very little irregularity within it. The way of life demanded that traditional custom be maintained thus skills were handed from generation to generation. Patterns were complicated and often comprised many colours. The Gringsing, or double Ikat, of Tenganan was the most difficult fabric to construct and weave, and as already outlined, it took many years to become an accomplished weaver of them.

In Japan, as in Turkestan, definite qualities of Ikat fabric may be distinguished made from fine cotton and silk yarns. For traditional aesthetic reasons the Japanese find as much, if not more, pleasure in the imprecise as they do in the precise, for example, the highly prized rough misshapen earthernware Raku Pottery. Thus there is the same desire to produce a naturally inexact image profile on their cotton kasuri fabrics. In some cases deliberate misplacement was carried out. Kasuri was, and is, traditionally a peasant craft and in its crudest form worn by the rural and municipal workers as work clothes. Therefore great precision was not necessary and was also impractical for financial reasons.

In addition to the common fabrics of the working community, Japan has an established luxury silk kasuri market, with tsumugi from the Ryukyu archipelago and kasuri from Honshu in Japan. Such fabrics were accumulated by the wealthy Japanese for kimonos even though Kasuri cannot be worn on ceremonial occasions. Thus sophistiated and skilled techniques for producing a precise image profile have been developed to satisfy the demand for this type of fabric.

7.3 Methods of Warp Printing

7.3.1 Introduction

As mentioned previously the method for applying the pattern to the yarn for the handwoven wool warp printed trials was by means of warp printing. It was felt necessary to define briefly the warp printing process and its likely historical development before specifying the principle differences in the appearance of Ikat and warp printed fabrics, to enable understanding of how such a distinction may be achieved. Following this explanation the exact procedure employed for the handwoven trials is described.

7.3.2 Definition and Historical Background

Warp printing is achieved by combining traditional fabric printing techniques with weaving skills to form a woven fabric, which like the Ikat appears intrinsically patterned from within. By creating such a combination it is possible to produce powerfully decorative textiles which compare favourably with the Ikat technique as regards aesthetic beauty.

It is believed that warp printing is derivative of the Ikat technique and that the former developed as a means of increasing the production of such fabric to meet demand. During the late 17th Century, Ikat fabrics became popular in the Western World after being transported from the East in their traditional form, to be presented as gifts in the French courts[231]. The Ikat technique gradually spread into Europe during the 18th Century and was semi-mechanised[232], and by the middle 19th Century a similar characteristic blurring effect could be achieved by printing upon the yarn as opposed to resist-tying it. With the industrial revolution in the 1850's new machinery was produced to aid the development of the warp printing industry, and by the late 19th Century fine and sophisticated warp printed fabrics were manufactured in abundance in Europe mainly for ladies apparel. These constituted mainly floral and geometric warp printed designs usually upon silk combined with highly complex weave structures which produced an overall effect of pattern upon pattern. Fig 7.2 illustrates one such example. It is not possible to elaborate in great detail the historical development of warp printing techniques in this thesis of which there are many, nor it is necessary to do so, but it was felt that a clear distinction should be made between the two yarn

19th Century Warp Printed Silk Dress Fabric

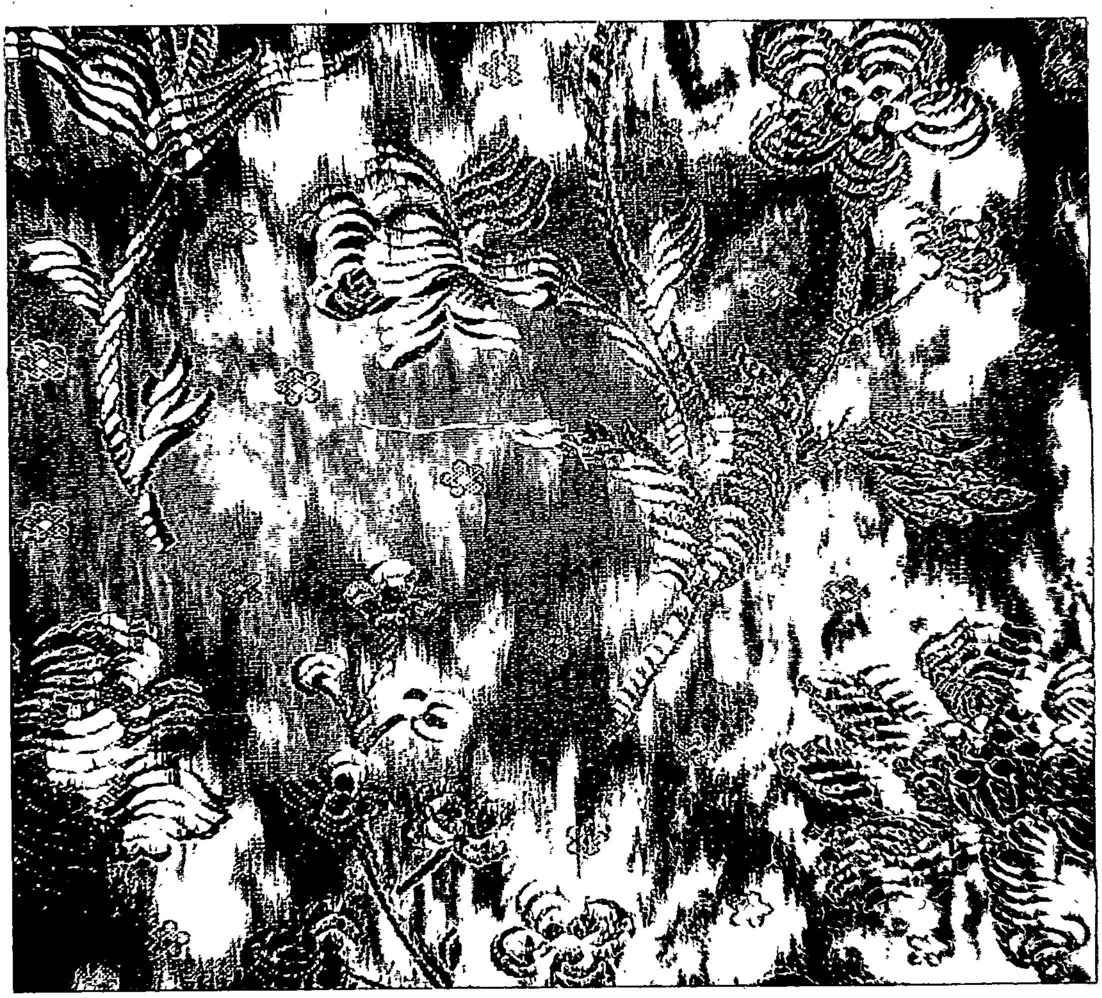


Fig 7.2

patterning processes as both create a very similar result and both are equally decorative in their own right.

7.3.3 Recognition and Distinctions between Ikat and Warp Printed Fabrics

To understand the principle elements that distinguish Ikat and Warp Printed fabric apart, a task easily accomplished with an experienced eye, it is necessary to observe points of general technical importance which in turn subtly vary the final appearance of fabrics produced by the two processes.

Initially and with regard to Ikat fabrics it was mentioned in Chapter 1.2 that the Ikat technique is a hand dyeing process whereby the natural colour of the yarn is reserved by means of resists being applied in a predetermined pattern. The background is subsequently dyed i.e. the negative part of the pattern, and upon removal of the resists after completion of dyeing, the uncoloured yarn forms a positive image against the background colour. This describes the most simple method of Ikat which involves only one colour being dyed.

The application of the warp print to uncoloured yarn is the reverse of this, as it is a positive image that is placed onto the yarn, the background remaining uncoloured unless the yarn is initially pre-dyed.

In addition the resist-dyed yarn is perpetually prepared in groups in pre-arranged pattern sequences or bundles, the size of which vary according to geographical location and cultural requirements. These patterned bundles are retained during the production process and can be observed clearly upon the finished fabric in the form of vertical or horizontal columns or bands depending upon the direction of the Ikat patterning. See Fig 7.3(a).

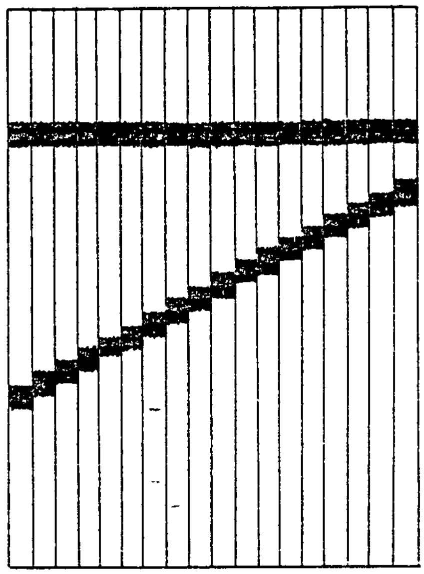
These columns vary in size according to the number of threads which make up a bundle, and it is usual for each bundle to comprise the same number of threads throughout one fabric.

Yarn that is to be warp printed is prepared in some manner that retains its order, weaving width and tension throughout the production process. This may involve for example placing a warp onto a printing table in a similar manner to traditional fabric printing, only that the yarn is tensioned with weights as opposed to being stuck to the table, or pinned to an undercloth. In all instances warp printed fabric does not show any type of columnar arrangement unless specifically designed to do so. See Fig 7.3(b).

A further distinguishing feature is the method of colouring the yarn. In the Ikat technique the yarn absorbs the dye from all angles as it is submerged in the dyebath, which allows the dyestuff completely to penetrate the uncoloured yarn. Additionally overdyeing is a method often employed to obtain a third colour re-tying and dyeing some of the resist-tied areas twice, usually with the darker colour first followed by the paler one. A popular example of this is the colour aubergine, a combination of pink (cochineal)

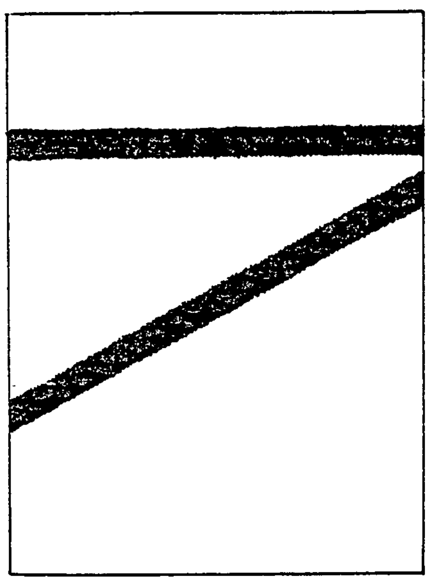
Methods for Distinguishing Between Ikat and Warp Printed Fabrics. Overall Layout

Ikat



(a)

Warp Printing



(b)

Fig 7.3

and blue (indigo) frequently used by the Uzbegs of Turkestan for the colouring of the ceremonial "khalat" fabric already described in section 3.3 and illustrated in Fig 3.7. However, it is the custom of this particular tribe to dye the paler colour first and overdye with the darker one as specified in Table 7.3.

Furthermore often tonal gradation of colour may be detected at the perimeters of the image where the colour changes which is either the result of the yarn absorbing the dyestuff very slightly at the edges of the resist, or as in the case of overdyeing, the secondary colour exceeding the perimeters of the first. A representative example of this is the sacred Gringsing fabric of Bali discussed in Chapter 5. It can be noticed that around the edges of the image there is a redish tinge which signifies that madder, the secondary colour exceeded the perimeters of the initial indigo colouring.

The colouration of warp printed fabrics, on the other hand, can be regarded as somewhat superficial in comparison, although the results are usually as effective as those of the Ikat technique. In this case the dyestuff is wiped onto one surface of the fibre and its penetration will depend upon the type and linear density of the yarn, as well as the number of times the impression was applied. When fine yarns with high absorbency levels are being employed as with silk for example, the dyestuff will penetrate swiftly and completely; but with coarser or more tightly spun yarns penetration is often slow or incomplete,

the dyestuff remaining on the one surface of the yarn. This can produce the streaking effect which can be observed occasionally in handcrafted warp printed fabrics and was discussed in section 7.2.1, and can be seen illustrated in Fig 7.4. With regard to overdyeing printed yarn to obtain a third colour, it is achieved in an identical manner to traditional fabric printing, so in this respect Ikat and warp printing procedures can be regarded as similar. However, warp printed yarn is not affected by tonal gradation of colour at the perimeters of the image, as an equal amount of dyestuff covers the entire impression.
The final obvious distinction between the two processes lies in the formation of the image profile itself, once the fabric has been formed. The image profile of an Ikat motif is often of a naturally irregular appearance however controlled or precise it is, and the irregularity of an image profile of a deliberately manipulated shape is likely to be accentuated further both in its formation and length. This is true also of the image profile of a handcrafted warp printed fabric particularly if the tension of the printed yarn is not retained consistently during the manufacturing process. Under such conditions the resulting irregularity of the image profile is likely to be extremely similar to that of Ikat. However if the printed yarn is carefully controlled either by hand or machine during the manufacturing process, the resulting image profile is likely to be even and regular. These differences may be observed in Fig 7.5.

Methods for Distinguishing Between Ikat and Warp Printed Fabrics

Insufficient Penetration of Dyestuff Causing Streaking Effect

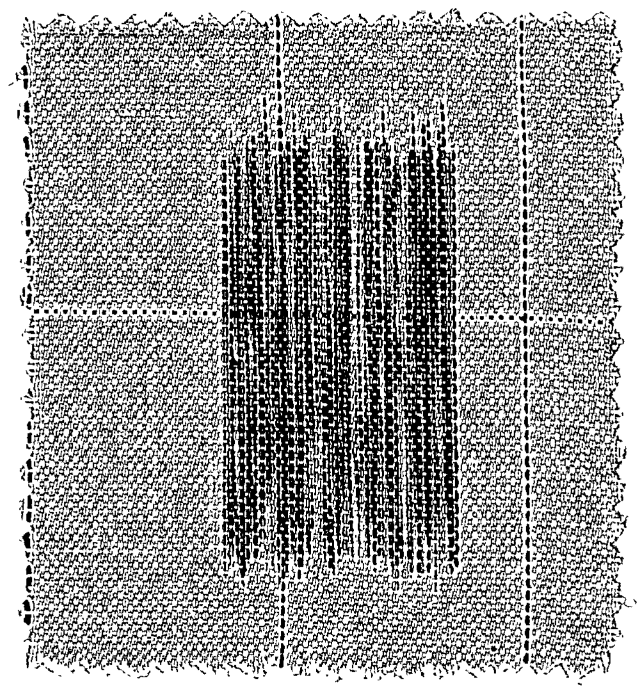


Fig 7.4

Methods for Distinguishing Between Ikat and Warp Printed Fabrics

Image Profile Showing Degree of Irregularity

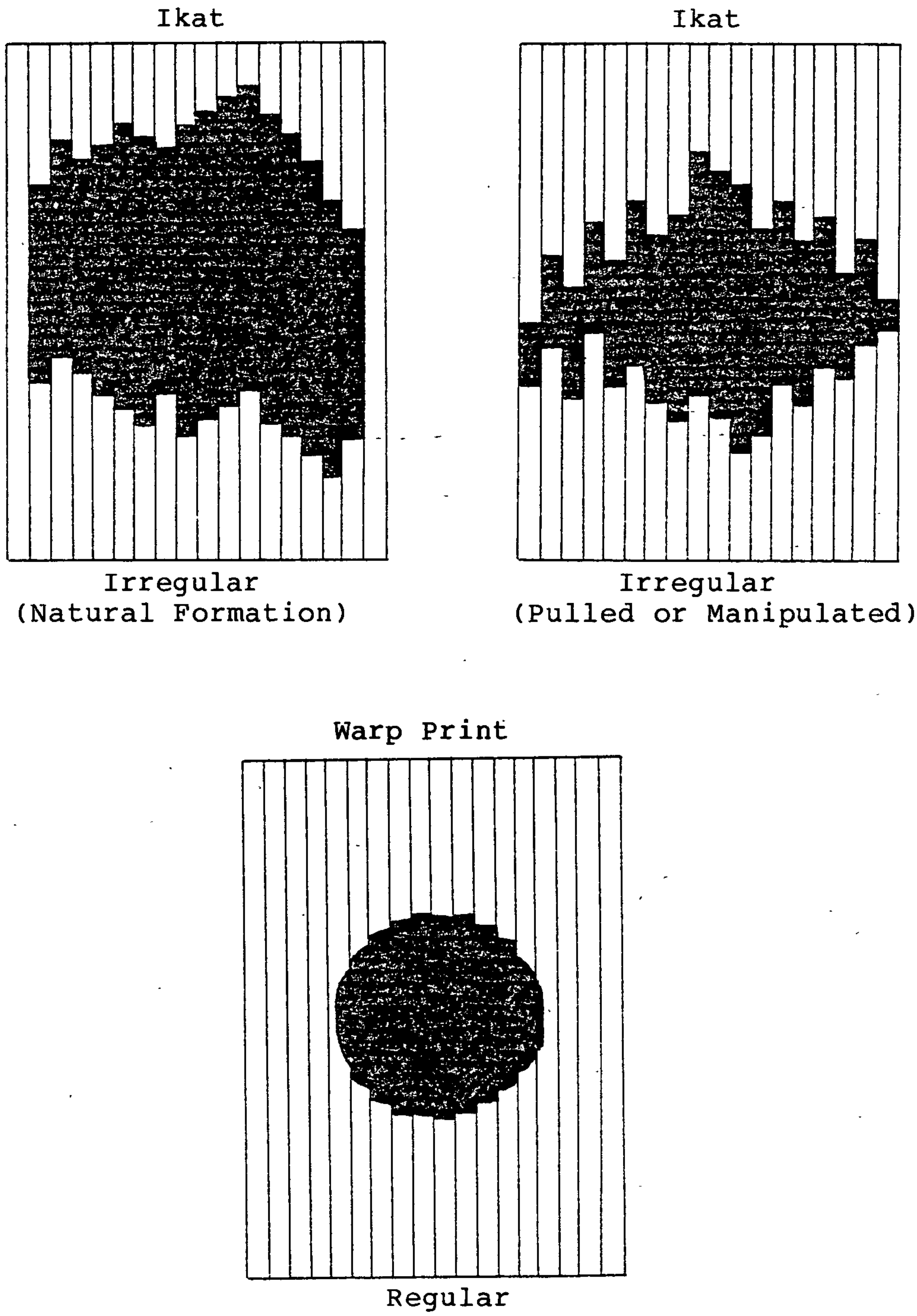


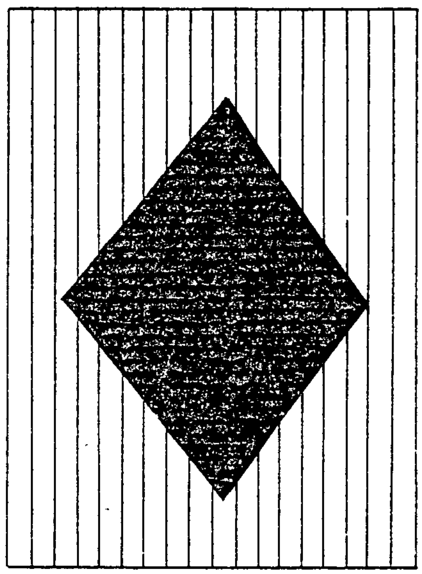
Fig 7.5

As the warp printed design repeats, the image profile of each motif will be identical throughout the fabric unless some area is affected by tension changes during the production process. This is not true of Ikat fabrics as marginal differences such as area of colour, or layout of motif can usually be observed in each repeat however carefully the fabric was manufactured. This can be attributed to the ever changing effect the human element has upon the production process.

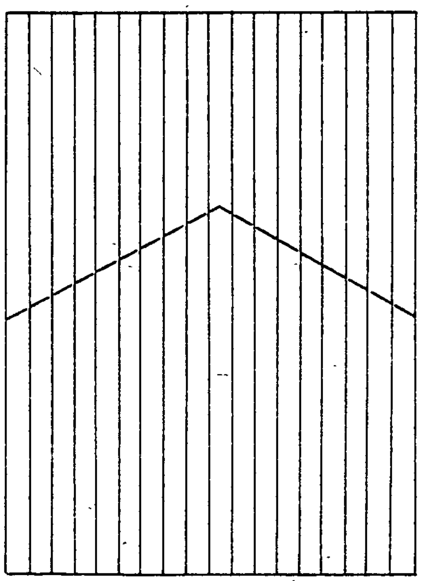
Thus one of the simplest methods of ascertaining a warp printed fabric is closely to examine the manner in which the printed image lies upon the yarn. This may be accomplished by observing the perimeters of the printed image once the fabric is woven, as it is here that technical minutiae may be noticed. These are represented in three ways.

The first and most important is that, upon close inspection, it can be seen that the edges of the printed image does not entirely cover the whole width of the end of the yarn. This is because the printed image does not relate to the yarn distribution in any way therefore the edge of the print may finish half way across an end. Secondly, the image profile of each individual printed end of yarn will reflect the shape of the image, for example the image profile of each end of yarn of a diamond shape will be diagonally delineated. Both these details are illustrated respectively in Fig 7.6(a) and (b). Thus to compare these features with those of the Ikat technique, Methods of Distinguishing Between Ikat and Warp Printed Fabrics

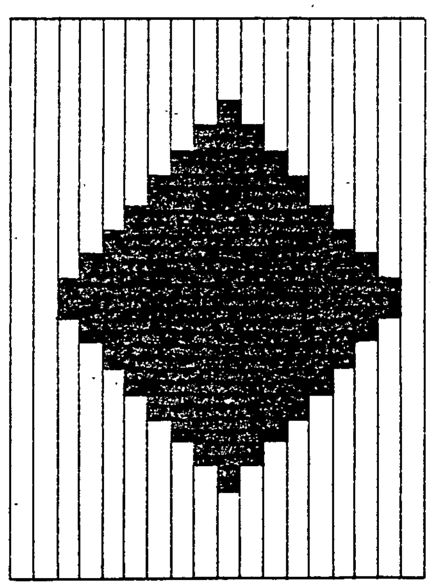
Position of Image Upon the Yarn



(a) Warp End Partially Printed on Lefthand edge of Diamond



(b) Magnification. Diagonally Delineated Profile of Each printed end of a Diamond Shape.



(c) Ikat. Horizontal Profile of each warp end

Fig 7.6(a),(b) and (c)

the resist-tied and dyed image of one may be said to be composed of straight lines as seen in Fig 7.6(c), which appear in columnar or grid formation, whilst the printed motif of the other comprises a more curvelinear outline relative to the shape of the image.

The third detail is the presence of one or two printed ends of yarn being detached from the main unit of the print which gives the effect of an uneven outline at the edge of the print and even a broadening of the image as a whole, which can be seen illustrated in Fig 7.7. This is caused by one or two ends of yarn becoming crossed over during the preparation for printing. Once the print has been completed, the newly printed ends return to their correct positions having crossed back over one or two uncoloured ends which are positioned outside the perimeter of the stencil. Thus the distinct outline at the edge of the image appears broken, or the image itself appears to continue depending on the extent of overcrossing. This fault should not occur if the yarn to be printed is distributed in its correct sequence during its preparation.

In addition to these technical points there are some general aesthetic distinctions that also aid the identification of Ikat and warp printed fabrics.

Firstly, the subject matter of the image itself. With Ikat fabrics this generally relates to cultural traditions inherent to the producing tribe or community who used popular images or symbols to create their patterns. The design image of warp printed fabrics however is linked more

Methods of Distinguishing Between Ikat and Warp Printed Fabrics

The Effect of Overcrossing in Warp Printed Fabrics

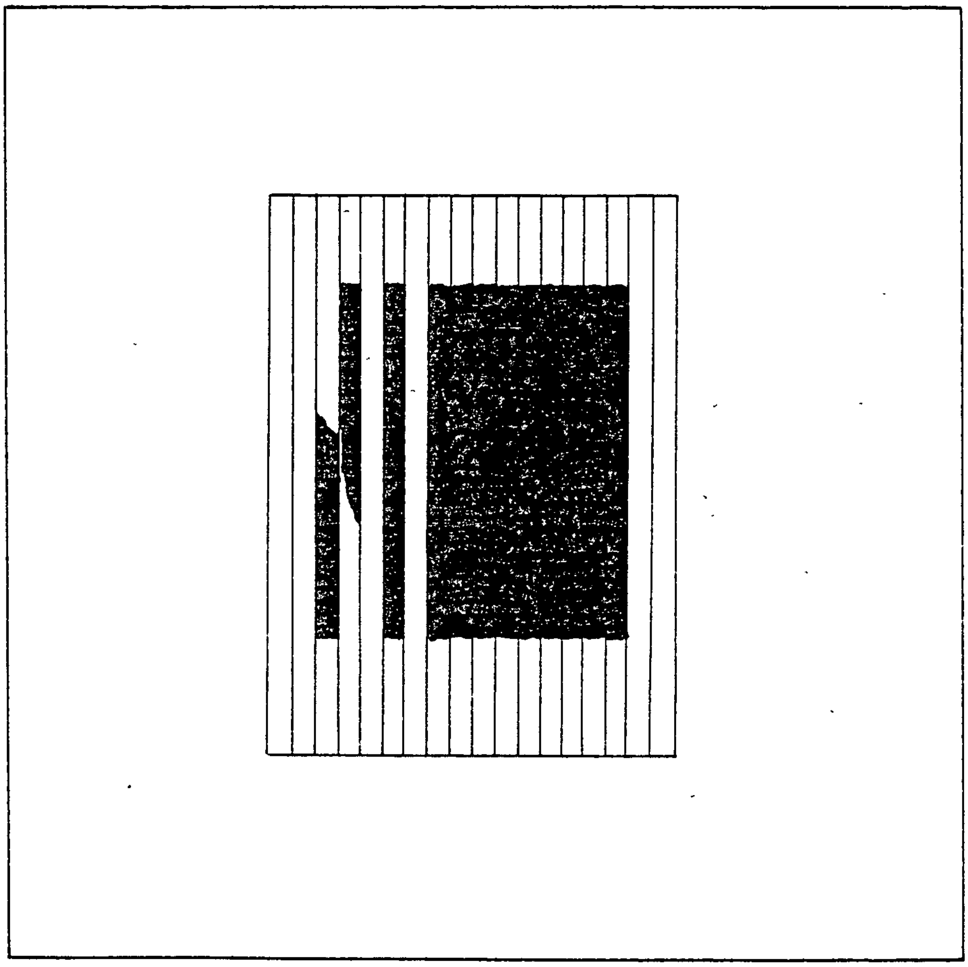


Fig 7.7

with fashion than culture. As warp printed fabrics became popular from c.1840s to 1930s the designs used to decorate these fabrics constituted representative features of everyday life which become stylised in relation to fashion. Thus warp printed fabrics could be divided into groups devoted to pattern such as abstracts, florals, polka dots, checks, plaids, geometrics and stripes[233]. The prints and weaves themselves were related to the general design trends of each period which included Victoriana; and Japanese influence in France; Edwardiana; Art Nouveau; Art Deco.

A further general distinction can be made in the colouration of the two types of fabric. Ikat fabrics tend to comprise colours that constitute the primary hues which are vivid and bold in character and contain few tonal variations. This may be attributed to the availability of dyestuff and the timescale required to obtain a specific colour, as well as forming an identification system between one group and another.

The colours of warp printed fabrics on the other hand are more subtle in nature and often contain tonal variations of great fineness which are controlled by the printing method, a good example of which is the engraved copper roller.

In addition to colouration, the use of constructions is an identifying factor. As outlined in Chapters 1.7 and 7.2.4 Ikat patterned yarn is woven with simple one dimensional structures to form a fabric of stability as well as to facilitate the clarity of the resulting Ikat pattern, and the loom upon which it is woven is mechanically simplistic.

More advanced structures are employed to weave warp printed yarn of extreme fineness, and these structures are combined to form two dimensional weaving patterns which give the finished article a far more complex appearance. Furthermore warp printed fabrics are usually woven on technically more versatile machinery which enables a more comprehensive range of fabric constructions to result.

Finally it is possible to detect the difference between Ikat and Warp Printed fabrics by recognising the probable method of yarn colouration. In most cases such an examination is straight forward for Ikat fabrics since resist dyed fabrics are visually similar in this respect, and their recognition may be achieved by following the points such as the total absorption of dyestuff by the yarn; the use of overdyeing; and the gradation of colour at the perimeters of the image.

The production method or colouring technique of the warp printed image is more difficult to detect accurately as many different printing and colouring procedures were employed each giving a slightly varied result to the final appearance of the fabric. It would require much further research to establish a reliable identification system of warp printing methods and their resulting visual effects which is not possible in this thesis.

Thus it is possible by considering all these identifying factors to distinguish between Ikat and Warp Printed fabrics. To summarise Table 7.7 lists the principle distinctions outlined above.

Principle Distinctions Between Ikat and Warp Printed Fabrics

Ikat	Warp Printing
Negative pattern	Positive patterning
Pattern applied to bundles of yarn forming a columnar arrangement in finished fabric.	Pattern applied to yarn in warp form. No columnar arrangement.
Resist-tied yarn submerged in dyebath-total absorption.	Dyestuff applied to one surface of yarn only. Penetration may not be complete. This may cause streaking effect in finished fabric.
Overdyeing sometimes employed.	Overprinting sometimes employed
Tonal gradation of colour at perimetres of image.	No tonal gradation of colour at edges of the print.
Moderate irregularity of image profile of both ordinary and manipulated Ikat.	Moderate irregularity of a handwoven image profile.
	Reduced irregularity of image profile when produced by machine.
Each repeat slightly dissimilar throughout fabric-human element.	Each repeat similar throughout fabric. Regularity of machine.
	Edge of printed image does not entirely cover width of yarn
The perimeter of the image profile crosses each end of yarn horizontally.	The perimeter of the image profile reflects the shape of the printed impression.
No overcrossing.	Overcrossing

Table 7.7

Principle Distinctions Between Ikat and Warp Printed Fabrics

Ikat	Warp Printing
Traditional design imagery reflecting cultural influences.	Stylised design imagery reflecting fashion of the moment.
Colouration. Mainly bold and vivid primary colours. No tonals.	Colouration. More subtle, many tonals, relating to production process and fashion.
Constructions. Basic weaves of one dimension.	Constructions. Varied and complex structures, some of two dimensions.
Method of yarn colouration. The resist technique visually similar.	Method of yarn colouration. Many varied production processes resulting in many different visual effects.

Table 7.7 (continued)

7.4 Conclusion

It can be seen from this observation that various factors relating to the appearance of the image profile have become apparent.

Firstly, the geographical origin of the Ikat fabric gives an identifiable semblance to the image profile. This in turn reflects the type of yarn used and its linear density combined with the skill of the weaver who produced it. The degree of the weaver's ability is determined firstly by the traditional requirements of the community in the form of religious and ceremonial influence; and secondly by the demand for the resulting fabric by the utilizer.

Thus it may be concluded that geographical location, fibre and the skill of the weaver all affected the appearance of the image profile of traditional Ikat fabrics to varying degrees, but the predominant element of that characteristic appearance has yet to be understood.

CHAPTER 8 EXPERIMENTAL PLAN FOR WOVEN FABRIC TRIALS

8.1 Image Profile

8.1.1 Introduction

It has become evident from the preceding chapters that the most important and apparently unexplored element of the Ikat technique is the characteristic blurring effect itself, the image profile.

It appears that each community favoured a particular degree of irregularity within the profile and as discussed, in most cases they went to considerable lengths to achieve and preserve this effect. Some communities desired perfection of the profile and perfect alignment whilst others were content with a more natural formation.

This in turn indicates that the weaver's knowledge of control of the behaviour of the ikatted yarn was well developed and that all procedures were predeterminedly arranged.

Thus the following points were raised necessitating investigation and explanation:

i. the exact cause of the image profile in the first place; and

ii. the element responsible for the degree of irregularity within the profile itself.

In addition, and relevant to both these considerations, the following list of supplementary queries subsequently arose, that is did the following affect the formation or the degree of irregularity of the image profile:

i. the type of yarn employed;

ii. the type of construction used;

iii. the method of preparation and the weaving;

iv. deliberate manipulation of the yarns; or

v. the shedding action.

8.1.2 Hypothesis

It was possible to hypothesize and presuppose the effect of these points particularly with the knowledge of the Ikat technique previously gained by the author.

It was felt that one of the main causes of the image profile was the result of the shedding action during weaving. From experimentation it was known that a geometric image printed onto warp yarn had a perfect uniform shape before weaving commenced. Immediately shedding occurred the straight edges of the image were lost altogether. Thus, it was thought that the element responsible for the degree of irregularity within the image profile itself was the tension created by the unequal strain on the warp ends between the front and back healds in relation to the back beam, as well as the general rocking effect the shedding action had on the warp yarns. This in turn could be related to the traditional Ikat weavers in that their body weights controlled the tension of the warp yarn during weaving, so the warp was equally affected by stretch and movement thus creating the irregularity of the image profile.

It was felt that although the type of yarn used did not actually cause the irregularity of the image profile the type of yarn or its linear density may well contribute to the amount of irregularity. In addition, the use of different constructions was thought definitely to affect the image profile and its irregularity, and to a lesser extent so was the method of warp preparation and the weaving. It was not thought that the image profile was caused by deliberate manipulation of the yarn, although it was known that in some Ikat producing areas the weavers did create patterns by manipulating the resist dyed yarn before weaving. This however affected the layout of the pattern on the unwoven warp thus accentuating the degree of irregularity of the image profile. Two points enabled such manipulation to be detected. Firstly, in general, it was the arrowhead pattern that was created by manipulation and could be linked with countries such as Greece, Turkey, the Middle East, and Japan. Furthermore, if manipulation had taken place this could be recognised by the observance of the overall behaviour and placing of the Ikat patterning. If manipulation had occurred, an exactly similar image profile would result throughout the whole fabric. Secondly, the usual method of creating an Ikat arrowhead pattern is to build up such an image by means of stepped blocks, which generally enable great accuracy of the image profile to be maintained. Thus it was decided that although deliberate manipulation was the unlikely cause of the image profile, it should be considered as a possibility.

Finally, and as already outlined, it was thought that the shedding action was indeed responsible to some degree of the image profile and affected its irregularity.

In order to reach an accurate conclusion of this hypothesis it was necessary to investigate it experimentally.

Primarily it was decided an analysis of a series of carefully constructed woven trials should be undertaken in conjunction with a close observation of the manufacturing process. The experiments were to incorporate some of the classifying criteria of the historical survey which was outlined in Chapter 7 in order to ascertain any observable correlation between historical fact and present day practice. Completion of the woven trials would thus result in a comparative analysis which would be in part quantitative. It should be noted that one of the original intentions of the woven trials was to reproduce specific aspects and conditions of the traditional fabrics in order further to understand the Ikat technique and its production.

8.2 Experimental Plan

8.2.1 Introduction

To enable the comparative analysis to be as comprehensive as possible and to relate directly to the historical survey extremes of variant were included within three of the five common factors outlined in Chapter 7 namely fibre, construction and design. Each aspect of the manufacturing process was considered separately in order to encompass the widest range of values in the experiments.

8.2.2 Fibre

It can be noted in Chapter 7 that the range of yarn types utilized by the traditional Ikat weavers discussed varied from coarse to very fine according to geographical location. To relate to this, three fibre types were selected - wool, cotton and silk. Each of these fibres was to be represented by one warp. The linear density of the respective spun yarns was: wool R40 Tex/2; cotton 37.5/2 Tex; and silk R12.5/2 Tex. The weft yarns selected for use with each warp ranged progressively in count from fine to thick. Six samples of weft yarn were used in each case: the details of the yarn linear density are given in Chapter 9.

It was envisaged that a useful series of fabrics would result exemplifying the behavioural properties of the image profile under the various production conditions.

8.2.3 Structure

Each of the three warps were to be woven with the same constructions: plain weave; 2/2 repp; 3/1 twill; 2/3 hopsack and 8 end satin, as a general representation of the types of constuctions used by the communities in question. However, it may be noted from classification in Table 7.3 that 3/1 twill does not appear. This is true for the areas under discussion, but there are other Ikat producing regions in the world that include 3/1 twill, an example of which is Cambodia. Therefore, to add interest to the group of constructions already selected, 3/1 twill was included. Additionally, it was realised that such a twill is much used in the Western world and would produce fabrics with a distinctive effect because of the twill line.

8.2.4 Design

Upon further study of the classification table and the five common factors it was decided that a geometric shape should be used, as it was an image obviously preferred by the weavers in question. It also had the merit of being ammenable both to measurement and visual assessment.
Therefore, a simple rectangle was selected, an image often employed in traditional Ikat weaving, one that would remain constant throughout the whole series of trials, to ensure accurate analysis in the final comparison.

8.2.5 Colouration

Similarly, the colour of the rectangle had to be constant and only one colour was used as it was felt many colours would create confusion. Hence, the colour blue was selected which represented the universal use of indigo throughout the world.
Additionally, it formed a strong contrast against the white background of the image, enabling accurate measurement of the image profile.

8.2.6 Positioning

Subsequently, it was necessary to decide upon the directional positioning of the image which, for the purpose of the tests, had to be quick and uncomplicated. The warp rather than the weft was chosen for patterning which not only fulfilled the requirements but also linked well with the evidence identified in the historical survey in that warp Ikats are the most common form.

8.2.7 Procedure

Finally, it was decided to produce the chosen image in a method other than that by the traditional Ikat weavers. The hand method of resist tying and dyeing was a lengthy process unsuitable and uneconomic for the purpose of the trials. Thus, a simpler and more up to date technique was to employ one of the imitation processes outlined in Chapter 1, that of warp printing. This is a printing procedure whereby the image is applied to prearranged uncoloured yarn, usually the warp, and is a process exactly similar to conventional fabric printing.

8.2.8 Summary

Thus, the plan was to produce hand-woven samples:

i. three warps to be woven: one of wool; one of cotton; and one of silk;

ii. each warp to be printed identically;

iii. each warp to be woven with five identical constructions namely plain weave; 2/2 repp;

3/1 twill; 2/3 hopsack; and 8 end satin;

iv. each construction to comprise six samples each measuring approximately 21.25 cm by 30.5 cm;

v. each sample of each construction to be woven with equivalent counts of yarn which progress gradually from fine to thick;

vi. completion of all woven trials to result in a comparative analysis.

CHAPTER 9 METHODS, MATERIALS AND EQUIPMENT FOR THE PRODUCTION OF WARP PRINTED HANDWOVEN FABRIC

9.1 Introduction

The preparation for weaving of the three warps described in Chapter 8 was to be completed in an identical manner for the accuracy of the resulting comparative analysis. It was decided that of the three yarn types the account of the preparation of the wool warp would be exemplary, with the cotton and silk warps being described in less detail, but with any change in the production details or dyestuffs being described as appropriate.

As noted previously, each of the yarn types corresponded with particular chapters discussed in the historical survey, and to commence, the wool warp related directly to the type of fabric produced by the Araucanian Indians of Chile which was examined in Chapter 2.

9.2 Warp Printed Wool Fabrics

9.2.1 Warp and Weft Yarn Details

Table 9.1 identifies the warp and weft yarns employed, showing them in their order of linear density. The yarn selected for the wool warp was a twofold worsted of resultant Text count R40 Tex/2. Although this yarn was of a much finer type than that employed by the Araucanians it was suitable for the trials for two reasons. Firstly it absorbed dyestuff relatively efficiently which was an

Wool Warp and Weft Yarn Details

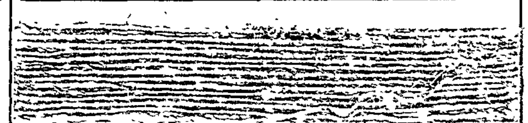
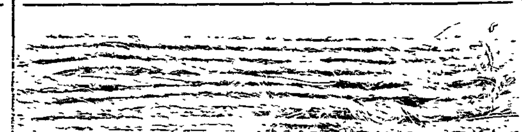
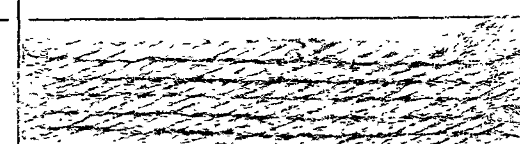
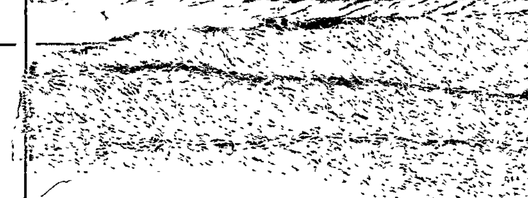
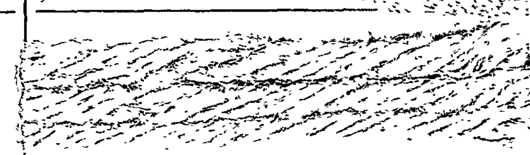
Warp Yarn	R40 Tex/2	
Weft Yarns	Counts	Sample
1	R40 Tex/2	
2	155 Tex	
3	389 Tex	
4	R722 Tex/4	
5	1525 Tex	
6	R1745 Tex/6	

Table 9.1

important consideration, since poor dye penetration would result in the colour lying upon one side of the yarn only, particularly if the yarn was tightly spun. This subsequently would produce the undesirable effect of an overall streaky appearance of the printed image which is uncharacteristic of the true Ikat technique. Upon weaving, the warp yarn would naturally twist to some degree, thus exposing the uncoloured side. Therefore, upon construction of the fabric some printed ends would return to the position in which they were printed and some ends twist so that some or all of the print is obscured, thus showing the unprinted side of the warp end on the fabric face. Secondly, from previous weaving experience that yarn was known to result in a suitable fabric from both design and present day manufacturing viewpoints.

In addition to the twofold worsted which was used not only for the warp, but also for the finest weft yarn, five further weft yarns were incorporated, progressively increasing in linear density, viz: 155 Tex, 389 tex, R 722 Tex/4, 1525 Tex and R 1745 Tex/6.

The final two yarns were included for interest. The 1525 Tex yarn constituting a regularly slubbed yarn with a wide range of variant, and the R1745 Tex/6 being a coarse sixfold yarn.

Seemingly, such coarse counts of yarn did not exist in the Araucanian fabrics or generally in other types of Ikat fabric as far as is known, but they were included here to allow observation of their effect upon the image profile, as well as being relevant in relation to present day manufacturing trends.

9.2.2 Warping

Table 9.2 gives the warping details of the wool yarns, indicating the number of ends per centimetre used, the width and length of the warp, the reed size and the total number of ends necessary to complete a warp of the width identified.

The particular number of ends per centimetre was determined by three factors of which consideration and examination of the traditional Araucanian fabrics was the first. The second was the number and type of weft yarns being used in the trial, a finer warp yarn integrating better with the diversity of the linear density of the weft yarns. Additionally, as previously discussed in section 7.2.6, a finer warp yarn gives clearer definition of the image profile thus aiding the subsequent mathematical analysis. The third factor was the knowledge that 19 ends per centimetre of R40 Tex/2 worsted gave rise to the desired type of fabric suitable for present day design and manufacturing trends with regard to specific aspects such as weight and handle.

All these issues were reconsidered for both the cotton and silk warps.

The length of the warp was determined by the quantity of samples calculated and included an additional amount of warp to account for wastage and possible mishaps. As the

Wool Warping Details

	Plain, 2/2 Repp, 3 and 1 Twill	2/3 Hopsack, 8 End Satin
Ends Per Centimetre	19	29
Width of Warp	30.5 cm	20 cm
Length of Warp	13.5 metres	
Reed Size	9.6/2 cm	
Total Number of Ends	600	

Table 9.2

length of each sample was to measure 21.3 cm and each group consisted of thirty samples, a minimum length of seven metres was required.

The width of the warp was determined firstly by the breadth of the loom which was of the narrow sampling variety with the maximum fabric width of 60 cm, and secondly by the specific size of the printed image itself which covered an area of 16.5 cm x 20 cm.

The width of the sample was to be 30.5 cm wide to enable a satisfactory sized sample to be obtained which was neither too large, which would increase the worktime involved, nor too small, which would restrict the true behaviour of the fabric and hinder the subsequent examination. Thus a width of 30.5 cm seemed an ammenable size lending itself well to yarn behaviour, fabric managability, and mathematical observation. In addition, this particular fabric dimension was known to be suitable for sampling, the result of previous weaving knowledge.

It is necessary when assessing the warping details to decide upon the size of reed suitable for the number of warp ends, and in most cases, but particularly for wool yarns it is usual to place two warp ends in a single dent spacing. Thus a reed size is required constituting half the number of ends per centimetre of the warp. Sometimes however if a suitable reed size cannot be found it is necessary to fractionally adjust the ends per centimetre.

The type of warper upon which each of the three warps was made constituted an upright variety rotated by hand at a central axis. Fig 9.1 illustrates diagramatically this type of warping mill.

The first cross bar as shown in Fig 9.2 was placed between any two of the upright posts at the top of the warping mill, and to determine the position of the second cross bar, a single end of yarn, measuring the length of the warp required was attached to the first peg of the first cross bar. Whilst the warping mill was rotated to the left the single end of yarn was wound to the right in a downward spiral until its length ceased. At this point the second cross bar was attached, with the pegs subsequently arranged in their correct positions, three pegs for the top cross bar, and two for the bottom. By following a particular winding sequence around the pegs during the warping procedure which was illustrated in Fig 9.2, the warp is kept in its winding order with pegs 2 and 3, and pegs 4 and 5 forming the position of the leases. Their preservation was essential for the successful completion of the fabric production process.

Thus the warp yarn selected was mounted onto the warping mill commencing at the top of the apparatus and was wound as the mill was rotated by hand at a speed and tension regulated so that the printed image would not be effected during the weaving process which might give an imperfect outline or unwanted effect to the intended imagery. Naturally this is not such an important consideration when producing ordinary woven fabric which is not to be warp printed.

Hand Operated Warping Apparatus

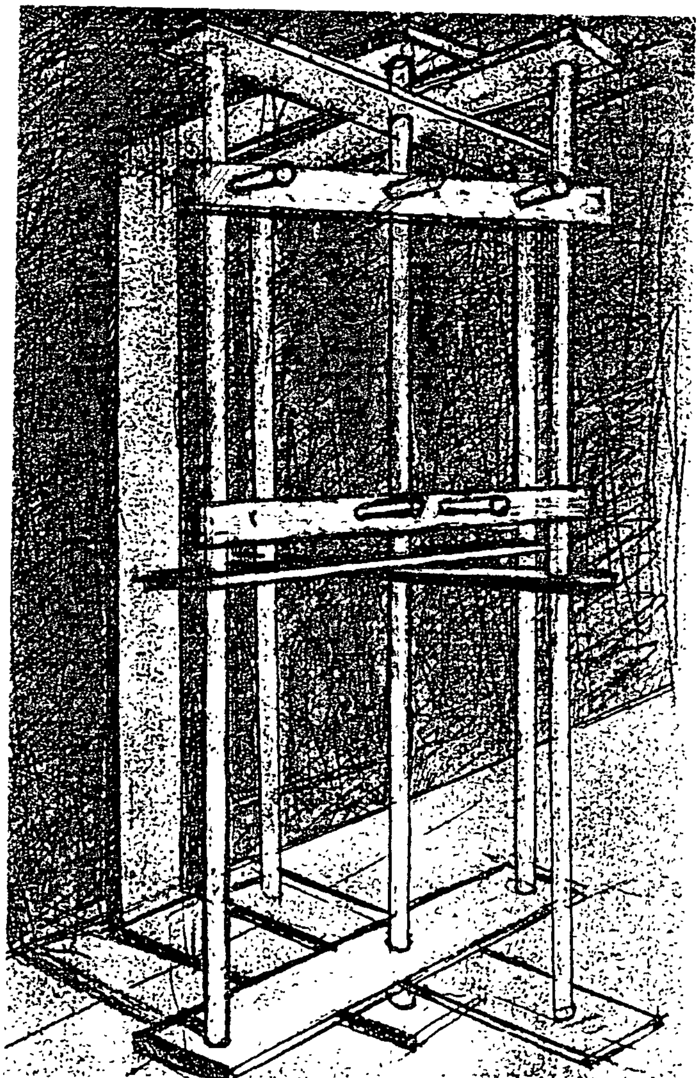


Fig 9.1

Crossbars Showing Winding Direction of Warp Yarn

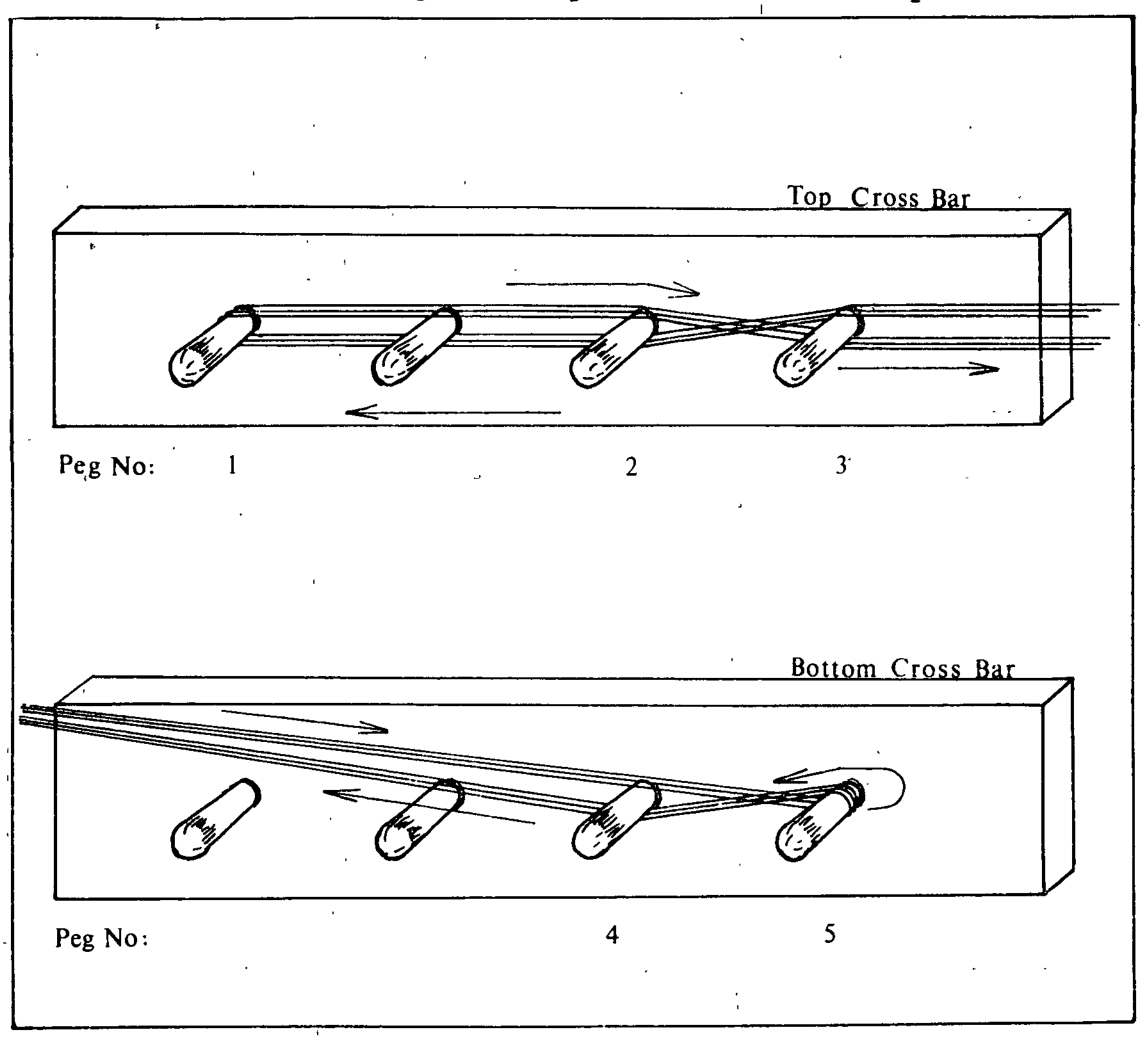


Fig 9.2

During the winding of the warp the yarn was sectioned into groups of equal size by means of a contrasting coloured marker threaded at the end of the warp as shown in Fig 9.3. The number of ends of each group was precalculated in accordance with the number of ends per centimetre and to form the exact divisions required for the raddling procedure, this marking greatly reduced the work involved during the dressing of the loom.
After warping the total number of ends required, a sufficiently strong yarn or string was inserted into the position that the pegs occupied, thus forming leases and retaining the order of the yarn which was shown in Fig 9.3. Additionally the warp itself was bound at intervals of approximately 1 metre along its length, and the prepared yarn was removed from the warping mill whilst under tension, in the form of a chain which retained the order of the whole and ensured its managability during the dressing on the loom.

9.2.3 Loom Details and Looming Processes

The type of loom employed for the production of all the warp printed handwoven fabrics was a sixteen shaft handloom with single lift bottom closed shed dobby as illustrated in Fig 9.4.
It was felt that at some stage during the investigation the possible effect of the shedding mechanism upon the warp printed image should be examined, if only to eliminate it as one of the controlling factors of the irregularity of

Insertion of Coloured Marker to Indicate the
Raddling Divisions in the Warp

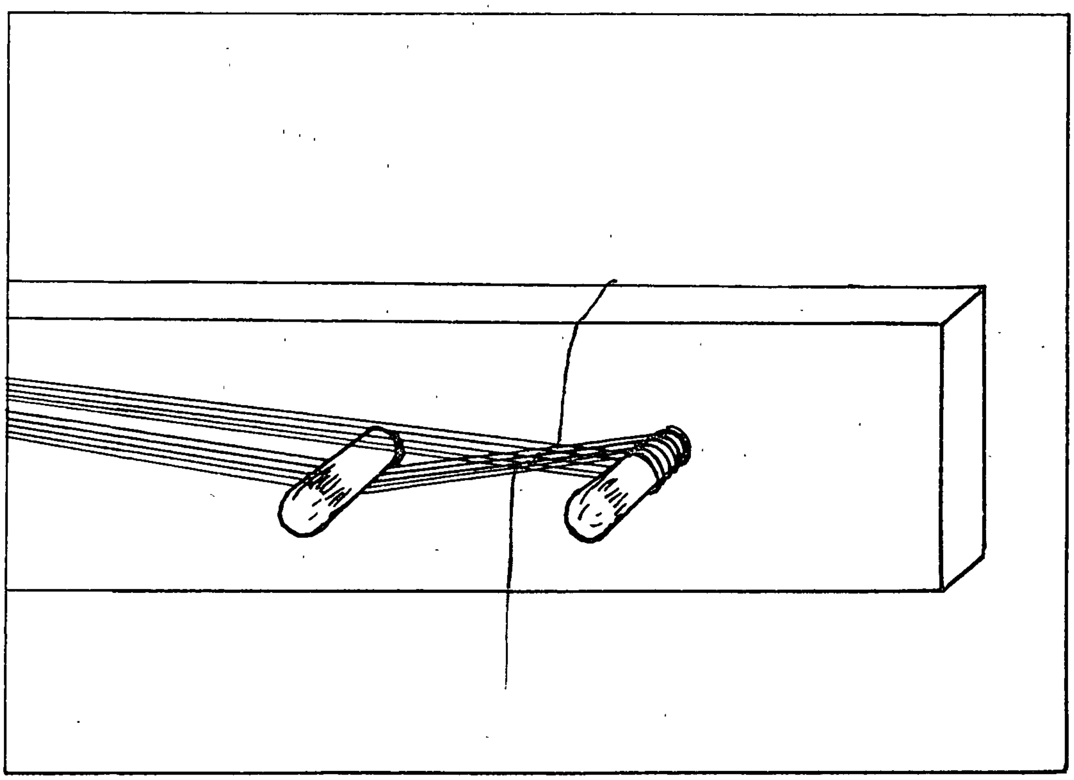


Fig 9.3

George Wood Sixteen Shaft Handloom
With Dobby Mechanism

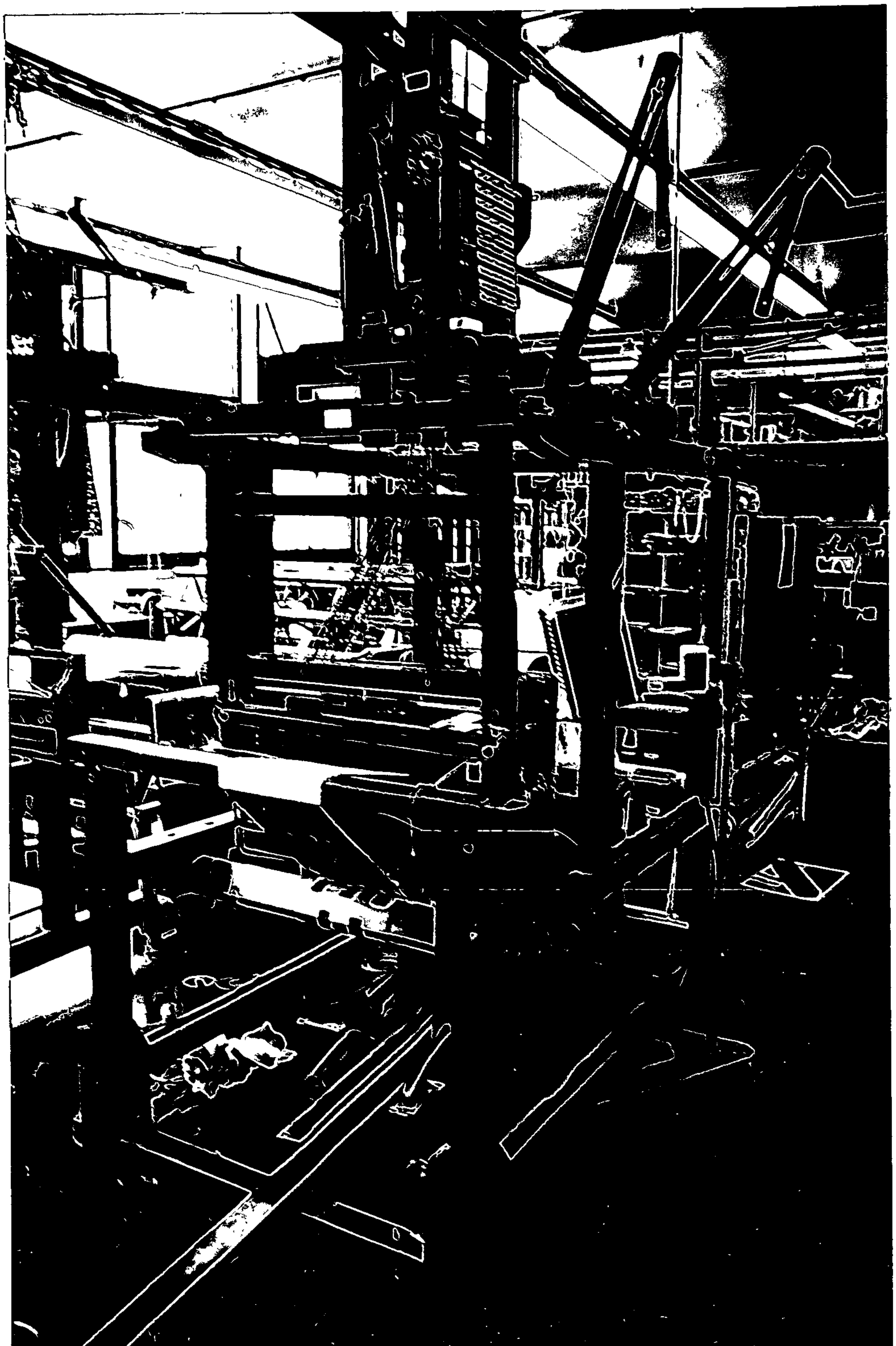


Fig 9.4

the image profile.

The dobby mechanism constitutes a small, but immensely weighty component which is housed in a framework directly above the shafts. This position not only facilitates the connection between the mechanism and shafts themselves, but also enables the weight to be distributed centrally as the shedding action itself is somewhat vibratory.

The design plan is positioned onto a chain of wooden lags by means of small wooden pegs being inserted in a predetermined sequence. The chain rotates around the cylinder and each lag represents one pick or shed formation of the construction. Each lag supports the same number of pegging points as the number of shafts and these relate numerically.

The lag cylinder is normally situated on the right hand side of the mechanism (when the loom is viewed from the front) and is controlled by a star and peg wheel.

To activate the shedding procedure the peg pushes against a vertical flat spring or "faller" of which there are sixteen (one for each shaft), which is connected to a hook by means of a crosswire. The faller and the hook are both pushed out of the vertical parrallel by the peg.

The action of opening the shed by depression of the foot peddle depresses additionally the lever to which it is attached by rope and a rigidly fixed lifting knife situated within the mechanism. The action of the knife lifting picks up the selected hooks that are out of their normal vertical plane, thus lifting the shafts required for that pick of the construction. Upon completion of the pick the foot pedal is returned to its stationary position which lowers the lifting knife. The hooks are released and the fallers return to their original positions. The action of the lifting knife decending automatically rotates the lag cylinder one-eighth of a revolution thus positioning the next lag and set of pegs in preparation for the next lift or shed formation of the construction[231].

Brief details of the loom to enable a more comprehensive understanding of the subsequent looming, warp printing and weaving procedures are included. In some cases the latter two demanded much adjustment of the loom firstly in order for the printing to take place, and secondly to enable examination of the variables affecting the image profile during the weaving process.

Beaming is the primary process of dressing a loom. Initially the lease at the back of the chained warp was placed onto a warp stick which was subsequently attached to the apron stick at the outer edges only. The apron comprised a length of callico fabric pinned to the warp beam itself and enabled the warp to be extended very nearly to the back of the healds thus reducing waste during weaving when the warp neared its end.

The warp beam situated at the back of the loom comprises a roller onto which the warp is wound and works in conjunction with an identical roller at the front of the loom, the front beam, enabling the warp to be kept in order throughout the weaving process. The warp beam has a controlling device in the form of a ratchet and pawl which prevents the warp from unwinding when tension is not applied. This is supplied by a counterbalanced weight box which regulates a negative, but compensating let-off motion, and becomes the principle method of tensioning the warp during the weaving process. Prior to the mounting of the warp it was necessary to ensure that the warp ends were evenly distributed in their warp winding order across the intended width. This was achieved with the use of a raddle, a coarse dented comb with a detachable top similar in appearance to a reed. The raddle was clamped firmly to a stool and placed directly behind the warp beam at a corresponding height to it with the detachable top removed. The back leases occupied a position between the warp beam and the raddle, thus the groups of ends which were the pre-calculated divisions of the entire warp were placed in each dent. For all the warp printed handwoven experiments a quarter inch raddle consisting of four dents to the inch was employed as it was the only type available. Therefore when raddling the wool warp, groups of twelve and thirteen ends respectively were arranged alternatively.

As already outlined in section 9.2.2 it was decided to make the divisions for the raddling during the warping process by inserting a coloured marker in the appropriate divisions. This greatly reduced the timescale of the subsequent raddling process as the warp ends were divided into neat packages, only necessitating placement of each one in consecutive dents. Fig 9.5 illustrates clearly the

The Warp Prepared for Beaming

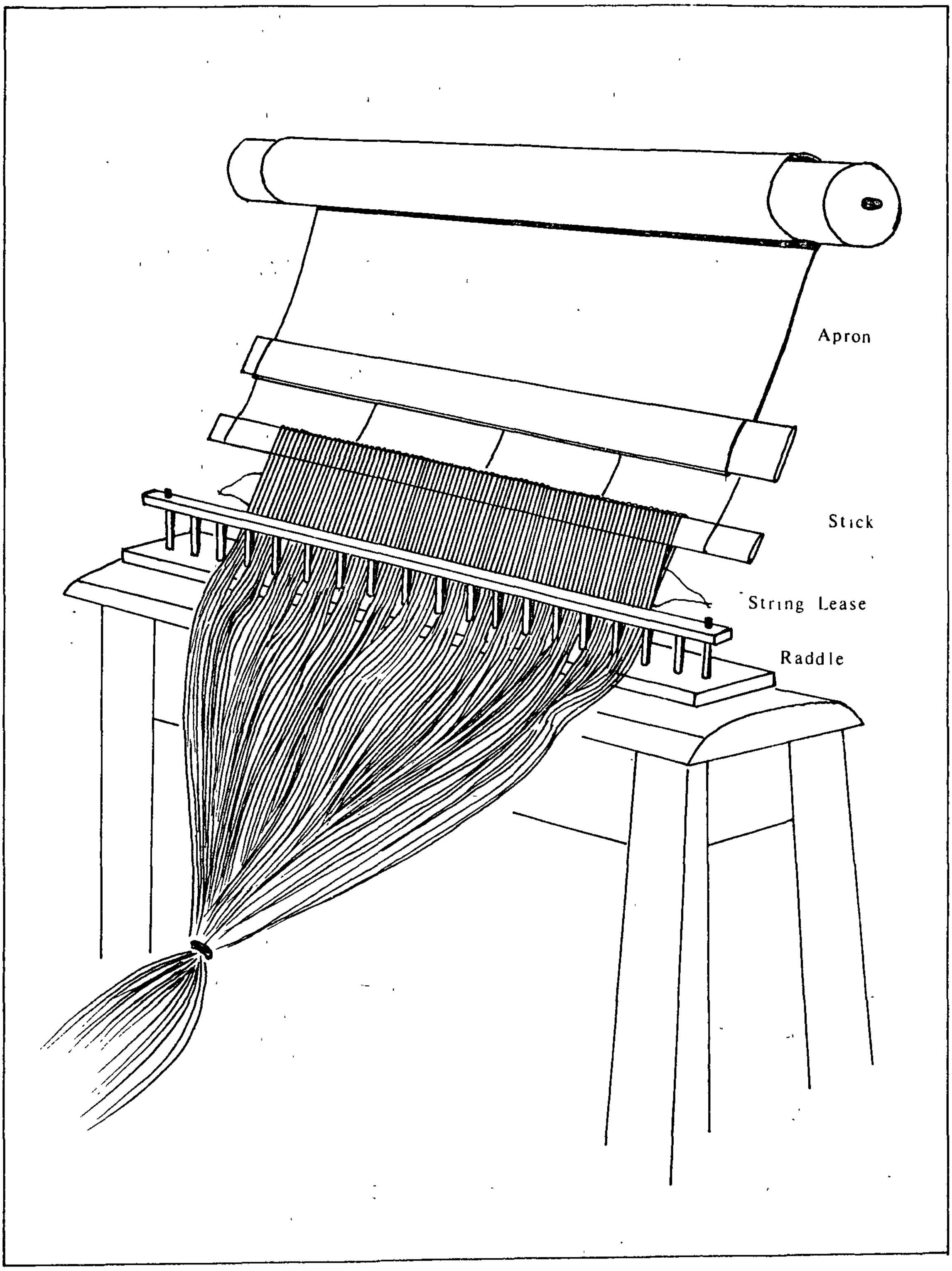


Fig 9.5

position of the warp upon completion of raddling. The beaming of the warp was successfully accomplished with the aid of an assistant. One person was responsible for winding the warp onto the beam which was rotated by a handle slotted into the side of the roller itself and additionally paid attention to the yarn traversing the raddle as disordered groups of yarn could occur during winding, causing breakages of individual warp ends. The other person stood approximately two metres away facing the warp beam, holding the warp under tension in both hands with the ratchet and pawl in operation to prevent the warp unwinding. The weight box or warp tensioner was not in operation at this stage and only became so once the loom preparation was complete. The ties placed along the warp retaining its order and tension were removed one by one as the warp was gradually mounted.

Diligence must be exercised throughout the entire mounting process to ensure that even tension of the warp is retained particularly at the edges. This is of great importance because any slackness that does occur in any part of the warp will become evident during weaving by affecting the even circumference of the printed image which will become misshapen. It is intended to enlarge upon this point later in the thesis.

Once the excess of warp came to within approximately half a metre of the raddle the latter was removed and smooth rods known as cross or lease sticks usually the width of the loom replaced the string leases which had occupied the front lease position since the warping process. The rods were attached overhead to the loom framework with cord so that they were unable to slip out of their individual shed positions. Additionally they assisted the subsequent threading process by forming a rigid base from which the individual warp ends could be plucked easily for threading. The heald shafts comprise individual rigid frames that connect and correspond with the shedding mechanism, shaft number 1 being the first shaft observed at the front of the loom, and shaft number 16 occupying a position at the back of the group of shafts. The depth of the area occupied by the sixteen shafts of the dobby loom employed amounted to 17.1 centimetres.

Each shaft contains a number of wire healds and each heald supports a centrally placed eye through which each warp end is carried. The number of healds required for a warp varies according to the design and warp sett.

Prior to drawing in it is normal to mark the threading sequence onto squared drafting paper which acts as a guide. In the case of each of the three warps for the handwoven warp printed fabrics the threading draft was identical as can be observed from Fig 9.6.

The dobby loom beater comprises a rigid frame which is hung from the framework of the loom directly in front of the shafts. This type is known as the overslung beater, as opposed to the type which is attached to the base of the loom. The crossbar at the top of the beater supports a short length of iron rod that protrudes horizontally from

The Threading Draft

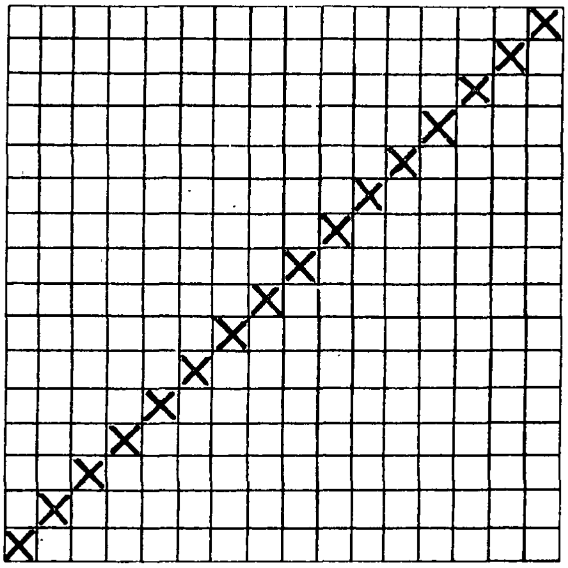


Fig 9.6

either side of it. When the beater is hung in its correct position by these projections which pivot upon grooved supports, it enables the whole to be swung freely to and fro. The purpose of the beater is threefold. Firstly it holds the reed firm which is necessary for even beat-up; secondly, it supports the board on which the shuttle passes through the shed; and thirdly, with the reed it beats up the pick to the fell of the fabric. It is possible fractionally to adjust the height of the beater at the crossbar which is often necessary particularly when the preceding warp was of a different yarn type.

The reed constitutes the metal comb through which the warp is threaded retaining even distribution of the yarn. Reeds vary in size according to the warp yarn type being woven. In most cases two ends are placed in each dent. As indicated in Table 9.2 the wool warp required a 9.6/2 centimetre reed to ensure correct distribution.

Once the warp was dented it was pulled forward toward the front of the loom and was tied onto a warp stick attached to the apron stick of the fabric roller. To ensure the warp was evenly tensioned across its width it was divided into neat sections of approximately 2.5 cm and attached to the warp stick by a double reef knot. The centre of the warp was tied to the stick first with only half the knot complete.

Working alternatively from left to right the other warp sections were tied with a half knot. At this point evenness of the warp was tested by the palm of the hand being placed gently across the width. Any slackness was adjusted by tightening the knot for that area. The knots were completed only when the warp was of satisfactorily equal tension.

The fabric beam is self-explanatory, being the roller onto which the newly woven warp is wound. Like the warp beam the fabric beam is prevented from unwinding by a ratchet and pawl. Additionally there is a further pawl on the fabric beam which is constantly utilized and is connected to a wooden lever situated at the right inside edge of the loom, which enables the warp or fabric to be wound on.

Before weaving can commence the warp tension was set by means of the weight box being attached to the warp beam. This was done by winding two lengths of rope each supporting counter weights around the roller three times, one at each edge, so that the weights hung down clear of the floor at the back of the roller. The free ends of rope were connected to the weight box by hooks placed on either side of it. By adjusting the ropes around the roller either forwards or backwards the distance between the floor and the box can be decreased or increased. It is usual for the weighted box to be positioned approximately 10 cm - 15 cm from floor level during weaving. This distance will increase as the warp is wound forward at the fabric beam, thus the box must be readjusted to its original position when it rises too close to the roller.

According to the type of warp yarn being utilized the box is filled with iron weights which tension the warp at the desired rate. The correct quantity of tension is achieved by 'feeling' the warp with the palm of the hand as well as testing it by weaving a small portion. Consequently if there is any difficulty in locating the shed with the shuttle, or in beating up the pick the warp is generally too loose. It is too tight if the shafts bounce around during the completion of the shedding action.

It was thought advisable to weave approximately 30 cm - 45 cm of plain weave before preparing the warp for printing, to enable the warp to establish itself evenly, during which any necessary final adjustments to either the warp or the equipment were made in order to produce fabric to good effect.

9.2.4 Weft Preparation

Before weaving could commence each of the six selected weft yarns had to be wound onto pirns for weaving.

The coarser woollen yarns such as R722 Tex/4, 1525 Tex, and R1745 Tex/6 had to be guided onto the bobbins with great care as their sheer volume restricted the quantity of yarn that the bobbin could hold. Thus during weaving it was necessary to reload the bobbins with these yarns approximately four or five times to complete one sample.

The type of shuttle used was a boat shuttle which was employed for all the handwoven trials. It is likely that the weft yarns of the traditional Araucanian fabrics were scoured in some way as these were dyed either dark brown or blue, in preparation for weaving.

9.2.5 Constructions

As outlined in 8.2.3 five different constructions were selected for weaving. Fig 9.7 denotes the individual pegging plans for each construction which repeat over eight shafts.

The plain weave, 2/2 repp, and 3 and 1 twill groups were completed initally as the sett of the warp had to be altered for the 2/3 hopsack and 8 end satin groups.

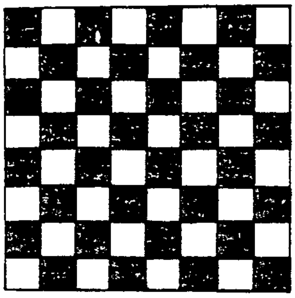
This was achieved by redenting the warp to 30 epc giving a predominantly warp-faced covering to the fabric which simulated similar repp constructions in traditional Ikat fabrics, as well as being essential for the successful formation of the 8 end satin. This in turn altered the width of the warp from 30.5 cm to 20 cm.

It was hoped that the chosen selection of constructions would show clearly their effect upon the image profile not only from the point of view of the formation of it, but also to see whether the degree of irregularity was accentuated by any particular construction.

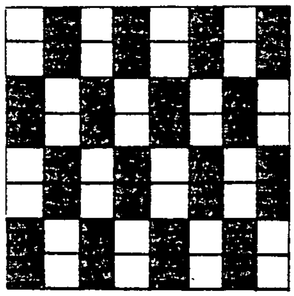
For example it was thought that the satin construction might well cause irregularity of the image profile because there was less take up of the warp during weaving. As it was thought that the shedding action may be the cause of the irregularity, it was thought also that a construction with a slow take up rate might affect the irregularity more as it would take proportionally more shedding to complete.

Additionally these constructions were selected with present day design trends in mind, as it was known through previous

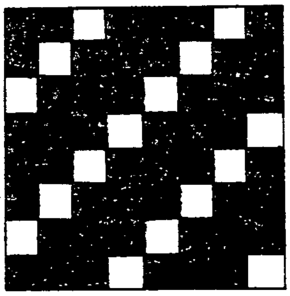
Individual Pegging Plans



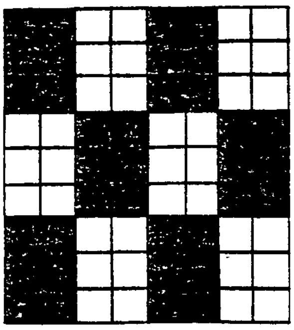
Plain Weave



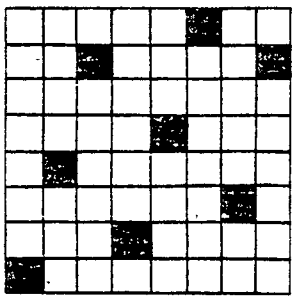
2/2 Repp



3 and 1 Twill



2/3 Hopsack



8 end Satin

Fig 9.7

experience that they all could be utilised to achieve interesting qualities, which would be simple to manufacture.

9.3 Printing Details and Process

9.3.1 Preparation of Stencils

The initial stage of the warp printing procedure for the handwoven wool trials was the preparation of the stencils. First and foremost it was necesary to plan the layout of the design itself. The rectangular image was to measure 6.4 cm by 3.5 cm. It was decided to place five identical motifs in an area of 21.3 cm long by 30.5 cm wide, with three motifs along the lower portion of the area arranged at distances of 5 cm between each one, and two motifs placed 3.8 cm above and between the other three, as Fig 9.8 demonstrates. The object of such positioning was to distribute the motifs evenly so that most central parts of the warp would be affected by the dyestuff but in regular form.

Additionally, as with the motifs themselves, their chosen layout was the result of a personal choice, an intuitive selection representing aesthetic values influenced by present day designs trends.

Instead of exposing a silk screen with the design described, it was decided that for speed and flexibility the design should be transferred to the yarn by means of a paper stencil and a clear silk screen, owing to the unavailability of more up-to-date printing facilities.

Layout of the Rectangular Image

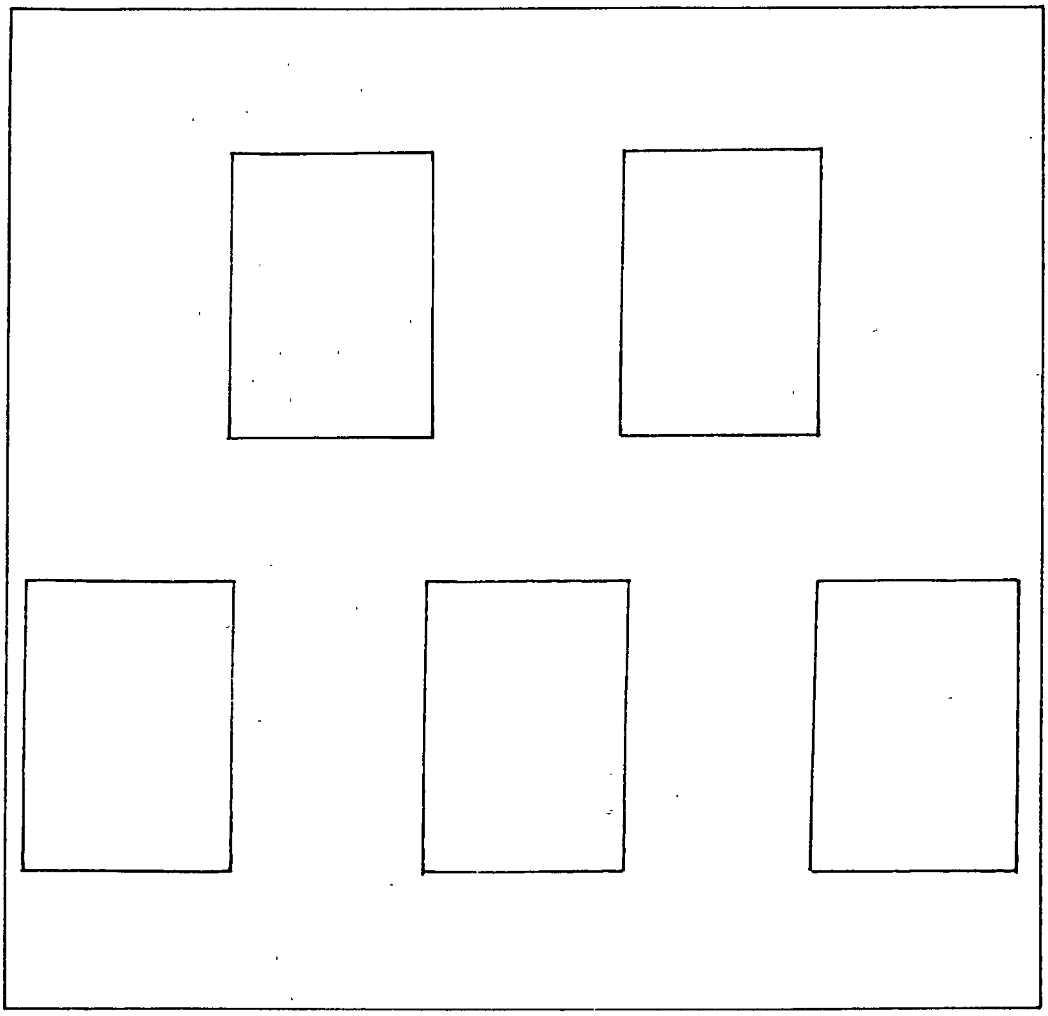


Fig 9.8

The type of stencil paper selected was an M.G. paper which was reasonably opaque with one surface matt and the other gloss. The glossy side was placed against the surface to be printed to resist any dyestuff that may seep beneath the paper, while the matt side stuck strongly to the silk screen thus assisting the clean removal of the stencil. Consequently numerous identical paper stencils were produced, and the motifs themselves were removed with the use of a scalpel. The amount of work for this purpose was reduced by cutting out numbers of stencils at one time.

9.3.2 Dyestuff Selection and Preparation

A further task to be accomplished prior to printing was the selection and preparation of the dyestuff.

As outlined in Chapter 8.2.5 the colour blue was selected for the warp printed handwoven trials which represented the worldwide use of indigo and this was continued for all subsequent weaving experiments to ensure that regularity of colour was maintained.

With these points in mind Coomassie Blue RL was selected for the printing of the wool and silk warp printed handwoven experiments. The acid type is the standard and most suitable range of dyestuffs used for the printing of wool and silk fibres[9], ensuring solubility, ease of fixation, shade and fastness properties necessary best to represent the printed image.

As mentioned previously, prior to printing the yarn it was necessary to scour it to increase the absorption of the dyestuff. This was achieved by gently washing the yarn which was in hank form in hand hot water with the addition of the washing agent Lissapol ND. The hanks were subsequently rinsed and dried. This task was completed prior to the warping procedure.

The preparation of the printing paste was as follows.

Initally it was necessary to prepare the thickening agent which constituted a cold-dissolving chemical gum 301 extra. To obtain a suitable thickening consistency 10% 301 extra was sprinkled onto 90% cold water and thoroughly beaten until a smooth homogenous mass was obtained.

Subsequently the wetting agent Perminal KB was added to the prepared gum followed by the dissolved fixing agent ammonium oxalate. The selected dyestuff Coomassie Blue RL was weighed out with a 1% concentration equalling 1 gram of dyestuff. This was the maximum percent of colour concentration recommended to achieve a good contrast of the printed image upon the natural colour of the yarn. The dyestuff was dissolved in a small amount of cold water and to assist in the dissolving action agents were added particular to the type of dyestuff. Thus the dyestuff solution and the dissolving agent glycerine were boiled together to ensure complete dissolution.

Finally the concentrated solution of dyestuff as combined with the prepared thickening and the paste was amalgamated thoroughly. The consistency of printing paste depends largely upon the particular method of application and the type of surface that is being printed, and is adjusted

Acid Dyestuff Printing Recipe

Recipe	Action of Chemical Additive
X % Dyestuff	
20cc Glycerine or Glydote BN	Dissolving Agent
20cc Water	
300gms 301 Extra	Thickening Agent
6gms Ammonium Oxalate	Fixing Agent
20cc Water	
5cc Perminal KB	Wetting Agent

Table 9.3

Summary of Method of Preparation:

Weigh out thickening agent and stir in Perminal KB. Weigh Ammonium Oxalate and dissolve in 20cc water over heat. Stir into thickening. Weigh dyestuff and dissolve in 20cc water and Glycerine over heat. Add to thickening and mix thoroughly.

according to the necessary requirements.

Thus, in this case, the printing paste was of a suitably thin consistency to penetrate both the silk screen gauze and the wool yarn effectively without soaking the impression completely.

Table 9.3 demonstrates a typical acid printing recipe and a summary of its method of preparation[235,236].

The cotton warp printed handwoven experiments required a different type of dyestuff solution to be prepared which will be outlined at a later stage in this chapter.

9.3.3 The Process of Hand Warp Printing

Initially it was necessary to tie the shafts and the beater together with string firmly securing them to the fabric beam, after having pulled them well forward as Fig 9.9 illustrates.

In effect this procedure lengthened the printing space considerably, by uncovering the area where the healds were normally situated. The lease-rods were placed just in front of the back beam before a string lease was inserted in place of the wooden sticks. This reduced the amount of stretch that occurred around the sticks when the screen was placed in position besides allowing more space for it. A fine metal comb at least the width of the warp was placed directly behind the healds and eased toward the back beam distributing the yarn evenly over the whole expanse.

To enable the silk screen to rest firmly upon the surface of the yarn it was necessary to support it underneath with

The Shafts and Beater Secured to the Fabric Beam

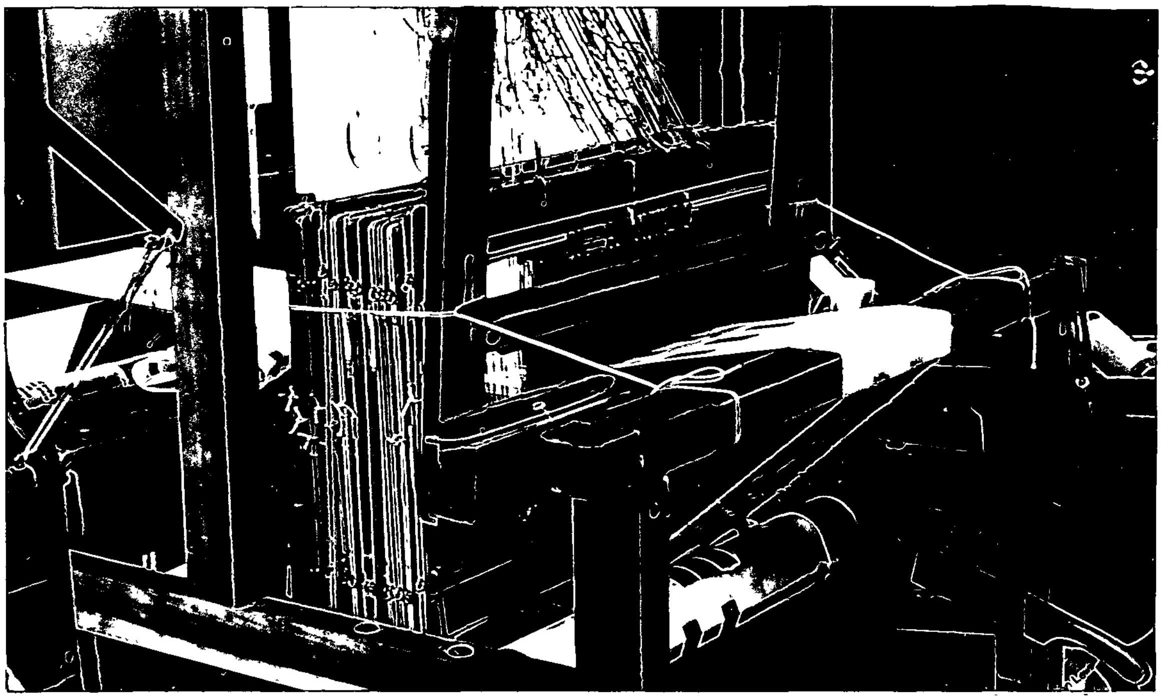


Fig 9.9

Objects Holding Support Board Rigid

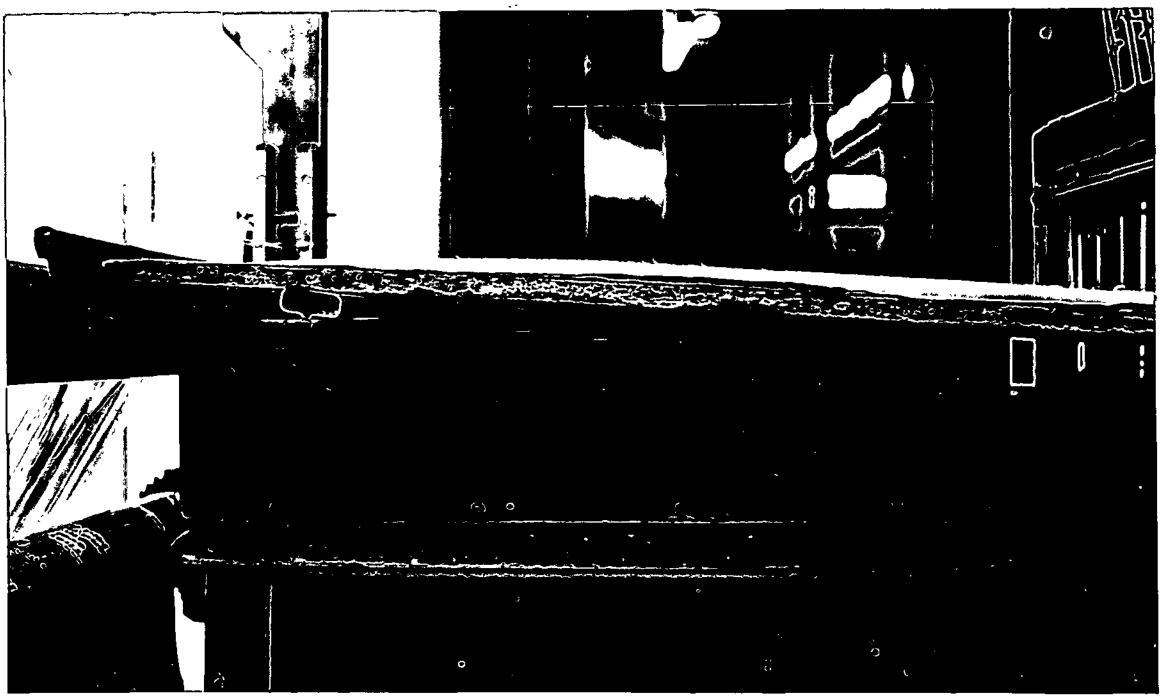


Fig 9.10

a board. To assist positioning of the support board, a stool some 15 cm lower than the warp was placed beneath the stretched yarn to bear the weight of the board.

The support board was covered with layers of newspaper and a piece of plain paper not only to assist in the absorption of the dyestuff, but also to protect the board from becoming stained.

The board was raised to the level of the underside of the warp and wedged tightly in position by inserting objects into the space between the stool and the board as Fig 9.10 illustrates.

Thus a firm support was achieved which not only allowed the yarn to remain tensioned and flat, but also provided a hard surface upon which to place the silk screen.

Before the latter was positioned the paper stencil was placed correctly and attached to the support board by a few small pieces of masking tape, which kept the stencil straight, but enabled it to be removed with the screen upon completion of printing.

Fig 9.11 shows the silk screen in position at the back of the loom being held steady by four iron weights placed in each corner. This avoided any risk of movement during printing.

The number of pulls required across the screen to transfer the print depended largely upon the type of yarn that was being printed. The wool yarns required up to twelve pulls thoroughly to soak through.

Upon the completion of the printing itself the excess dye

Silk Screen Placed in Position for Printing

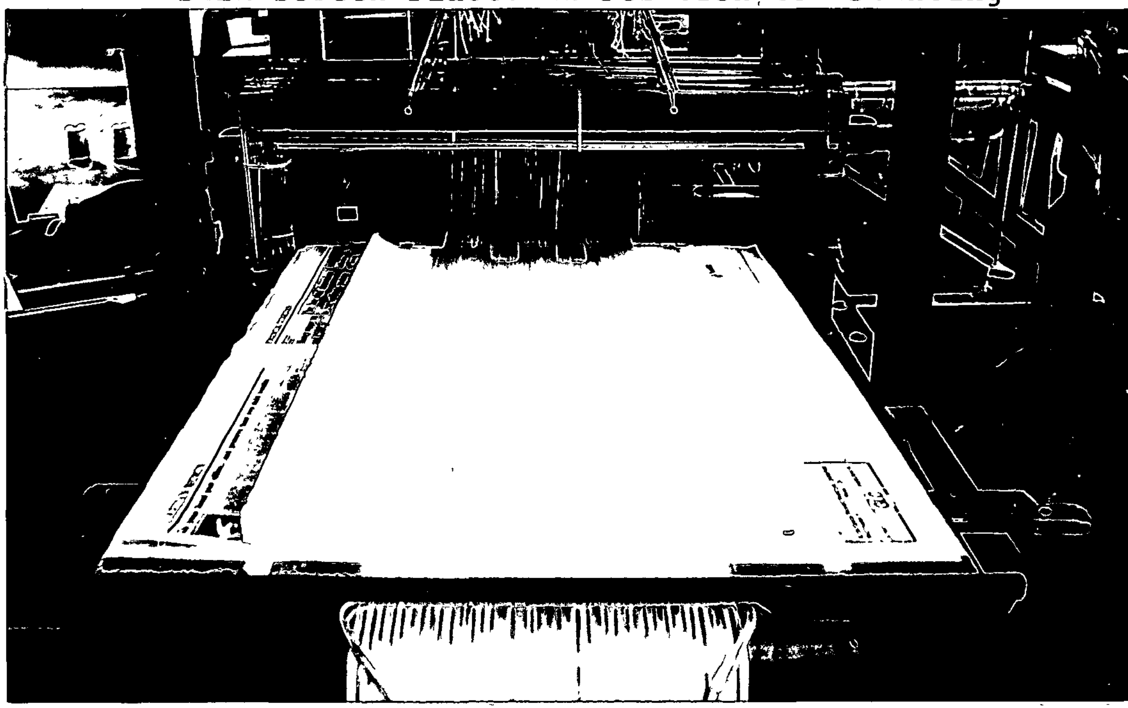


Fig 9.11

The Newly Printed Yarn Upon Removal of the Silk Screen

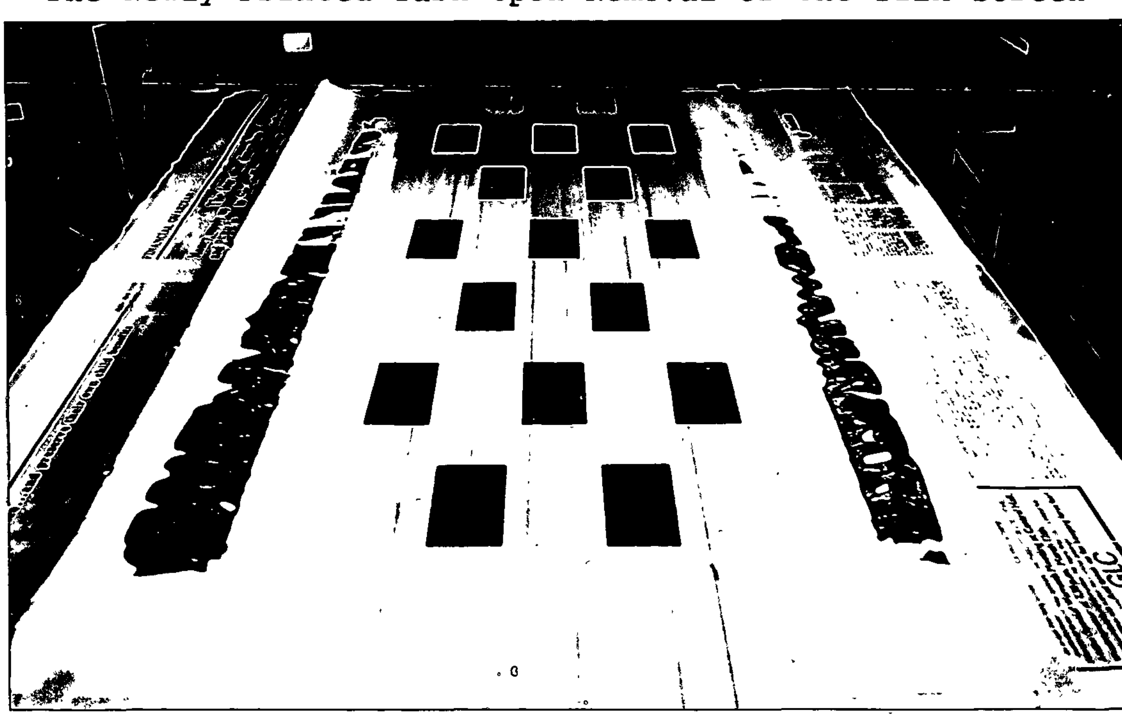


Fig 9.12

was scraped up and reserved. The screen was carefully removed with the saturated stencil stuck to it, revealing the wet impression as Fig 9.12 shows.

It was important to remove the support board and paper immediately as if these were left to dry with the print, it was likely that bleeding or smudging would occur on the edges of the impression. Therefore the objects supporting the board were removed and it was returned to rest upon the stool, which can be observed in Fig 9.13.

9.3.4 Drying of Printed Warp

In most cases the yarn was dried artificially with the use of an electric drier, see Fig. 9.14, which shortened the whole procedure to a matter of minutes, instead of hours. Once the yarn was dry the warp was reassembled again, and Fig 9.15 shows the lease-rods being returned to form the cross once more. The healds and beater were released and replaced in their correct positions and thus, as Fig 9.16 illustrates, the patterned warp was ready to be woven.

Although this production method may appear slow and complicated the whole procedure could be completed in twenty minutes and in general the quality of printing could be maintained. Naturally there are many ways in which warp printing can be achieved and the method presented here is but one procedure, developed for this work. This method is constantly undergoing adjustment to best achieve the particular end that is sought.

The Support Board Lowered onto the Stool

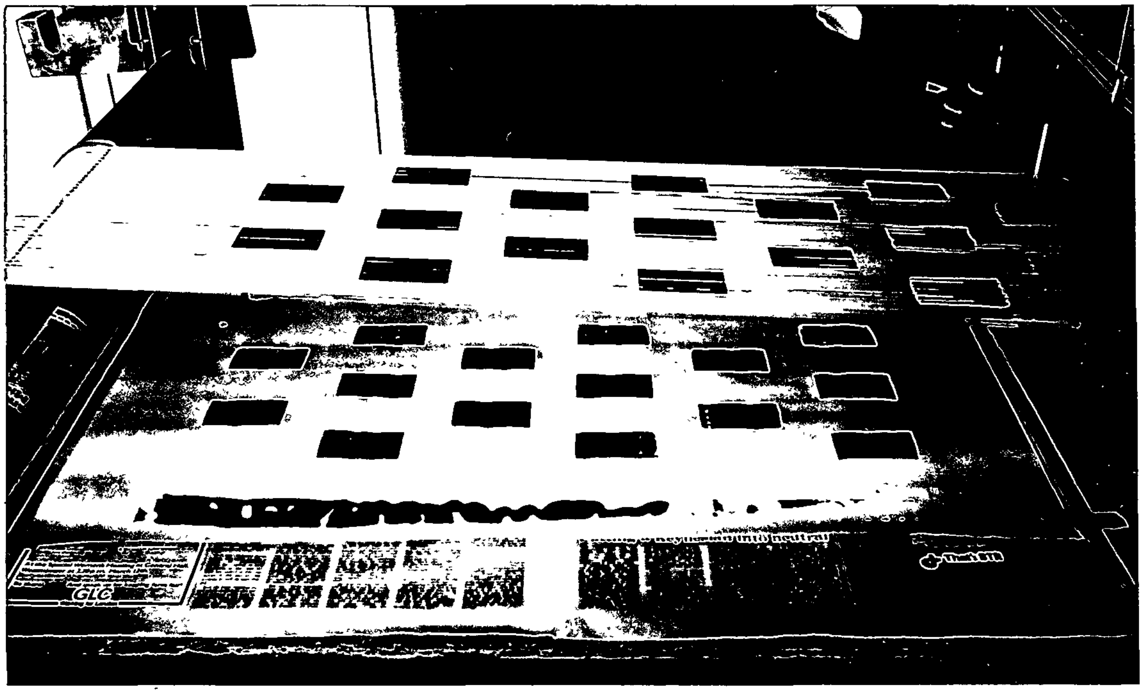


Fig 9.13

Artificially Drying the New Print

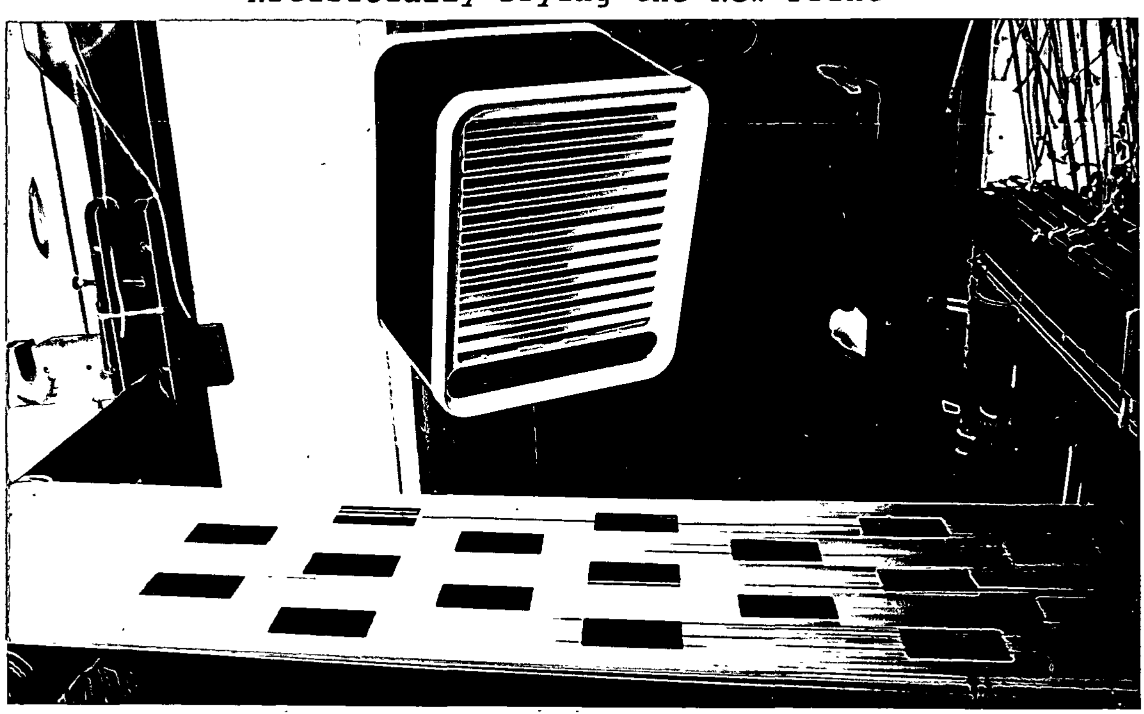


Fig 9.14

Reinsertion of the Lease-Rods

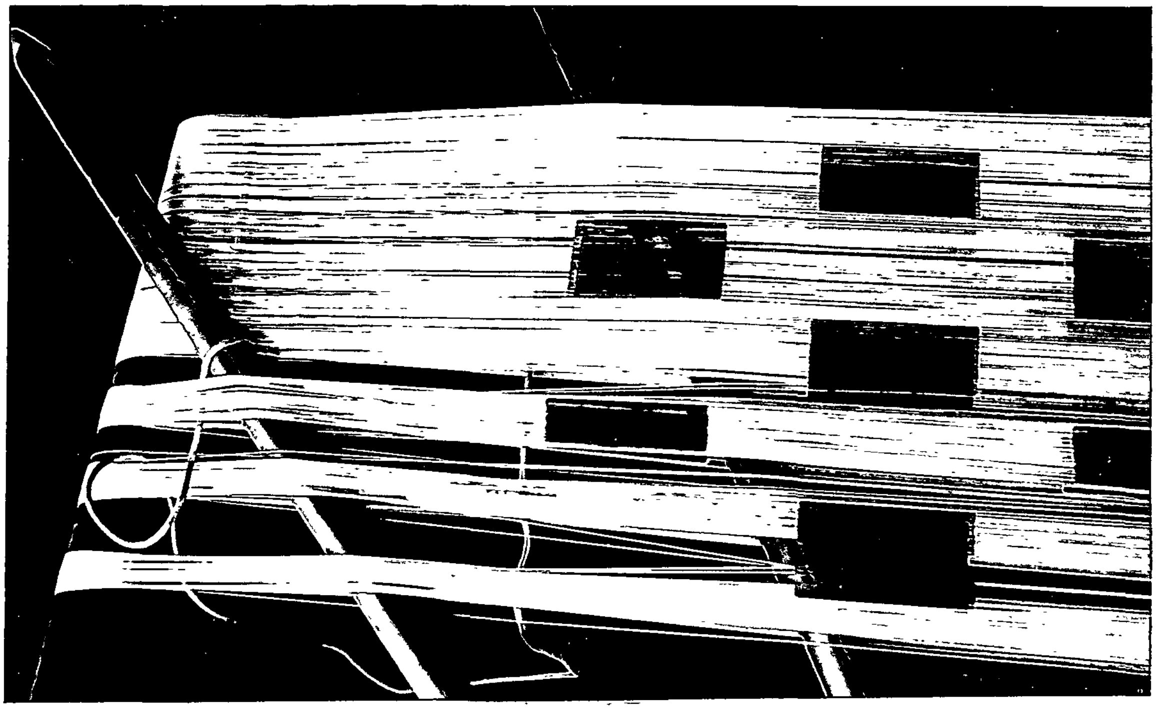


Fig 9.15

The Newly Printed Warp Prepared for Weaving

Fig 9.16

9.4 The Weaving Process

9.4.1 Range of Samples and Weaving Order

Table 9.4 gives a summary of the description outlined in section 9.2.5 of the weaving order of each group of samples and the subsequent alteration of the fabric sett which enabled the 2/3 hopsack and 8 end satin construction groups to be formed successfully. This entailed rereeding the warp to 9.6/3.

Each sample was numbered consecutively throughout the series of handwoven trials in order to distinguish the change in linear yarn density of the weft and how its variation altered the ends and picks per centimetre in each construction category.

During the weaving process each sample was woven in an identical manner. Between each impression of the printed image approximately 1 cm of the finest weft count was woven. This enabled a compact fabric to form which was less prone to fraying enabling each sample to be separated neatly from its neighbour with the use of pinking shears once the group was completed and removed from the loom.

During the weaving of each individual sample constant attention was paid to the overall visual and tactile qualities in an attempt to produce a pleasing fabric whereby such factors as drape and weight had been carefully considered. Thus as regards the visual qualities, the horizontal placement of each pick and the even formation of both selvedge edges were diligently maintained. This was achieved with the finer wool yarns without too much

Numerical Order of the Woollen Samples Showing the Variations of Construction, End and Pick Measurements, and Linear Yarn Density

Sample Number	Construction	Ends Per Centimetre	Weft Yarn Count	Picks Per Centimetre
1	Plain Weave	20.4	R40 Tex/2	13.6
2	" "	20	155 Tex	8.3
3	" "	20	389 Tex	5.9
4	" "	20	R722 Tex/4	3.9
5	" "	21.2	1525 Tex S	3.1
6	" "	20	R1745 Tex/6	2.3
7	2/2 Repp	20.4	R40 Tex/2	11.0
8	" "	20	155 Tex	5.9
9	" "	20	389 Tex	4.3
10	" "	20.5	R722 Tex/4	3.1
11	" "	20	1525 Tex S	1.9
12	" "	20.4	R1745 Tex/6	1.6
13	3/1 Twill	21.2	R40 Tex/2	20.4
14	" "	20.4	155 Tex	10.2
15	" "	20	389 Tex	7.9
16	" "	20	R722 Tex/4	5.1
17	" "	20	1525 Tex S	3.1
18	" "	19	R1745 Tex/6	2.3
19	2/3 Hopsack	31.4	R40 Tex/2	9.4
20	" "	30	155 Tex	4.7
21	" "	31.4	389 Tex	3.5
22	" "	28.3	R722 Tex/4	2.4
23	" "	29.9	1525 Tex S	1.9
24	" "	29.9	R1745 Tex/6	1.1
25	8 End Satin	31.4	R40 Tex/2	26.7
26	" "	31.4	155 Tex	15.7
27	" "	31.4	389 Tex	9.4
28	" "	31.4	R722 Tex/4	7.0
29	" "	29.9	1525 Tex S	4.3
30	" "	29.9	R1745 Tex/6	3.1
31	Repeat Plain Weave	21.6	R40 Tex/2	13.1
32	" " "	20.3	155 Tex	7.6
33	" " "	19.7	389 Tex	5.9
34	" " "	20	R722 Tex/4	3.8
35	" " "	19.9	1525 Tex S	2.7
36	" " "	19.9	R1745 Tex/6	2.0

Table 9.4

difficulty, but the heavier ones such as those of 1525 Tex and R1745 Tex/6 (see Table 9.1) were more cumbersome to place. Owing to their sheer volume a good deal of hand manipulation was necessary whilst they were passed through the shed, and each selvedge edge required individual attention in its formation.

With regard to the tactile aspect, the beat up rate of each weft pick was constantly intuitively monitored in order that an even fabric should result. Intuitive monitoring may be explained as a combination of continued weaving experience, and a personal facility instinctively to ascertain the required pressure and rythmn necessary to produce a particular type of woven fabric.

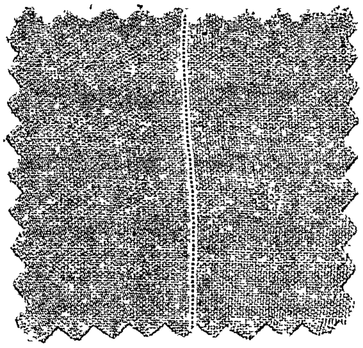
During beat up it was possible to detect not only natural fibrous property of wool yarn which gave rise to an abrasive sensation as the beater passed through the warp ends, but also the feeling of great firmness as the pick was beaten into place, the result of enormous tension at the fell of the fabric.

Thus to complete the warp printed handwoven wool trials a total of 36 samples was produced which included six additional plain weave samples repeated at the end of the five groups to incorporate markers from which accurate end and pick measurements could be assessed.

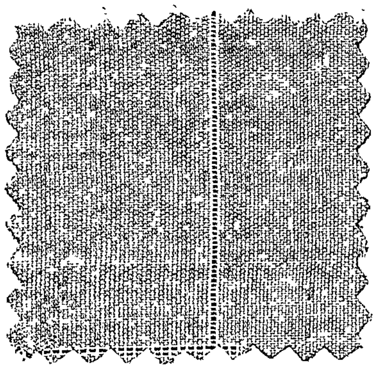
9.4.2 Measurements Made

Measurements for each sample of the original five construction groups were recorded by means of a ruler and

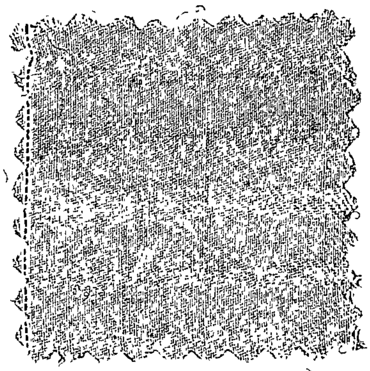
APPENDIX VI - SILK FABRICS



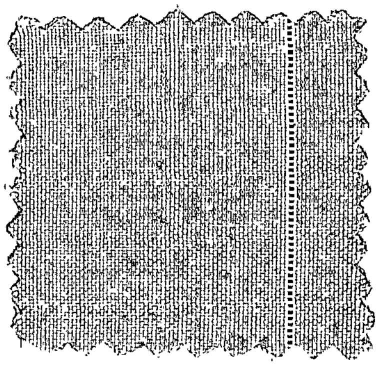
Plain Weave



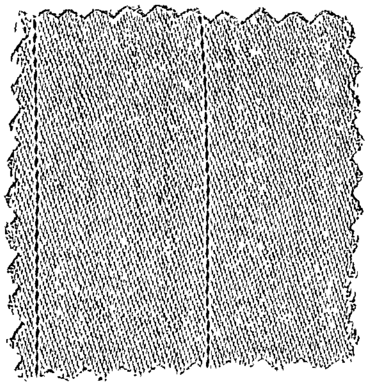
2/2 Repp



3 and 1 Twill



2/3 Hopsack



8 end Satin

eyeglass whilst the fabric was still in the loom state. It soon became apparent that this method of measurement was extremely inaccurate which resulted in a further method being devised.

This entailed individual markers of identical yarn counts as the warp and weft being placed within the fabric structure. The markers were a black coloured yarn contrasting with the natural shade of the warp and the tone of the print so they could be clearly observed.

Initially seven black markers were placed in the warp after it was set up on the loom, at intervals of 100 ends each. Each black marker replaced an end of warp. For accuracy the 100 ends were measured on the reed instead of being counted individually. As weaving progressed, identical black markers of the same linear density as the weft being woven were placed into the shed thus dividing a determinate number of picks. This division depended upon the thickness of the weft yarn being woven. For very fine yarn it was possible to weave 100 picks placing a black marker at pick number:1 and pick number:100. The measurement taken would include the outer perimeters of these markers.

For yarn of medium density it was possible to weave only 50 picks including the markers; and for very coarse weft yarn it was usually only possible to weave 25 picks including the markers. It was necessary only for two black marking picks to be inserted in each sample, and the black marking ends they formed a grid upon the woven sample as Fig 9.17 illustrates.

Layout of Marking ends and Picks for end and Pick Measurements

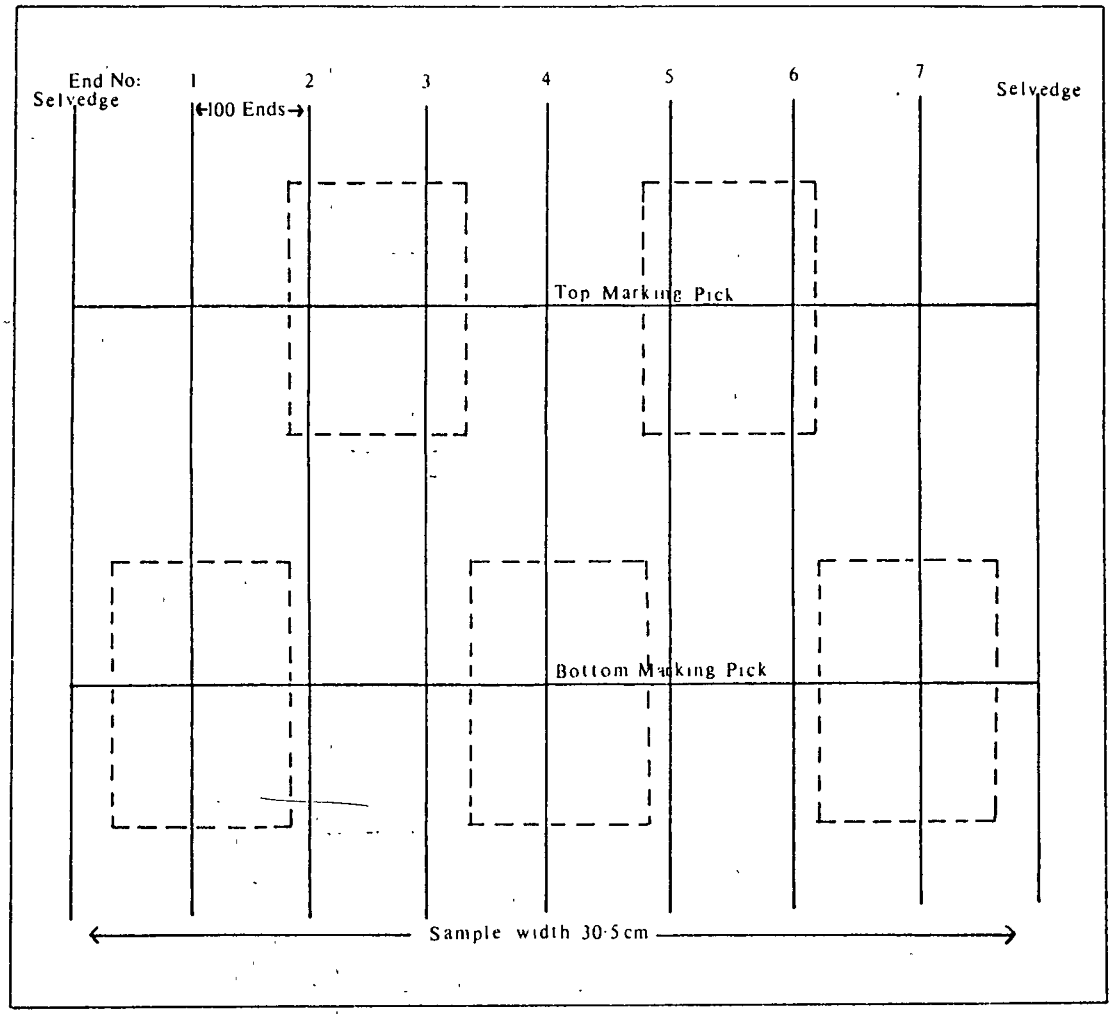


Fig 9.17

This grid formation enabled warping and picking measurements to be taken accurately with the aid of a vernier caliper measuring tool. For assessing the ends per centimetre three identical measurements were taken in different areas of the sample to give the number of ends per centimetre in each area. These three results were added up and subsequently divided to give the average number of ends per centimetre for the particular sample.
For picking assessment each individual marking end was measured between the marking picks providing seven individual calculations.
Each one was subdivided into equal units and the quantity of picks in each unit was counted. The total number of picks counted at the point of each black marking end was divided by the original measurement giving the number of picks per centimetre at that point. This procedure was repeated for each of the seven sets of measurements which were then averaged to give the mean number of picks per centimetre for the particular sample. This method of measurement of the warp and weft was continued throughout the whole series of warp printed handwoven trials.
Adjustment was made to the number of marking ends placed in the cotton and silk warps from seven to five, in that subsequently it was felt that only five were necessary from the view point of practicality.
Appendices I-III list the end and pick measurements for each sample for the whole series of woven trials.

9.5 The Finishing Process

9.5.1 Finishing Routines

Owing to the type of dyestuff used it was necessary to put the completed samples through a finishing routine. The purpose of such a procedure was to fix the dyestuff into the yarn by means of a steaming operation, after which the fabric was subjected to a thorough rinsing in clean water to remove any loose dyestuff, thickening agent or chemicals which may have been left on the surface of the fibre. This latter routine causes the fabric structure to become evenly distributed and imparts a soft handle to it.

The type of equipment employed for steaming comprised a deep cylindrical chamber approximately 80 cm wide, covered by a detachable lid. This type of apparatus is known as an atmospheric steamer, functioning by means of a 60 gallon header tank feeding into the bottom of the steamer on a ballcock system. Situated at the base of the cylinder are two 12 watt immersion heaters which boil the water. Thus with this type of steamer there is no poundage of steam pressure[237].

Each fabric to be steamed was pinned onto the centre of the backing fabric which was attached at one end to hooks situated on the underside of the detachable lid of the steamer. To facilitate this task the lid was pulled away from the cylinder so there was enough room for the backing fabric and samples to hang toward the floor freely. Thus the backing fabric was wound around itself protecting the warp printed handwoven samples on the inside from becoming wet, and ensuring that the printed fabric would be evenly affected by the steam. Once the attaching task was complete the backing fabric was carefully guided into the steaming chamber and the lid made fast.

Upon contact with the steam the printed areas absorb the moisture and form a localized concentrated wet dyebath which is controlled by the amount of thickening agent used. If the steam contains too much moisture or the quantity of wetting agent is too great, bleeding will occur. Alternatively, if the steam is not moist enough the thickening substance will not absorb enough moisture to enable the dyestuff to fix satisfactorily. Acid dyestuffs are subject to steaming periods of one hour which ensures that the dyeing operation is thorough. Thus for such lengths of time, the moisture level of the steam must be carefully controlled to avoid bleeding.

Upon completion of steaming the backing fabric was removed from the steam chamber and detatched from the lid, whereupon it was laid flat to allow the damp samples to air and be unfastened.

To conclude the finishing process it was necessary to submerge the steamed samples into cold running water to remove any printing substances that may have been left on the surface of the yarn. Once in the water the fabric was agitated continuously for approximately 15 minutes to ensure it did not lie in one place and run the risk of becoming coloured in 'white' areas by any loosened dyestuff. Gradually the temperature of the water was increased until it was tepid, whereupon sometimes a mild washing agent such as Lissapol ND was employed gently to ensure that any surplus dyestuff, thickening agent and chemicals had been removed.

After spin drying the rinsed samples quickly, they were laid flat to dry naturally. This position proved more desirable than suspending the fabrics as it was discovered to some cost that slight bleeding can occur in a downward direction if the fabrics were not completely thoroughly rinsed and spun.

9.5.2 Pressing and Sample Preparation

Finally to complete the whole production process the dried samples were steam pressed with a hand iron, and neatened up at the edges by clipping any projecting tail ends of yarn with scissors. Additionally, the samples were separated from each other with pinking shears as mentioned in section 9.4.1 and each corner of the separation was cut obliquely with scissors to reduce any possibilities of fraying.

9.6 Warp Printed Cotton Fabrics

9.6.1 Warp and Weft Yarn Details

From the historical survey and ensueing classification it was noted that cotton was a fibre of great popularity in Southern Russia, Indonesia and Japan. The linear density of the yarn in both the latter countries consisted of a coarser type than that employed by the Uzbegs of Turkestan, which constituted a much finer composition. To correspond with these findings, a yarn similar to those used in either Indonesia or Japan was selected for the warp and comprised a twofold natural grey cotton of resultant Tex count R37.5 Tex/2. Its constitution was considered to be amenable for use as a warp yarn as it was neither too fine nor too coarse. Additionally, through examination it was considered to have good properties of absorption because of its natural character, although it did appear tightly spun. Furthermore it was felt that this yarn would produce a series of agreeable fabrics when coordinated with the various selected weft yarns.

Table 9.5 identifies the warp and weft yarns employed for the cotton trials, showing that the R37.5 Tex/2 natural grey cotton was used not only for the warp, but also for the second weft yarn. Like the wool weft yarns, they are shown in metric order. The five other weft yarns comprised one very fine twofold gassed cotton of resultant Tex count R11.75 Tex/2; a coarser twofold gassed cotton of resultant Tex count R98 Tex/2; and a natural grey slubbed cotton of 125 Tex; followed by two coarser gassed cotton yarns of resultant Tex counts R195 Tex/2 and R390 Tex/2 respectively.

It was felt that in most cases this selection of weft yarns linked with the types of cotton yarn used by the traditional Ikat weavers in the three geographical areas identified, and that the resulting fabrics would correspond closely.

Cotton Warp and Weft Yarn Details

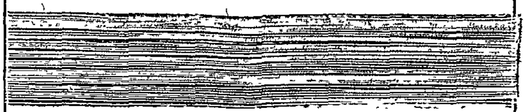
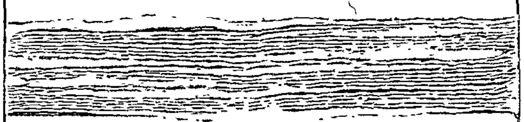
Warp Yarn	R37.5/2 (Tex)	
Sample No.	Weft Count (Tex)	Sample
1	R11.75/2	
2	R37.5/2	
3	R98/2	
4	125	
5	R195/2	
6	R390/2	

Table 9.5

9.6.2 Process Details

Table 9.6 indicates the warping details of the cotton yarn, showing the number of ends per centimetre used, the width and length of the warp, the reed size and the total number of ends necessary. As mentioned in the section on warping in 9.2.2 various factors were considered to determine the particular number of ends per centimetre for the cotton warp. By observing a selection of traditional cotton Ikat fabrics it was noted that in most cases the ends were not very closely sett, thus a wide range of tactile qualities existed, each with different degrees of managability. It was mainly this aspect which determined the particular sett of the cotton warp at 20 ends per centimetre, as there was no previous experience in the use of this yarn for weaving. As with the preceding warp the linear density of the weft yarns was selected to comprise a range of variants that coordinated appropriately with the warp, and answered present day design and manufacturing requirements.

It is not planned to reiterate the entire warping and looming procedures outlined at the beginning of this chapter, but it is necessary for the success of the comparative analysis that each series of warp printed handwoven experiments should be identical. Hence the cotton warp was produced in exactly the same manner as its wool counterpart, and the only changes necessary to facilitate the weaving operation were made, during the setting up of the warp.

Initially the length of the warp was reduced to

Cotton Warping Details

	Plain, 2/2 Repp, 3 and 1 Twill	2/3 Hopsack, 8 End Satin
Ends Per Centimetre	19	29
Width of Warp	30.5 cm	20.1 cm
Length of Warp	11.9 metres	
Reed Size	9.6 cm	
Total number of ends	570	

Table 9.6

11.9 metres, from the 13.5 metres used for the wool one. It became evident upon completion of the latter that the percentage of warp reserved for wastage was too generous thus a reduction in the length of the cotton warp would be reasonable.

In addition, a check had to be conducted to ensure each shaft carried the correct number of healds since the linear density of the warp yarn had altered slightly. Such alteration in fact was not necessary as the difference in volume of both yarns was negligible. Consequently neither was a change of reed size required.

The preparation of the six selected weft yarns for weaving was accomplished in an identical manner to that for the wool yarns. Any in hank form were converted to cones to facilitate the winding of the weft. The fine density of the yarns enabled the pirns to be filled to capacity which was enough for the completion of a whole sample in most cases. Only the pirns holding the coarser yarns required refilling during weaving.

No variation was made to the five constructions employed for the weaving of the cotton warp. Like the wool warp the plain weave, 2/2 repp and 3 and 1 twill groups were woven initially, whereupon the sett of the warp was altered for the 2/3 hopsack and 8 end satin groups. Accordingly the warp was redented to 29 ends per centimetre giving a more warp faced covering, and reducing the overall width of these samples to 20.1 cm.

9.6.3 Dyestuff Selection

Direct dyestuffs are a standard and suitable type used for printing cotton fibre, with good solubility, fixation, shade and fastness properties.

To represent a similar tone of blue as the acid dyestuff used for the wool and silk samples, 2% of Durazol Blue 2R was selected as the appropriate shade for the cotton warp. The procedure for the preparation of the printing paste was similar to the acid recipe but the main components differed.

The thickening agent 301 extra again formed the basis of the solution: 425 grams of prepared gum was weighed and placed into a mixing bowl. To this the fixing agent sodium dihydrogen phosphate was added after being dissolved over heat in 20 cc water. The gum and fixing agent were amalgamated thoroughly. Two grams of the selected dyestuff were weighed out, followed by 25 grams of the dissolving agent urea. These were added to 25 cc of cold water and heated to dissolve completely. Subsequently this was stirred into the thickening solution forming approximately 500 cc of dyestuff paste.

Table 9.7 demonstrates a typical direct printing recipe and includes a summary of its preparation[238,239].

9.6.4 Printing Details and Process

The methods described in section 9.3.6 were repeated exactly for the preparation of the loom and warp prior to printing. Additionally the printing itself was identically

Direct Dyestuff Printing Recipe

Recipe	Action of Chemical Additive
X % Dyestuff	
25gm Urea	Dissolving Agent
25cc Water	
425gms 301 Extra	Thickening Agent
7.5gms Sodium Dihydrogen Phosphate	Fixing Agent
20cc Water	

Table 9.7

Summary of Method of Preparation:

Weigh out thickening agent. Weigh out Sodium Dihydrogen Phosphate and dissolve in 20cc water over heat. Stir into thickening. Weigh dyestuff and Urea and dissolve in 25cc water over heat. Add to thickening and mix thoroughly.

completed except that a fewer number of pulls were required to transfer the image. The R40 Tex/2 wool warp yarn required up to twelve pulls to be thoroughly impregnated with dyestuff, whereas the R37.5 Tex/2 cotton required between six and eight pulls. Upon completion of printing, the yarn was dried in the same manner as previously outlined and reassembled in its correct position in preparation for weaving.

9.6.5 Range of Samples and Weaving Order

Table 9.8 identifies the numerical and weaving order of each group of cotton samples, and shows the linear density of the weft yarns, and the corresponding end and pick measurements.

For ease of identification the numeration of the cotton samples continued on from the conclusion of the numerical order of the wool groups, the first plain weave cotton sample was numbered 37, and the final satin cotton sample was numbered 66.

Additionally each warp was colour coded: the wool warp blue; the cotton warp yellow; and the silk warp red. The sequence and procedure for weaving the cotton samples was identical to that of the wool warp and as mentioned the sett of the warp was altered for the 2/3 hopsack and 8 end satin groups.

As regards the quality of weaving of each sample, which included the placement and beat up rate of each pick, and the formation of the selvedges, the same diligent care was

Numerical Order of the Cotton Samples Showing the Variations of Construction, End and Pick Measurements, and Linear Yarn Density

Sample Number	Construction	Ends Per Centimetre	Weft Yarn Count	Picks Per Centimetre
37	Plain Weave	21.3	R11.75 Tex/2	12.9
38	" "	20.5	R37.5 Tex/2	9.0
39	" "	19.4	R98 Tex/2	8.4
40	" "	20.1	125 Tex S	7.9
41	" "	19.4	R195 Tex/2	7.2
42	" "	19	R390 Tex/2	5.1
43	2/2 Repp	20.7	R11.75 Tex/2	12.5
44	" "	20.1	R37.5 Tex/2	7.9
45	" "	19.5	R98 Tex/2	7.3
46	" "	19.9	125 Tex S	7.0
47	" "	18.8	R195 Tex/2	5.2
48	" "	18.8	R390 Tex/2	3.3
49	3/1 Twill	21.1	R11.75 Tex/2	21.3
50	" "	20.8	R37.5 Tex/2	13.4
51	" "	20	R98 Tex/2	12.5
52	" "	20.5	125 Tex S	12.4
53	" "	19.7	R195 Tex/2	9.2
54	" "	19.4	R390 Tex/2	6.1
55	2/3 Hopsack	15.3	R11.75 Tex/2	10.5
56	" "	14.9	R37.5 Tex/2	6.7
57	" "	14.2	R98 Tex/2	6.1
58	" "	14.8	125 Tex S	5.9
59	" "	14.1	R195 Tex/2	4.2
60	" "	14.1	R390 Tex/2	3.1
61	8 End Satin	30.5	R11.75 Tex/2	35.2
62	" "		R37.5 Tex/2	20.1
63	" "	29.7	R98 Tex/2	16.4
64	" "	30.4	125 Tex S	18.2
65	" "	33.9	R195 Tex/2	11.2
66	" "	29.5	R390 Tex/2	8.4

Table 9.8

exercised to ensure an agreeable fabric resulted. Great tension was detected again at the fell of the fabric as each pick was beaten into position.

In total to complete the cotton warp printed handwoven trials 30 samples were produced each incorporating marking ends and picks for the assessment of end and pick measurements, as devised for the plain weave samples (numbers 31-36) repeated at the conclusion of the wool warp. The method of measurement and calculation of the ends and picks was carried out in a similar manner to that outlined in section 9.4.2. The initial three end per centimetre measurements for the plain weave samples were assessed with a pieceglass in the finished state, as opposed to being measured with the vernier caliper in the loom state. This was the result of the measuring method for the ends per centimetre not being devised thoroughly. Assessment thereafter was more organised and achieved in the method outlined in section 9.4.2.

9.6.6 Finishing Process

Upon completion of weaving the samples were removed from the loom and subjected to an identical finishing routine to that of the wool samples described in sections 9.5.1 and 9.5.2. Like the acid dyestuff, the direct dyestuff was steamed for a period of one hour to be certain that the dyeing operation was thorough. Subsequently the same rinsing routine in cold running water was carried out to ensure any unwanted printing substances were removed from the surface of the yarn. Finally the samples were dried, before being neatened, separated and steam pressed, the task which concludes the manufacturing process.

9.7 Warp Printed Silk Fabrics

9.7.1 Warp and Weft Yarn Details

The warp and weft yarns used for the silk handwoven warp printed trials are shown in Table 9.9 in their order of linear density. To select a suitable warp yarn it was necessary to observe some traditional silk Ikat fabrics, and to refer to classification Table 7.2. Southern Russia, Indonesia and Japan were the countries identified and upon examination of traditional silk fabrics from these areas it was seen that in general silk fibre of reasonable fineness was used.

This is an interesting point as it is not known what governed such apparent convention.

It would be easy to assume that the fineness of linear density was the result of the type of yarn exported from China via the silk routes; but perhaps it was the method by which the silk thread was unwound from the cocoon and packaged; or perhaps it was a matter of economy, the finer the yarn the less utilized, thus the expense of production was regulated. Additionally its use could have been influenced by the consumer, the finer the linear density of yarn, the more expensive and luxurious the fabric became, irrespective of climate. Finally, as noted previously, the Ikat effect itself is enhanced by the use of fine yarns

Silk Warp and Weft Yarn Details

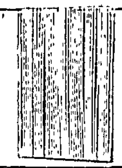
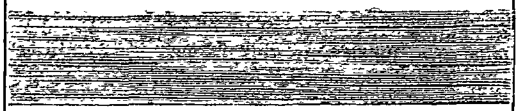
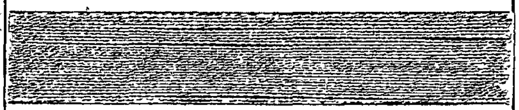
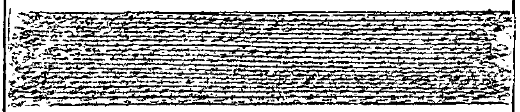
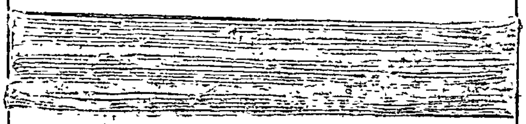
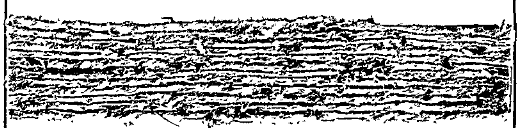
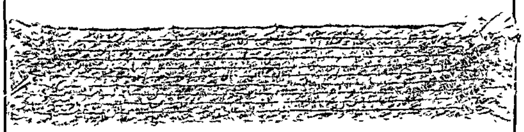
Warp Yarn	R12.5/2	
Sample No.	Weft Count (Tex)	Sample
1	R12.5/2	
2	R40/4	
3	R96/2	
4	118	
5	140	
6	R340/2	

Table 9.9

thus perhaps it was preferred not only by the consumer, but the weaver also.

To reflect these hypotheses a twofold spun silk of resultant Tex count R12.5 Tex/2 was chosen for the warp yarn. From previous weaving experience this particular yarn was known to produce fabric of fine quality hence its suitability for the handwoven warp printed experiments. Additionally from previous experience it was known to absorb printing dyestuff to good effect. Not only was this yarn used for the warp, but also for the finest of the six weft yarns. The subsequent five comprised a smooth fourfold spun silk of resultant Tex count R40 Tex/4; a twofold spun silk of resultant Tex count R96 Tex/2; a smooth singles slubbed silk of 118 Tex; followed by a further singles rough silk of 140 Tex. The final yarn was a coarse twofold spun silk of resultant Tex count R340 Tex/2.

Such a selection of weft yarns was thought not only to balance well with the chosen warp yarn, but also to represent the varying weights of weft observed in the traditional fabrics. It was anticipated that a collection of interesting and useable fabrics would result, which would be applicable to present day design trends also.

9.7.2 Process Details

The five construction groups were produced from two different silk warps. This was the result of additional analytical work which will be discussed in detail in a subsequent chapter, being carried out simultaneously as the weaving on the five constructions. Thus Table 9.10 identifies details of the first and second silk warps which like the previous wool and cotton warps, were prepared by hand on the type of warper discussed in section 9.2.2. From the first warp the plain weave, 2/2 repp, and 3 and 1 twill samples were produced. The number of ends per centimetre was the result of previous weaving experience, as was the selected R12.5 Tex/2 yarn which was frequently used for design purposes prior to this research programme. 31.5 ends per centimetre of this yarn type formed a fabric sett which like the wool and cotton warps, was slightly warp faced hence facilitating the clarity of the printed image. Additionally this fabric sett was similarly structured to some of the traditional silk Ikat fabrics examined in the historical survey. The length of the first warp remained the same as the cotton at 11.9 metres as this was found to be a suitable size for the number of samples being produced. At this stage it was not envisaged that additional weaving would occur which in turn would necessitate a further warp to be made.

The second warp only required a length of 1.8 metres which was sufficient to complete the 2/3 hopsack and 8 end satin groups.

The number of healds per shaft had to be altered for each warp to account for the additional number of ends, and the 9.6 centimetre reed used for the cotton warp was exchanged for a finer size of 16 dents to the centimetre to

Spun Silk Warping Details

Warping Particulars	Warp No: 1 Plain Weave, 2/2 Repp, 3/1 Twill	Warp No: 2 2/3 Hopsack, 8 End Satin
Ends Per Centimetre	31.5	48
Width of Warp	30.5 cm	25.5 cm
Length of Warp	11.9 metres	1.8 metres
Reed Size	16 cm	
Total Number of Ends	960	1200

Table 9.10

accommodate this permutation.

It was decided that the redenting of the 2/3 hopsack and 8 end satin groups of the wool and cotton warps to 20.1 cm was too narrow a width to accommodate the print suitably, since both sample groups showed the rectangular images closest to the selvedges to have a curvelinear outline instead of a sharp edged one. This was exaggerated also by the tension loss at these points from the retying of the warp after redenting.

To prevent this from occuring with the same silk samples a further warp of greater width was made. Hence, for silk warp number 2 the quantity of ends was increased to 48 ends per centimetre to give the correct warp faced covering over a width of 25.5 cm, which allowed enough room either side of the print to prevent any mishaping of the image.

There were in addition further factors which necessitated a second handmade silk warp. The predominant one was that due to the quantity and results of the further experimental work which included the preparation of a third powermade warp, this second handmade one which was infact woven last of the three, represented the findings of these experiments.

With regard to the silk weft yarns, those six selected were prepared for weaving in an identical manner to the other groups of weft yarns, and owing to their fineness of linear density each full pirn lasted for the duration of one sample.

9.7.3 Dyestuff Selection

It mentions in section 9.3.5 that the acid dyestuff type is not only suitable for printing wool fibre, but is used for silk fibre also. Consequently the printing solution was made from the same recipe as outlined in section 9.3.5. One small alteration was made to the solution which was an adjustment to the quantity of glycerine added. Too much of this dissolving agent can cause the dyestuff to bleed upon contact with the silk, therefore to avoid this possibility only 10 cc glycerine was added to the dyestuff solution during its preparation instead of the 20 cc recommended for the woollen fibre.

The dyestuff for the wool and cotton warps was combined to form a fairly liquid solution allowing penetration to occur easily, but the solution for the silk warps was coagulated slightly, since there was less bulk of yarn to impregnate and too much liquidity would risk saturation.

9.7.4 Printing Details and Process

The preparation of the loom for printing, and the printing of the silk warps was performed in an identical manner to that described above for the wool and cotton warps. The only change came at the printing stage when it was necessary only to execute four pulls to transfer the image to the yarn. Owing to the fineness and structure of silk fibre, dyestuff is absorbed efficiently and it usually becomes impregnated directly. Therefore no problems arose regarding the possibility of a streaking effect being caused by the dyestuff not penetrating, which as outlined, was a difficulty with the preceding warp yarns.

9.7.5 Range of Samples and Weaving Order

Table 9.11 identifies the numerical and weaving order of each group of silk samples, the former of which continued from the final 8 end satin cotton samples. Thus the first plain weave silk sample was numbered 67 and the final satin silk sample was numbered 96.

Additionally Table 9.11 shows the linear density of the weft yarns and the corresponding end and pick measurements.

The groups of samples were woven in the same order as the previous two warps, and the same attention was paid to ensure that a fine fabric was produced.

In this case the selvedges required careful formation initially as it was very easy to reduce the width of the fabric by pulling each pick too tight at that point. Once a few picks had been woven carefully and a weaving rythmn established the fabric was woven quickly without the vertical line of the selvedge being destroyed.

The smoothness of the silk gave the impression of a slippery sensation during weaving, but once the pick was placed at the fell of the fabric it remained quite stable.

Like the cotton warp, 36 silk warp printed handwoven samples were produced each containing black marking ends and picks, to enable the necessary end and pick measurements to be made.

Numerical Order of the Silk Samples Showing the Variations of Construction, End and Pick Measurements, and Linear Yarn Density

Sample Number	Construction	Ends Per Centimetre	Weft Yarn Count	Picks Per Centimetre
67	Plain Weave	33.8	R12.5 Tex/2	23.8
68	" "	32.4	R40 Tex/4	15.5
69	" "	32.1	R96 Tex/2	11.1
70	" "	32.1	118 Tex S	10.5
71	" "	31.6	140 Tex	8.4
72	" "	30.8	R340 Tex/2	5.7
73	2/2 Repp	32.6	R12.5 Tex/2	19.1
74	" "	31.5	R40 Tex/4	14.1
75	" "	30.7	R96 Tex/2	8.7
76	" "	33.3	118 Tex S	9.4
77	" "	31.7	140 Tex	6.4
78	" "	31.7	R340 Tex/2	4.3
79	3/1 Twill	33.7	R12.5 Tex/2	40.5
80	" "	33.7	R40 Tex/4	24.0
81	" "	35.6	R96 Tex/2	13.3
82	" "	34.6	118 Tex S	13.9
83	" "	35.6	140 Tex	11.3
84	" "	35.6	R340 Tex/2	6.4
85	2/3 Hopsack		R12.5 Tex/2	17.4
86	" "	43.5	R40 Tex/4	10.3
87	" "	43.4	R96 Tex/2	7.2
88	" "	43.3	118 Tex S	6.8
89	" "	43.3	140 Tex	5.0
90	" "	43.1	R340 Tex/2	3.5
91	8 End Satin	49.6	R12.5 Tex/2	43.0
92	" "	45.8	R40 Tex/4	28.9
93	" "		R96 Tex/2	18.3
94	" "		118 Tex S	17.7
95	" "	42.1	140 Tex	13.0
96	" "	41.9	R340 Tex/2	8.9

Table 9.11

9.7.6 Finishing Process

The silk samples were subjected to the same finishing routine once removed from the loom, as the two preceding warps.

After a steaming period of one hour, necessary for the acid dyeing operation to be completed, the samples were rinsed as previously described and dried. To complete the manufacturing process the samples were neatened, separated and steam pressed.

9.8 Summary

This chapter has been an explanation of the basic techniques used for the production of the warp printed handwoven fabrics which form the foundation of the comparative analysis of the image profile.

It may be seen that the preparation for weaving and warp printing necessitates discipline and order, and each stage of the production procedure must be painstakingly completed to ensure the formation of a distinctive fabric. The quality of the final result is directly related to the attention paid to the preliminaries prior to and during weaving.

Although such procedures are time consuming, in comparison to the resist dyeing methods performed by the Ikat weavers outlined in Chapters 2-6, the warp printing process is far quicker and efficient than the traditional technique.

CHAPTER 10 RESULTS OF WEAVING TRIALS ON WARP PRINTED HANDWOVEN FABRICS

10.1 Results from Woven Wool Warp Printed Fabrics

10.1.1 Introduction

The following comparative analysis of the three printed handwoven warps was divided into three sections to enable a thorough examination of each stage of development. Initially it was necessary to observe the visual results and behaviour of each group of samples, before performing quantitative tests. Hence a series of experiments was devised to determine which factor governed the shape and behaviour of the image profile.

With regard to the production of the woven wool warp printed fabrics, the warp yarn proved to be a suitable type (which was already known), providing no difficulties during the weaving process. Additionally, it absorbed the dyestuff efficiently during the printing procedure although approximately twelve pulls of the squeegee were required to ensure thorough penetration.

One apparent result of the printing process is the presence of crossed ends in some of the samples. Hence the warp yarn was obviously not always arranged parallel during its preparation for printing.

The weaving of each construction was completed simply. For the purpose of the experiments the sett of the warp was suitable giving rise to a variety of interesting weights of

fabric. If, however, these fabrics had been produced specifically for apparel purposes, a slightly finer sett of fabric with fewer ends to the centimetre, would have been more appropriate.
Furthermore, the overall size of each sample permitted such factors as yarn behaviour, fabric manageability, and mathematical observation, to be effected.
Finally, the finishing routines performed on the fabrics were completed successfully and without difficulty.

10.1.2 Results of Visual Observation of Fabrics

The woven wool warp printed samples arranged in their constructional groups are shown in Fig 10.1 to 10.3. Fig 10.1 shows the plain weave and 2/2 repp groups; Fig 10.2 the 3 and 1 twill and 2/3 hopsack groups; and Fig 10.3 the 8 end satin and repeated plain weave group. The order of layout corresponds with Table 9.5 which outlined the numerical order of the wool samples and gives the relevant yarn details, and end and pick measurements. Additionally Appendix IV displays a selection of fabric samples from the wool group.
Upon examination of the five groups general points of observation became apparent related to the behaviour of the image profile, and to the effect of the human element. The two immediately obvious points are the effect weave structure has upon the image profile, and the incidence of slightly mishapen images not conforming to the original rectangle.

Woven Wool Warp Printed Fabrics

Plain Weave Samples 1 - 6; 2/2 Repp Samples 7 - 12

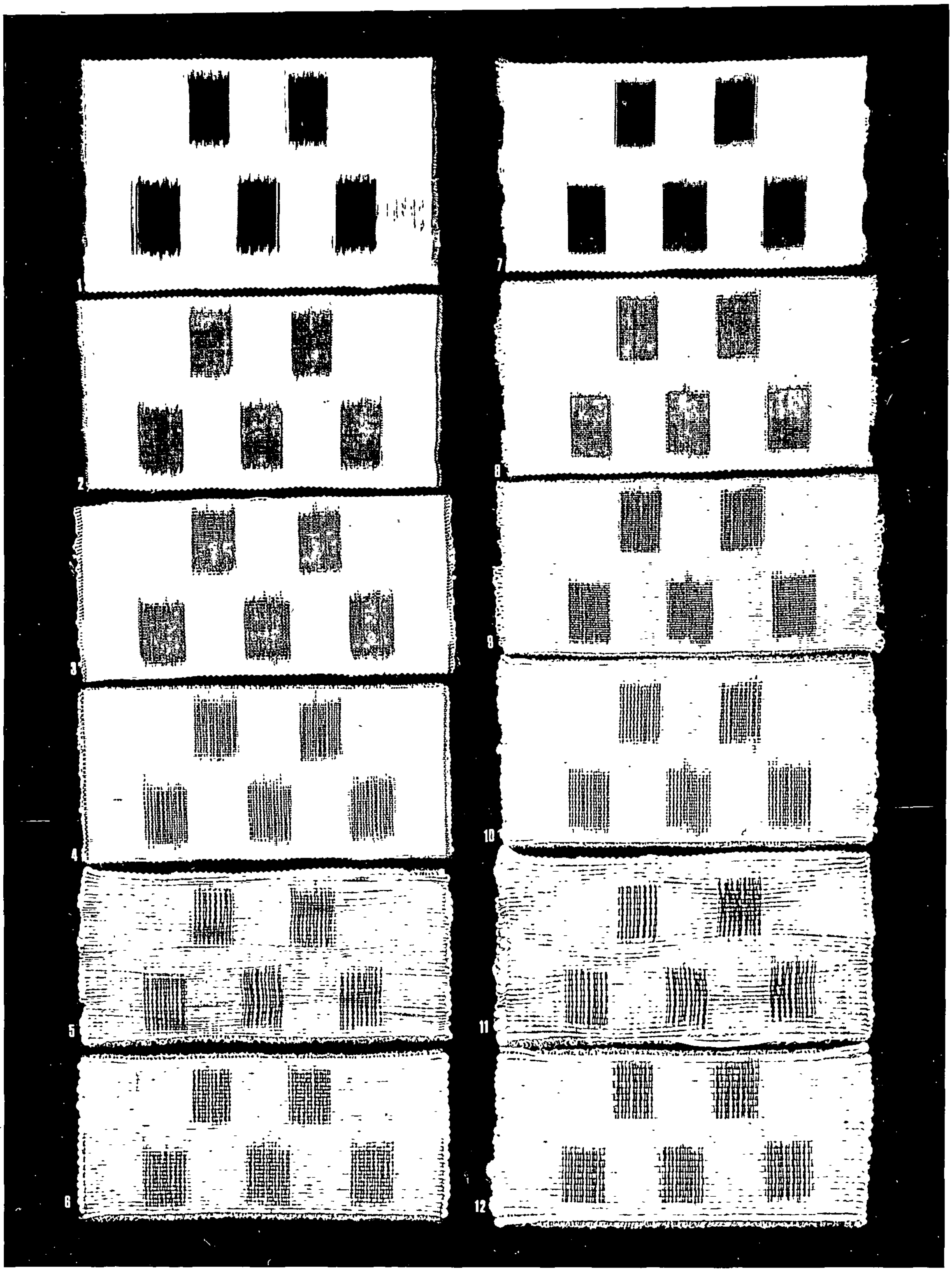


Fig 10.1

Woven Wool Warp Printed Fabrics

3 and 1 Twill Samples 13 - 18; 2/3 Hopsack Samples 19 - 24

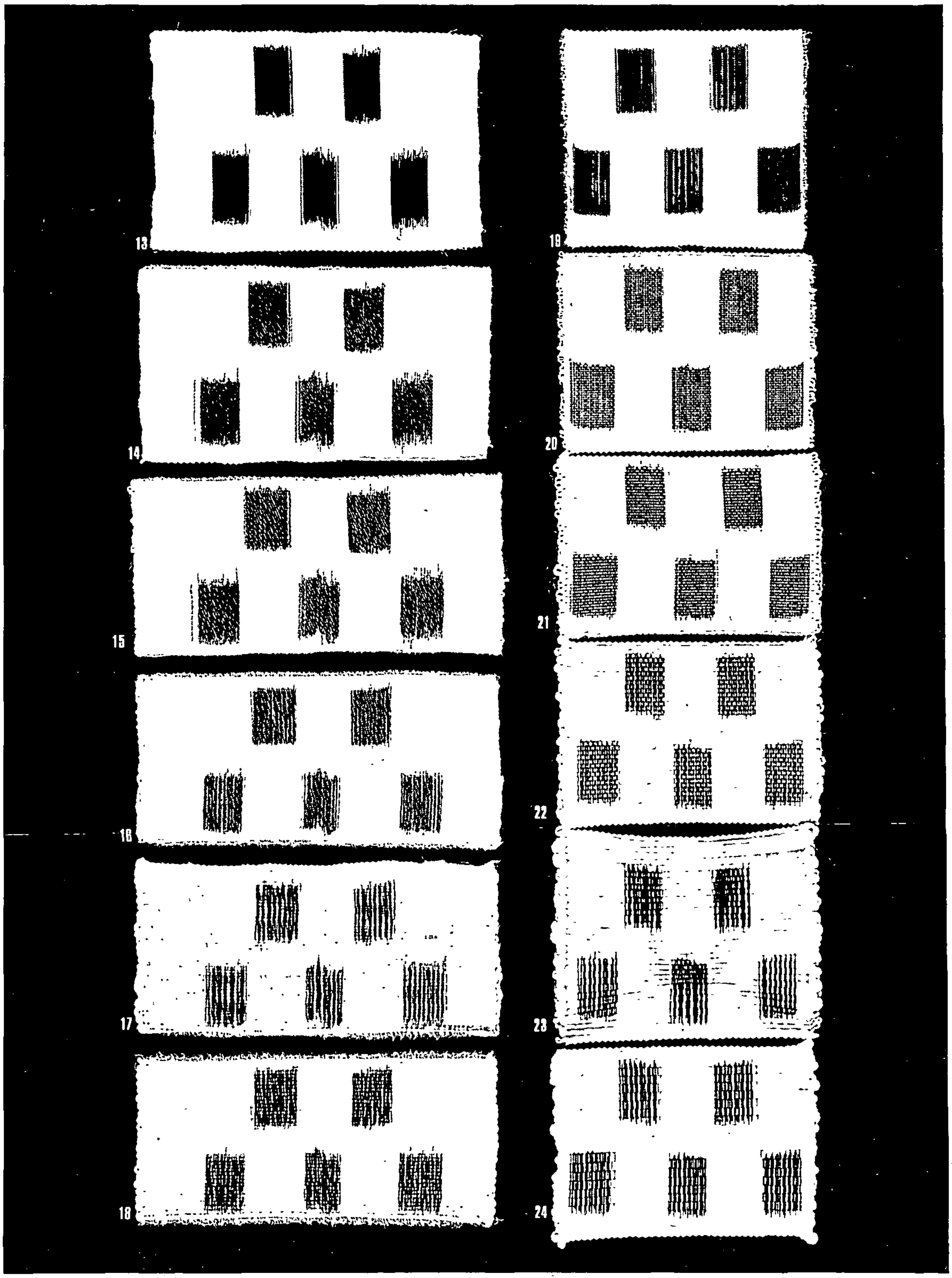


Fig 10.2

Woven Wool Warp Printed Fabrics

8 End Satin Samples 25 - 30; Repeated Plain Weave Samples 31 - 36

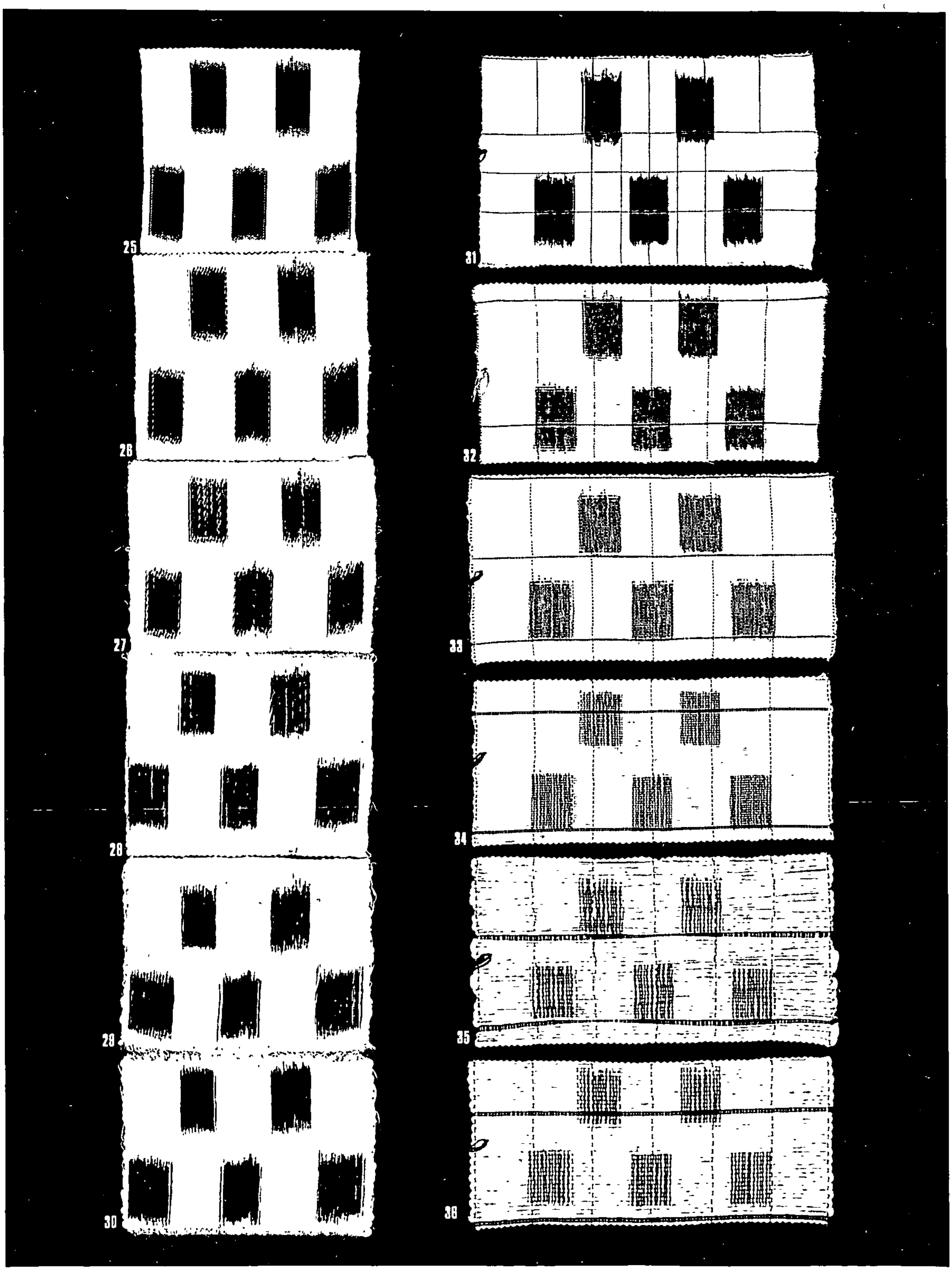


Fig 10.3

Additionally, the 2/3 hopsack group shows the least amount of irregularity of the image profile. Furthermore it was noticed that coarser yarns of greater linear density affected not only the overall shape of the image, but also the depth of colouration of the printed yarn.

Before presenting an explanation for the probable causes, it was thought sensible to discuss each of the construction groups in turn in order to validate any further information.

Plain weave samples 1-6 (Fig 10.1) show a distinct reduction in image profile as the linear density of the yarn increases. Samples 1 and 2 show the irregularity clearly, the first sample containing a further variation whereby the irregularity is not just haphazard, but forms a regularly jagged profile. Samples 4-6 show the warp ends spreading sideways as the linear density of the weft increases. This in turn reduces the colour intensity of the image as it is possible to detect clearly the weft yarn passing between the printed ends.

2/2 repp samples numbered 7-12 (Fig 10.1) show less irregularity of the image profile, but in a number of places the oblong shape has been lost giving way to a slightly uneven image. The second three samples numbers 10-12 show the warp spreading to a greater degree than the plain weave group as the count of the weft yarn increased, also reducing the colour intensity of the print. In both groups the increased size of weft yarn has altered the shape of the original oblong to that of a square.

Due to the warp faced structure of 3 and 1 twill the irregularity of the image profile of this group of samples numbered 13-18 (Fig 10.2) can be clearly observed. The first two samples show the greatest amount of irregularity and as with the 2/2 repp group, some images appear misshapen. Because of the nature of the weave there has been less warp spreading than with the other two groups. Thus the colour intensity has increased with the size of weft yarn, only one sample being paler than the others, that being the first which was woven with the finest yarn count. The warp was redented for the weaving of the 2/3 hopsack samples numbered 19-24 (Fig 10.2) and the 8 end satin group, which related directly to fabric types analysed in the historical section.

The irregularity of the image profile of the 2/3 hopsack group is minimal in comparison to the other construction groups. Only sample 23 shows signs of the warp spreading owing to the irregularity of the weft yarn employed. The colour intensity is strong in comparison to the other similar constructions of plain weave and 2/2 repp as a result of redenting the warp. Additionally the images of the first two samples 19 and 20 have taken a curvelinear form at their outer edges as opposed to being sharply rightangled, which is a direct result of a change of tension whilst tying on after redenting. This effect gradually evens itself out by the fourth sample of the group.

The 8 end satin samples numbered 25-30 (Fig 10.3) show a particular type of irregularity of the image profile which reduced as the linear density of the weft increased. It may be noticed that the image profile of samples numbered 25-27 and 29 show distinct twilling lines progressing from left to right. Such twill lines are the result of the direction of twist of the warp ends in relation to the direction of the twill line of the satin weave. To obtain such an effect both twill line and twist of yarn must be running in the same direction[240].

The twilling lines are not evident in samples 28 and 30 due to the spreading of the warp because of the coarseness of the weft yarn. As observed in some of the 2/3 hopsack samples, all the satin samples show that the images at the edges of the fabric have become curvelinear in form at their outer edge as opposed to being sharply rightangled, and additionally some images have become misshapen from their original oblong. Because of the warp faced nature of the weave the colour intensity is strongest for this group and increases as the linear density of the weft coarsens.

The final group of the woven wool warp printed fabrics comprises the repeat plain weave group numbered 31-36 (Fig 10.3).

In comparison with the initial plain weave group there appears to be little additional information evident, except that the irregularity of the image profile of the second three samples is minimal. This resulted in a further warp being made for this group, the first warp having come to an end, therefore as both were handmade, the tension at which they were wound was undoubtedly different. Additionally the colour intensity of this group appears more vivid than the first group owing to the fact that it is possible that more pulls of the squeegee were made during printing.

10.1.3 Identification System for Image Profile

Returning to the effect of weave structure upon the image profile, it was found throughout the visual examination of the woven wool warp printed fabrics that certain factors influenced the final outline of the image profile.

An identification system was evolved in order to distinguish between the image profile formed naturally by the construction, and that which was idiosyncratically irregular, the direct result of human inexactness.

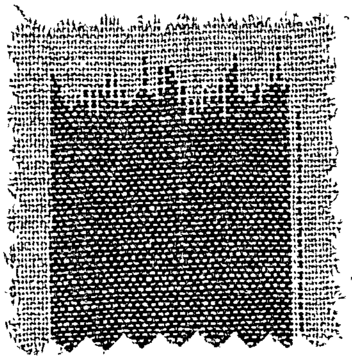
Fig 10.4 illustrates each of the five constructions used in the experiments showing the profiles of the printed image as they naturally formed. In most cases as the weft yarn increased in count such delineation of the profile of each construction was similarly reproduced.

In addition to these naturally uneven formations of the image profile further obvious irregularities became apparent which Fig 10.5 illustrates.

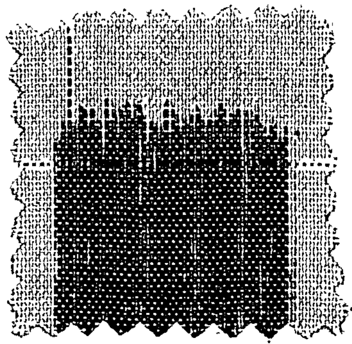
10.1.4 Types of Warp Profile Irregularity

Initially there was the "warp irregularity profile" which could be identified simply by the printed images becoming misshapen or misplaced themselves as the warp was woven (q.v. Fig 10.5a). Such irregularity occurred in the

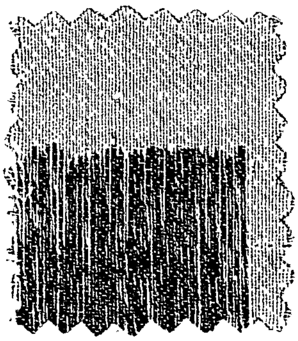
Construction Profiles
Natural Warp Printed Image Profiles Not Effected by Idiosyncratic Influences



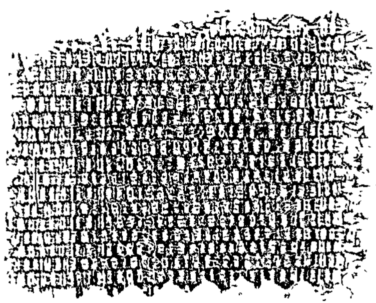
Plain



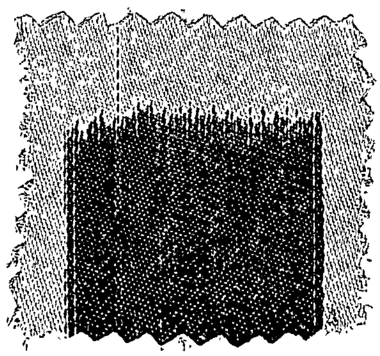
2/2 Repp



3 And 1 Twill



2/3 Hopsack



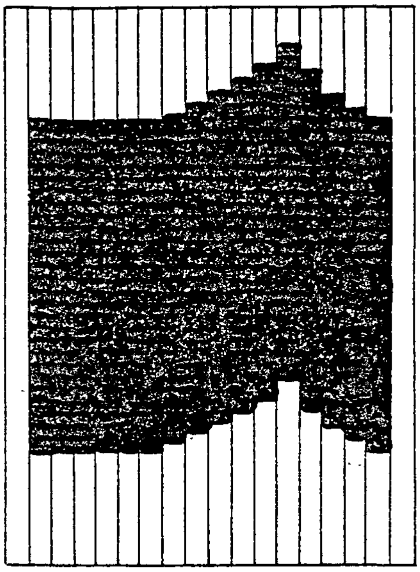
8 End Satin

Fig 10.4

Weave Profile Irregularities

Warp Printed Image Profiles. The Result of Idiosyncratic Influences of the Weaver

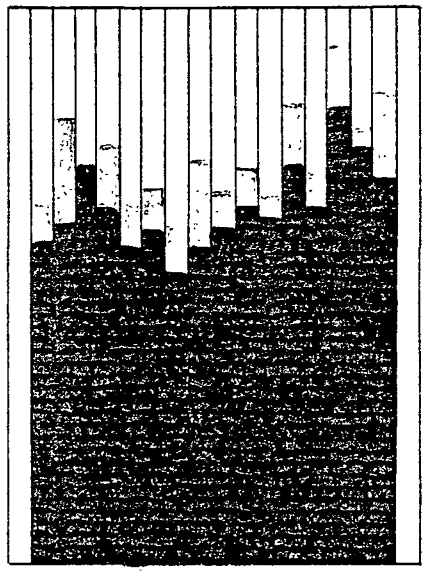
Warp



Reflects exact Profile Top and Bottom of Image
Cause: Loss of Warp Tension

(a)

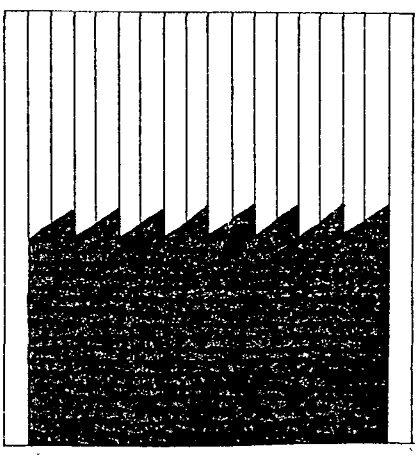
Shedding



Shadowing Effect Produced Behind Image
Cause: Different Tension Rates of the Two Sheds

(b)

Stretch



Regularly Irregular Profile
Reflected Top and Bottom of Image
Cause: Either Ends on Front Shafts or Ends on Back Shafts Stretching More Than Rest

(c)

Fig 10.5

2/2 repp, 3 and 1 twill, and 8 end satin sample groups.

It was discovered that the likely cause of this was probably uneveness in tension as the warp was made. Owing to human variability it is expected that a handmade warp during its making would be wound at slightly inconsistent rates of tension. Thus in some areas the warp was minimally slacker than in others. Additionally tension could be lost whilst the warp was mounted onto the loom in the same manner of inconsistency, which upon weaving would result in the misshapen imagery, described above, being formed.

A further cause of uneveness may occur during the preparation of the warp, as a result of tying on at the fabric roller. Again, it is likely that the tension rate of attaching the warp to the apron stick by hand is not identical throughout. This will inevitably cause differences in tension in the first metre or so of the warp.

If no printing of the warp yarn was to take place these slight inconsistencies of tension would pass unnoticed. However, once the yarn has been printed any uneveness in tension at any point in the warp can be detected immediately by the resulting irregularity or the misshapening of the image.

The second of the profile irregularities, which was not readily apparent in the wool sample group, constitutes the "shedding profile", described as a slight shadowing effect which follows exactly the outline of the image and appears as a paler replica of it (q.v. Fig 10.5b). Usually it occurs in isolated areas of the fabric, as it has done in the wool group, and not across its whole width at one time. The "shedding profile" is a result of even or uneven warp sheds caused by different tension rates which are the consequence of one or two factors. Firstly such an effect may be achieved if the uneven ends are mounted tighter onto the warping mill during its preparation than the even ends, or vice versa. For example, if the downward spiral or uneven shed is wound tighter than the upward or even one, or if the winding rate is generally uneven throughout the warps preparation, it is most probable that "shedding profiles" will be evident in the finished fabric. It can be seen however that only a few fabrics of the wool group show this type of irregularity. Sample 7 of the 2/2 repp group; sample 25 and perhaps 26 of the 8 end satin group; and sample 31 of the repeat plain weave group all show signs of "shedding profiles" in some part of the fabric. This effect can also be the result of some restriction in part of the warp during weaving. The following description did occur and although it is an unusual eventuality, the explanation for it could be applicable to tension experiments carried out at a later stage of the inquiry. As the warp nears its end and the apron stick still lies against the warp roller, it is possible for the shed lying against the roller to become clamped between the roller and the apron stick. As weaving continues the tension would increase on the shed that is caught and it cannot be released until the warp is wound forward, whereupon the tension in the two sheds would even themselves out. This will cause "shedding profiles" around the printed images as the tension of the trapped shed cannot even itself once weaving has taken place. Thus the horizontal axis of the warp which is looped around the apron stick will form in a new position to that it held at the outset of weaving.

The third profile irregularity may be defined as the "stretch profile", giving an overall outline to the image that appears consistently irregular, an example of which was illustrated in Fig 10.5c. This is the result of the angulation and distance that warp ends extend to complete the formation of the shed. These regular irregul-arities appear as a direct result of stretch on either the front two shafts or the back two.

At this stage of the investigation it was thought that when "stretch profiles" occurred it was always due to the ends on the back two shafts pulling backwards towards the warp beam. It was thought that this was a result of the manner in which the even ends on shafts 14 and 16 passed underneath the first lease-rod before passing over the second. The necessity for the even ends to travel underneath the first lease-rod as opposed to over it, is to restrict the movement of the back shaft which otherwise would move around unpredictably during shedding. Thus the angulation of lift from the even ends on shafts 14 and 16 to the first lease-rod was of a greater degree than for any of the ends on the preceding shafts.

It was not until further experimentation was carried out at a later stage of the inquiry that this hypothesis was questioned and an alternative explanation became apparent. Additionally it appeared that "stretch profiles" were formed as a result of the tying on of the warp to the fabric roller, but in this instance the ends on the front two shafts were the ones stretching most, the degree of angulation being greater between this point and the fell of the fabric.

This effect can be clearly observed in sample 1 of the first plain weave group, the image profiles of the row of three oblongs showing distinct signs of stretching over regular intervals. Apart from this one fabric, "stretch profiles" do not occur throughout the remainder of this series, but do appear more frequently with the subsequent silk warp printed fabric group.

It is intended that a more thorough examination of the behaviour of these types of irregularity will be undertaken in a subsequent chapter, when control and manipulation of printed warps is investigated.

It has been mentioned that the 2/3 hopsack group of wool warp printed fabrics showed the least irregularity of image profile in relation to the other construction groups of the series. In addition the irregularity appeared to decrease as the linear density of the weft yarn increased. This may be explained because the 2/3 hopsack group of samples showed an apparent lack of image profile due to the distance each warp end travelled to encompass the rotundity of each weft pick, there being little or no weft crimp formed with this construction type. As the printed ends followed such an arcuate path the edge of the printed image terminated either at a point around the weft pick, or at the point of weave intersection.

This explains the reason for the overall image apparently becoming squared in shape as opposed to rectangle as the linear density of the weft coarsened. This occurred very obviously with the plain weave, 2/2 repp, and 3 and 1 twill groups: it was the takeup rate of the warp being proportionally greater to contend with the coarser yarns which reduced the entire area of printed yarn. The effect yarns of coarser linear density have on the depth of colouration of the print are twofold. Observation of square set fabrics, in this case the plain weave and the 2/2 repp groups, shows that the colouration is more dense in the finer fabrics i.e. samples 1-3 and 7-9 respectively. The increased weft size of the subsequent coarser samples forced the warp ends apart which not only made the weft apparent on the surface of the fabric, but in turn reduced the overall depth of colour of the print.

With the warp faced weaves, such as the 3 and 1 twill and 8 end satin groups, the opposite was true. As the weft yarns coarsened the intensity of colour shade increased since more printed yarn was on the surface of the fabric as the weave intersections were further apart.

10.2 Measurements Made

10.2.1 Ends and Picks Per Unit Length

Two types of measurements were performed upon each series of warp printed experiments. As outlined in Chapter 9.4.2 the first was upon the fabrics whilst still in loom state for the assessment of the ends and picks. The second was performed once the fabrics had been removed from the loom and finished, and comprised the individual measurement of each image profile for the purpose of defining the percentage of irregularity of each sample.

Appendix I itemised the wool warp printed samples listing their end and picking measurements. It is usual to measure physical quantities in S.I. Units and thus dimensions would be in millimetres or metres. However, in this work whilst metric units have been used in the main text, the detailed result in the Appendices are given in Imperial Units. It was these converted metric results which were employed for all the successive mathematical analyses.

All end and pick measurements for samples 1-31 were made with the aid of a piece glass whilst the fabric was in the loom state. For the second and third samples of the repeated plain weave group number 32 and 33, three of the seven black marking ends were measured forming a range of picking results which were subsequently averaged to give concise values of picks per unit length of each sample. The ends per centimetre were calculated with the aid of a piece glass and ruler in a similar manner.

From sample 34 onwards a vernier caliper measuring tool was used in place of the piece glass to provide a more accurate means of measurement. Consequently seven marking ends were assessed, instead of three, and averaged to identify the picking rate, a plan followed for the final two samples numbered 35 and 36. End per centimetre measurements continued to be made with the piece glass and ruler for all the wool warp printed fabrics and it was not until the start of the cotton warp printed fabrics, that the vernier caliper was employed instead.

10.2.2 Measurement of Image Profile

Measurement of the image profile was completed by placing each sample in turn onto a sheet of graph paper, ensuring that the fabric and imagery was vertical and straight and then placing horizontally a steel ruler, which exceeded the width of the sample, onto the upper end of the printed block at the lower point of irregularity and securing it to the paper at each end with tape. From this point the lower edge of the vernier caliper was lined up with the edge of the ruler (the lowest point of irregularity) whilst the measuring tool's upper edge was eased to a position level with the highest point of irregularity. Thus a measurement of the maximum range of irregularity of the image profile was made.

Each printed block was assessed in this way giving rise to five measurements which were subsequently averaged to give the mean range of irregularity for the individual sample. This method of assessment was completed for all the woven warp printed trials and formed the basis of all the subsequent analysis.

10.3 Discussion of Results from the Woven Wool Warp Printed Fabrics

10.3.1 Irregularity of Image Profile

Tables 10.1 and 10.2 give a visual representation of the range of irregularity that occurred in the trials containing 100% wool yarns. These show an example of each weft count for every construction group. Table 10.1 illustrates the various profiles of the plain weave, 2/2 repp and 3 and 1 twill construction groups, and Table 10.2 illustrates those of the 2/3 hopsack, 8 end satin and repeat plain weave groups. These profiles are the top left hand printed block of each fabric. Every profile was recorded with its sample number, Tex weft count and percentage of irregularity value.

It can be seen from these tables that the irregularity of the image profile increased with the increased size of weft yarn indicating that the latter did have an effect upon the behaviour of the image profile. The percentage of irregularity value alongside each profile shows that this deduction was unfounded as the values did not increase similarly or in a consistant manner. It could be seen that the irregularity of the image profile appeared to decrease with increased weft yarn size in reality and that the profiles illustrated in Tables 10.1 and 10.2 omitted that the warp spread as the weft yarn became coarser. Apart

Degree of Irregularity of the Image Profile of the Woollen Samples

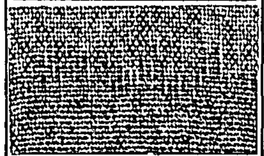
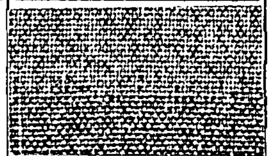
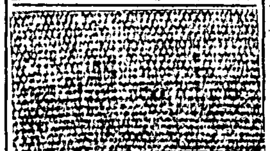
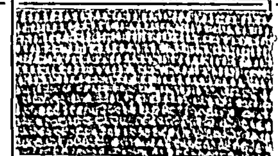
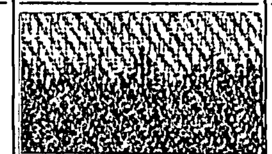
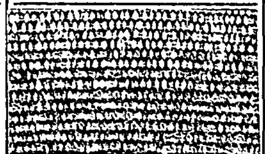
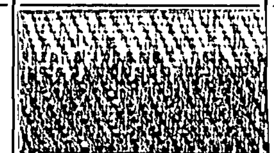
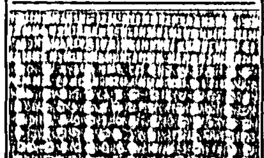
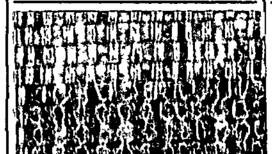
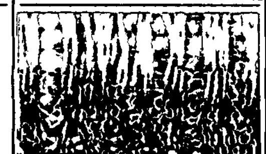
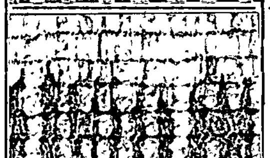
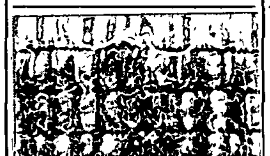
PLAIN				2/2 REPP				3 AND 1 TWILL			
Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity
1	R40/2		15.6	7	R40/2		12.5	13	R40/2		18.7
2	155		17.1	8	155		14	14	155		20.3
3	389		21.8	9	389		18.7	15	389		23.4
4	R722/4		21.8	10	R722/4		20.3	16	R722/4		14
5	1525		15.6	11	1525		14	17	1525		15.6
6	R1745/6		18.7	12	R1745/6		12.5	18	R1745/6		17.1

Table 10.1

Degree of Irregularity of the Image Profile of the Woollen Samples (Continued)

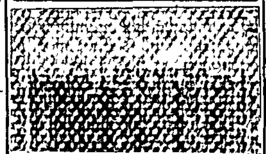
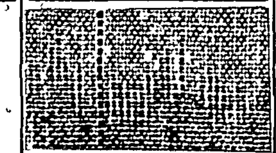
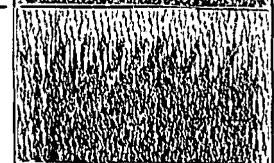
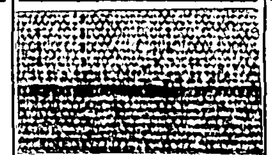
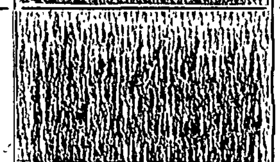
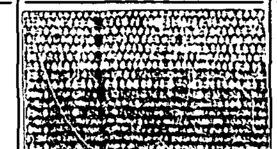
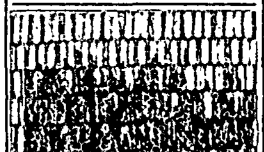
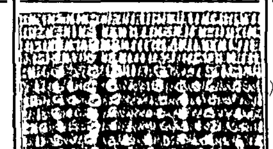
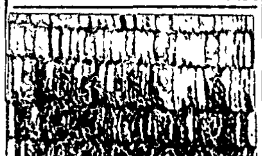
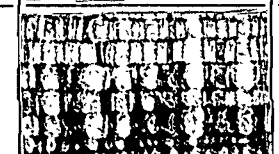
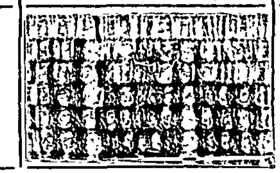
2/3 HOPSACK				8 END SATIN				REPEAT PLAIN			
Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity
19	R40/2		9.3	25	R40/2		18.7	31	R40/2		15.6
20	155		14	26	155		23.4	32	155		14
21	389		15.6	27	389		28.3	33	389		14
22	R722/4		14	28	R722/4		15.6	34	R722/4		7.8
23	1525		17.1	29	1525		23.4	35	1525		12.5
24	R1745/6		10.9	30	R1745/6		20.3	36	R1745/6		10.9

Table 10.2

from the effect weft count might have upon the image profile, it was thought that the number of picks per centimetre may influence the irregularity of the image profile particularly in combination with the changing sizes of weft yarn. Additionally it was thought that construction would have an effect on the irregularity of the profile. Thus to define any results in relation to these hypotheses it was necessary to carry out simple tests to this end.

10.3.2 Effect of Pick Spacing on Image Profile

Figs 10.6 - 10.11 illustrate the results of this synthesis and examination of the mean values show that the 8 end satin, plain weave and 3 and 1 twill groups exhibit the greatest irregularity respectively. The repp and hopsack groups show a lower percentage irregularity in comparison, whilst the repeat plain weave group shows the least irregularity due to the extra warp being made. The image profiles of the samples woven with 389 Tex and 722/4 yarns show a peak in most cases which cannot be accounted for. It appears however that there is no relationship between the two quantities identified.

10.3.3 Effect of Weft Count on Image Profile

Subsequently it was necessary to discover if the weft count had an effect upon the image profile. It can be seen from Fig 10.12 which shows a composite graph of each sample for every weft count, that the mean value of approximately 18%

Effect Of Pick Sampling On Image Profile Of The Wool Samples

Plain Weave Group

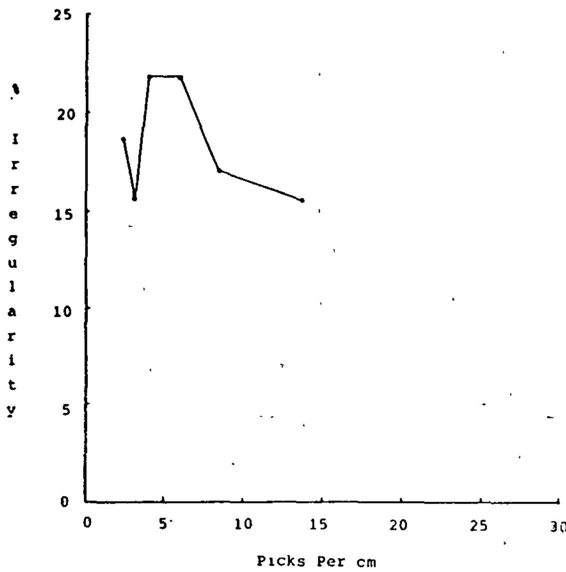


Fig 10.6

2/2 Repp Group

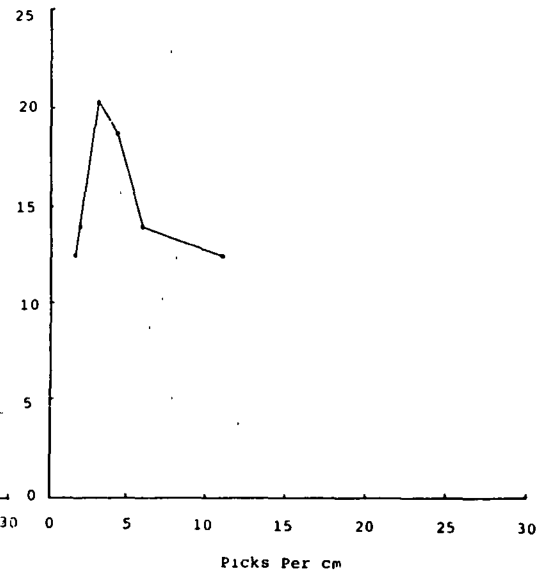


Fig 10.7

3 And 1 Twill Group

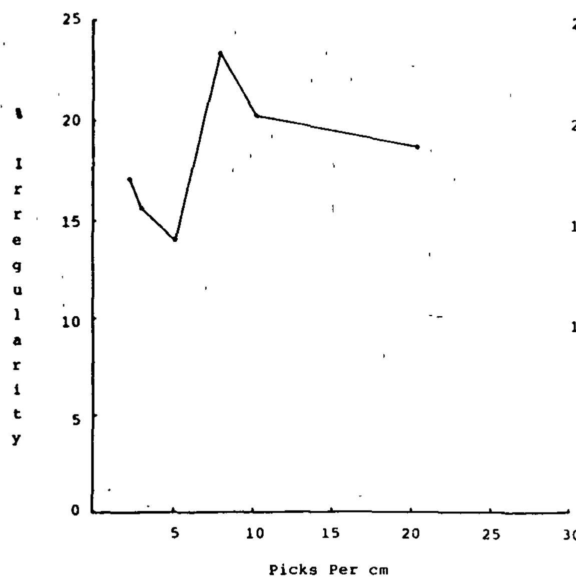


Fig 10.8

2/3 Hopsack Group

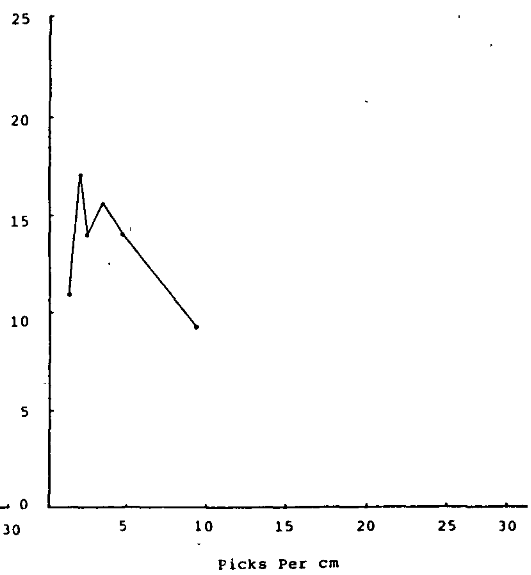
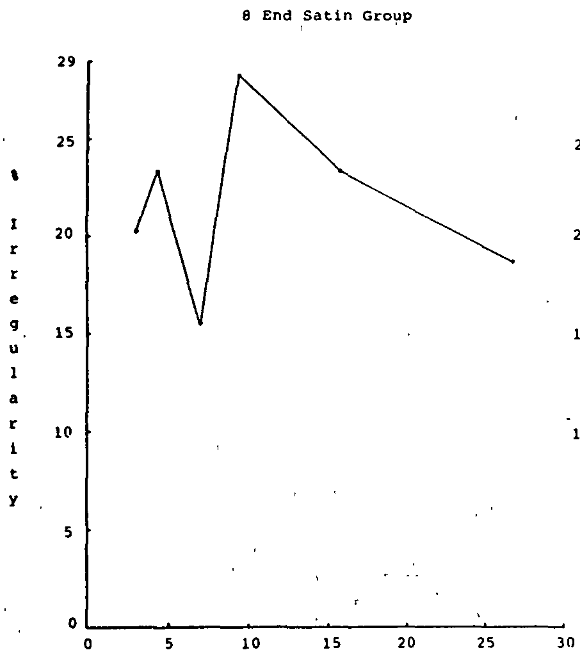


Fig 10.9



Fiq 10.10

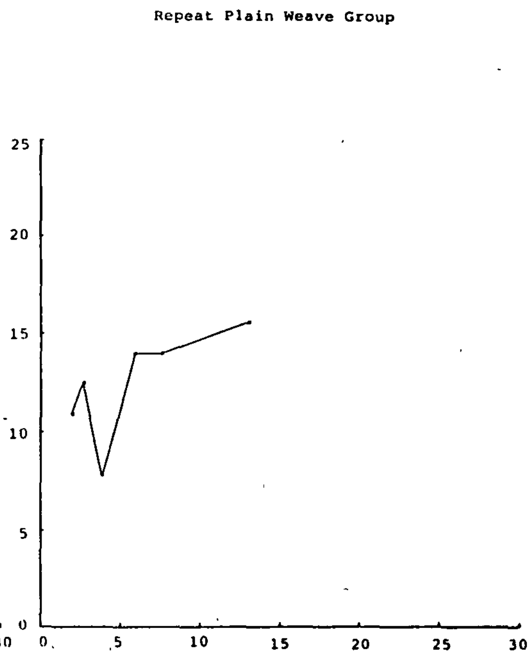


Fig 10.11

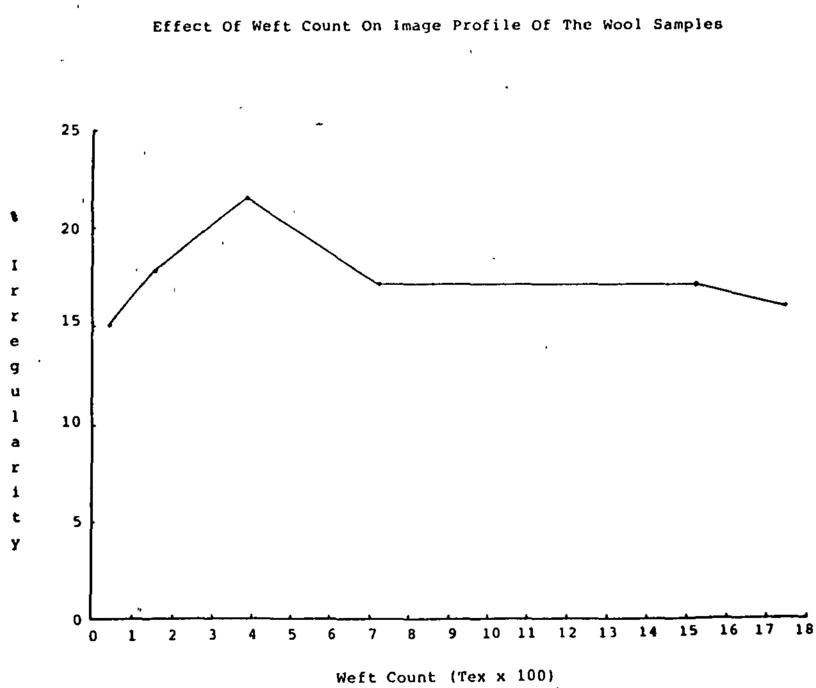


Fig 10.12

is relatively high, and that the greatest irregularity of the image profile occurred on the fabrics woven with the 389 Tex yarn. Although it was expected that the amount of irregularity would be effected by the varying linear density of the weft, the overall trend indicates there is little change of irregularity with weft count suggesting that the tension of the warp adjusted itself to cope with these variations. In addition Figs 10.13 - 10.18 were completed to see if a particular yarn effected the image profile of any one construction group. These reflect the result of Fig 10.12, but in more detail. It was thought that similar analyses of the subsequent cotton and silk samples might show a different effect, as both yarns were of a more regular and compact nature than that of wool.

10.3.4 Effect of Weave Float Length on Image Profile

Fig 10.19 shows the effect of weave float length upon the image profile, and it appears that there is some relationship between the two quantities. It can be seen that the highest degree of irregularity of the wool samples occured with the 8 end satin and plain weave samples respectively, with an overall mean value of around 18%. It was expected that the varying constructions would effect the image profile in some manner and that the satin in particular would have an effect partly because of the length of float lying on the surface of the fabric, and partly because of the irregularity of the construction itself in comparison to the others. It appears that this

Effect Of Weft Count On Image Profile Of The Plain Weave Group

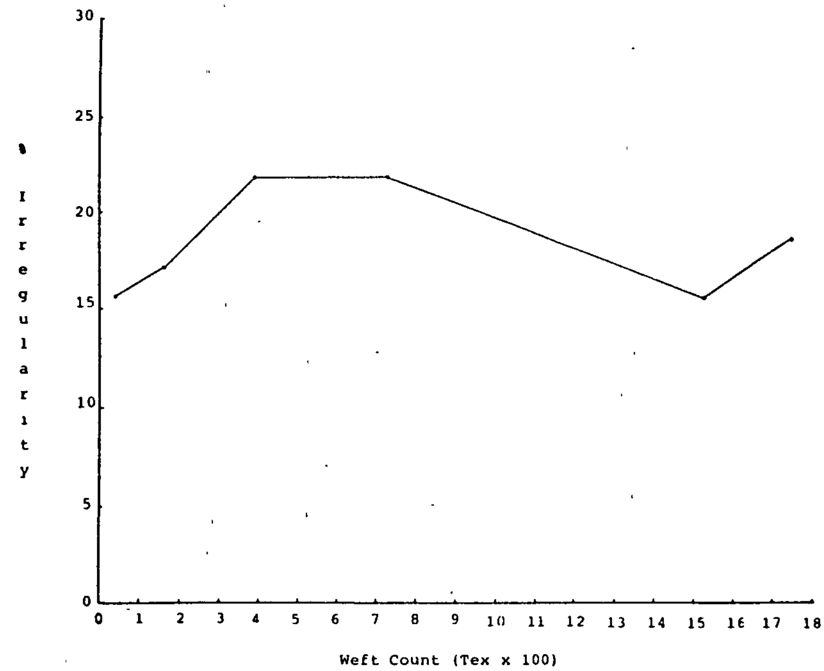


Fig 10.13

Effect Of Weft Count On Image Profile Of The 2/2 Repp Group

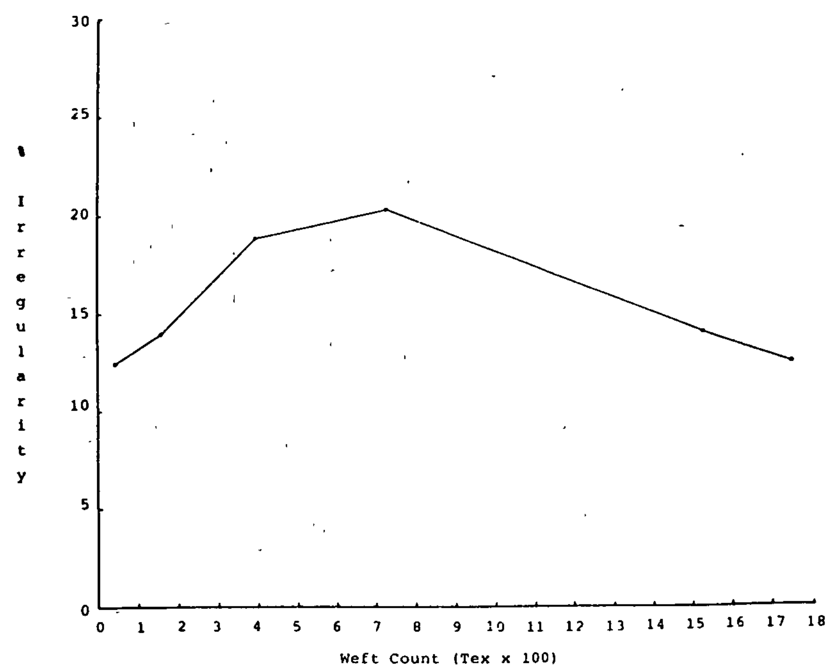


Fig 10.14

Effect Of Weft Count On Image Profile Of The 3 And 1 Twill Group

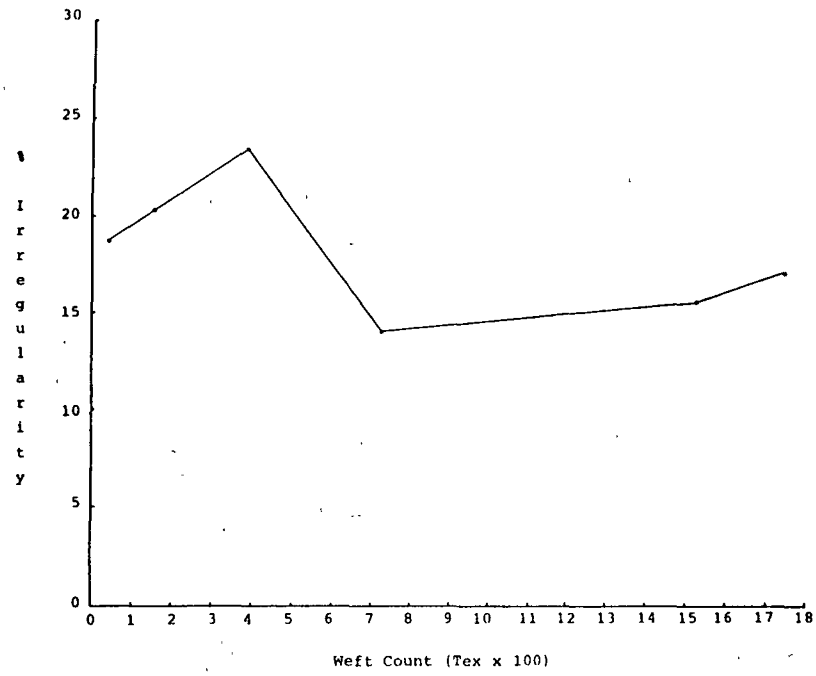


Fig 10.15

Effect Of Weft Count On Image Profile Of The 2/3 Hopsack Group

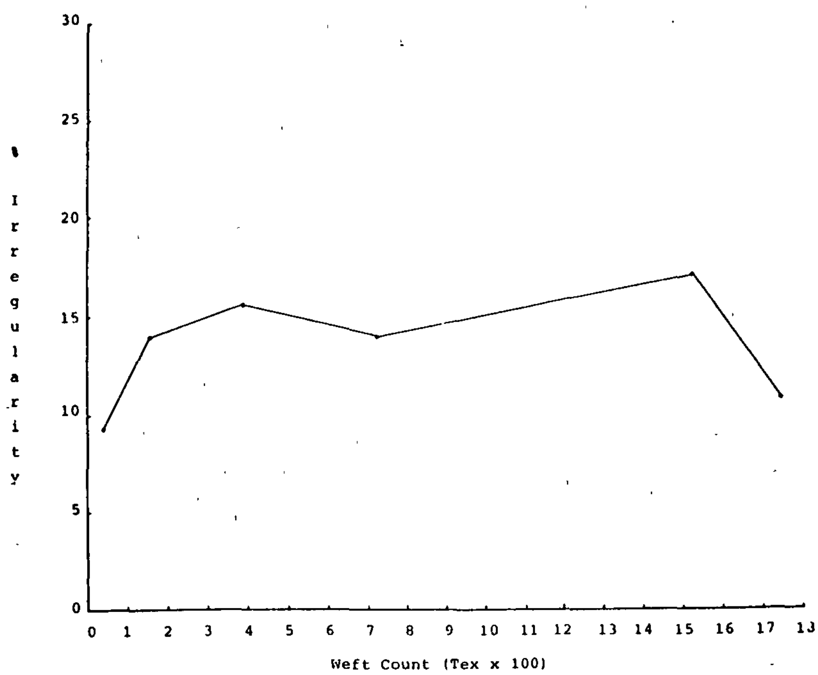


Fig 10.16

Effect Of Weft Count On Image Profile Of The 8 End Satin Group

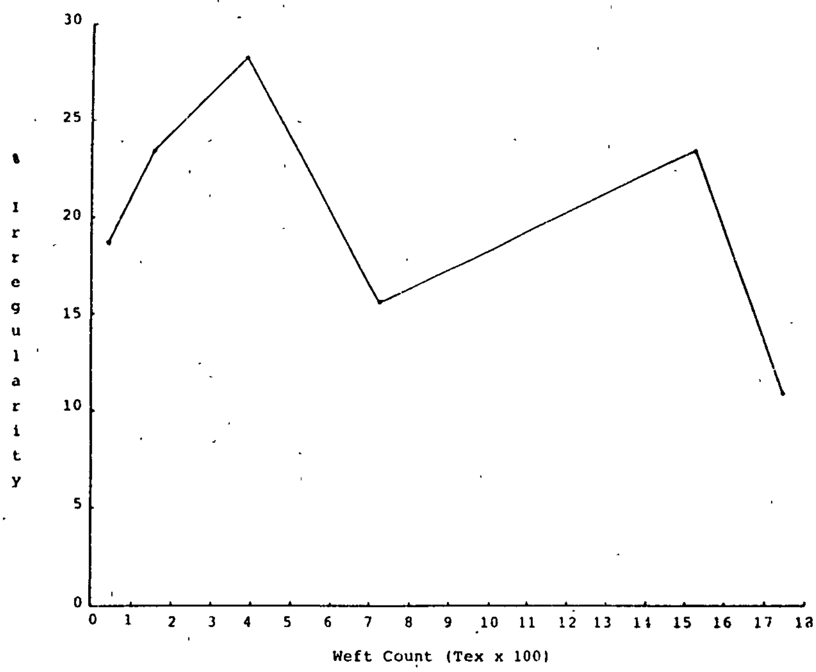


Fig 10.17

Effect Of Weft Count On Image Profile Of The Repeat Plain Weave Group

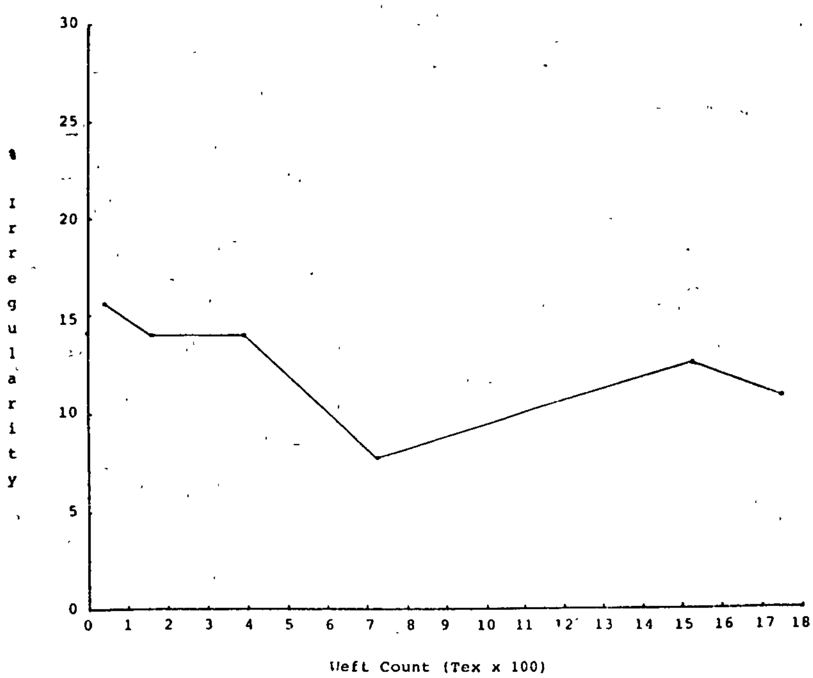


Fig 10.18

Effect Of Weave Float Length On Image Profile Of The Wool Samples

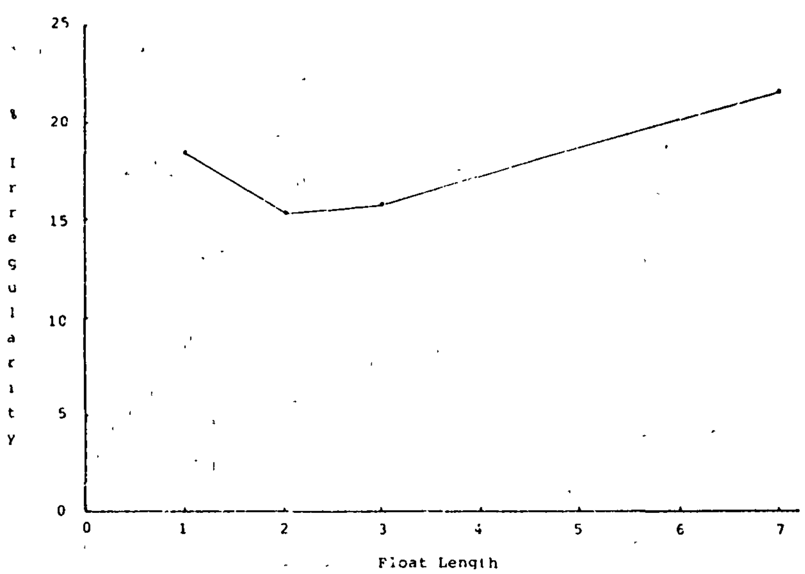


Fig 10.19

hypothesis may be correct.

10.3.5 Conclusion

From these experiments it may be concluded that whilst pick spacing and weft count have no apparent effect on the irregularity of the image profile of the wool handwoven fabrics, there appears to be some definite relationship between that and float length.

Furthermore, the mean values of irregularity displayed on most of the graphs are of a relatively high level with an average of approximately 17%. It is of great interest that in most cases the peak on the graphs represents samples woven with either 389 Tex or 722/4 Tex weft yarns. As yet there is no reasonable explanation for this outcome.

10.4 Results from Woven Cotton Warp Printed Fabrics

10.4.1 Introduction

The production of the woven cotton warped printed fabric was carried out in an identical manner to the wool fabrics. The warp yarn which had not been used before this experiment produced a fabric type very similar to some of the traditional Ikat examples discussed in the historical survey. There were some difficulties with the yarn during warping preparation and the looming as it tended to crimp when under tension due to the high degree of twist in its composition. Because of this the yarn did not absorb the dyestuff as well as anticipated and in most cases streaking is apparent on the woven fabric. Approximately 7 pulls of squeegee were completed to transfer the image. In retrospect additional pulls would have transferred the image more effectively onto this particular yarn type. The construction and subsequent finishing of the samples was completed without difficulty producing a series of interesting fabrics suitable for the type of experimentation being performed.

10.4.2 Results of Visual Observations of Fabrics

Fig 10.20 and 10.21 show the woven cotton warp printed samples arranged in their construction groups which correspond with the information outlined in Table 9.9 stating their numerical order, the weft yarn details and their end and pick measurements. Fig 10.20 shows the plain weave and 2/2 repp groups, while Fig 10.21 shows the 3 and 1 twill, 2/3 hopsack group, and 8 end satin groups. Appendix V displays a selection of fabric samples from the cotton groups.

From general observation of the construction groups together, certain behavioural effects are seen to have occurred. The most obvious detail is the lack of irregularity of the image profile, followed by the poor quality of colouration, nearly every sample exhibiting streaking, except for the 2/2 repp group. The reason for this is not understood, but a likely explanation is that during the printing of this section more pulls of the squeegee were performed than for the remainder of the warp. The effect of weave structure upon the image profile has

Woven Cotton Warp Printed Fabrics

Plain Weave Samples 37 - 42; 2/2 Repp Samples 43 - 48

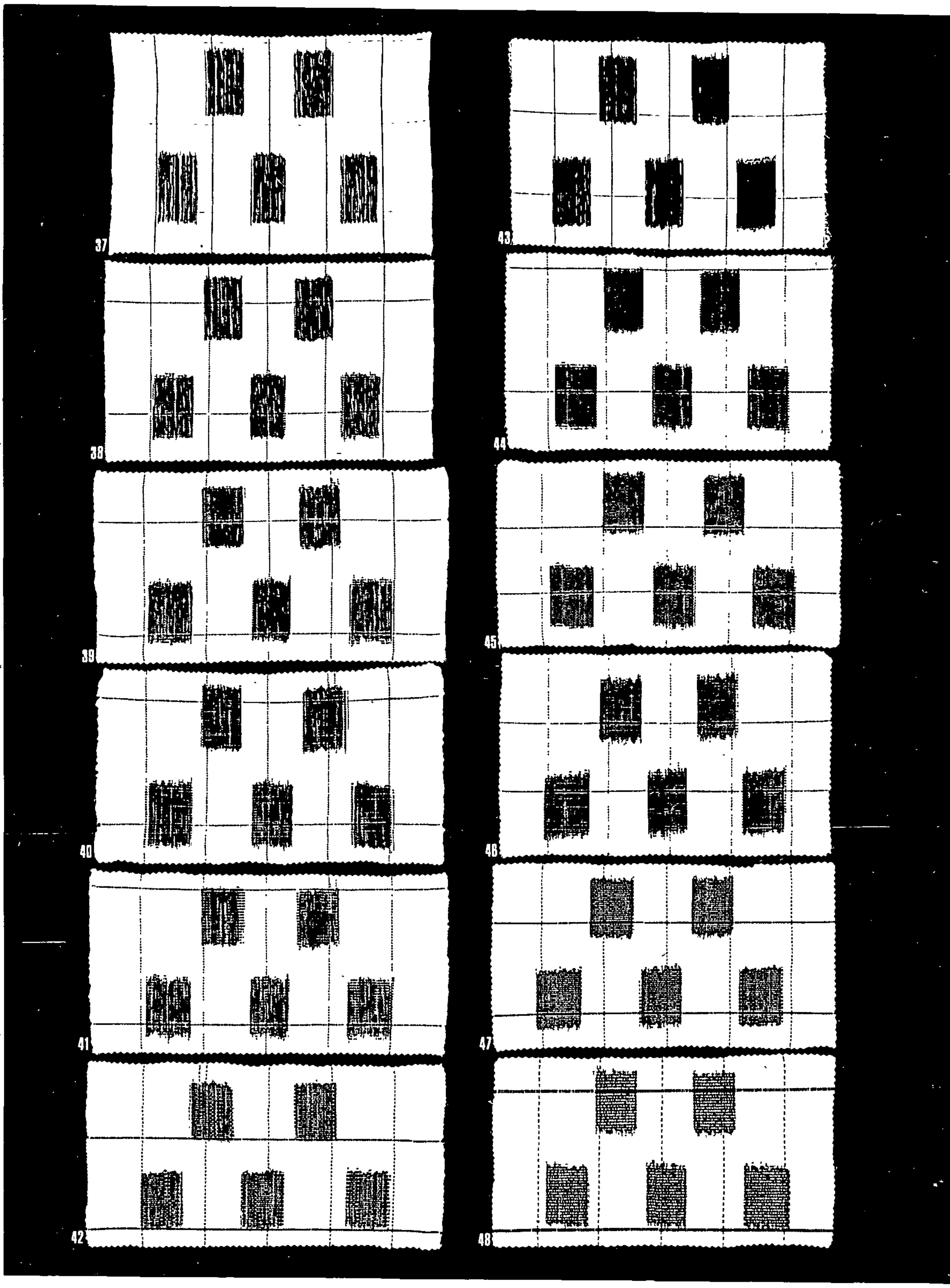


Fig 10.20

Woven Cotton Warp Printed Fabrics

3+1 Twill 49 - 54; 2/3 Hopsack Samples 55 - 60;
8 End Satin 61 - 66

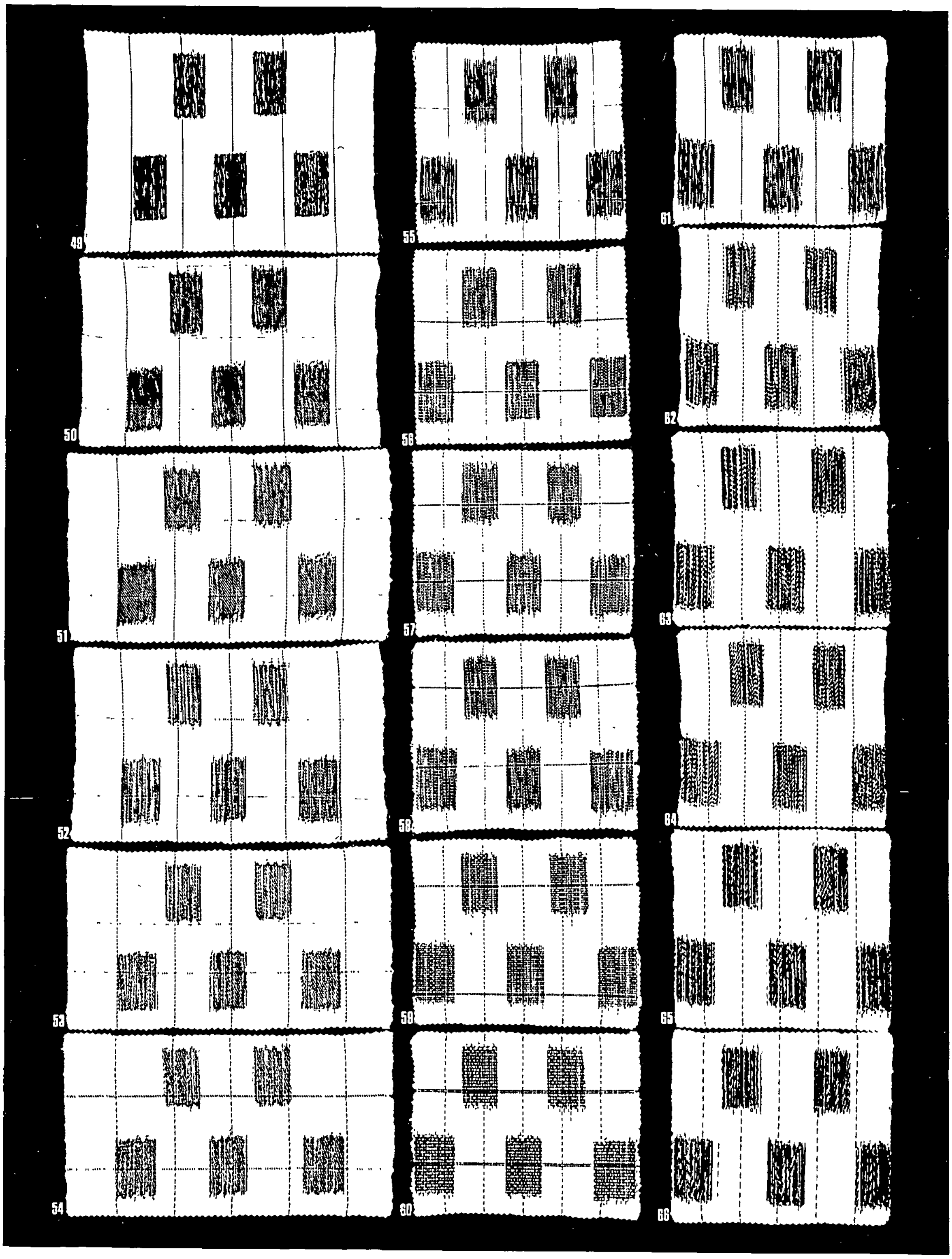


Fig 10.21

produced a different result in comparison to that of the wool warp. Very little warp irregularity is seen to have occurred and no shedding or stretch profiles are evident suggesting that the cotton yarn, because of its compositional nature, was more static during production than the wool yarn. Additionally the presence of crossed ends is minimal.

It is the plain weave group which shows the least amount of irregularity, but due to the streaking that has occurred throughout it is more difficult to see that yarns of coarser linear density, as for the previous warp, do effect the depth of colouration of the print. In general the overall shape of the image becomes more squared with this increase in weft yarn size.

The range of irregularity of image profile for the plain weave samples 37-42 (Fig 10.20) is less than that of corresponding samples of the wool warp. The irregularity itself appears indistinct throughout the cotton group. The wool fabrics in comparison showed definite irregularity and stretch profiles in the first three plain weave samples after which the image profile ceased to dominate due to the volume of the weft yarn.

Only sample 41 of the cotton plain weave group woven with R195 Tex/2 shows a more defined profile than the others which is partly due to warp irregularity having occurred in four of the five images. Again the increase in linear density of the weft reduces the overall proportions of the image changing it from oblong to square.

Greater irregularity of the image profile has occurred with the 2/2 repp samples numbered 43-48 (Fig 10.20) than with the plain weave group. The precise reason for this is not understood as the construction requires twice the amount of weft yarn to be used, so logically the increase in picking area should reduce the amount of irregularity to less than that of the plain weave group, which was the case with the wool 2/2 repp sample group.

A possible explanation is that in an effort to economise on materials and time the number of samples printed simultaneously was increased at this point which, during weaving, took proportionally more shedding to complete. Such continued shedding is thought to have some effect on the degree of irregularity of the image profile.

So with the 2/2 repp group there is a small, but distinct image profile which remains constant in all the samples.

Some warp irregularity has occurred throughout the group with the slub sample number 46 showing the greatest amount.

Unlike the remainder of the cotton groups, the 2/2 repp fabrics show very little streaking therefore the colouration of the print appears intense. The increase in linear density of the weft yarn and the subsequent spreading of the warp does not appear to have effected the depth of colouration in this case, as it did with the corresponding wool group.

In comparison with the preceding two construction groups the image profile of the 3 and 1 twill samples numbered 49 - 54 (Fig 10.21) is somewhat greater mainly due to the warp faced nature of the weave. The first sample of the group number 49 shows comparatively little irregularity suggesting that the sample was woven immediately after printing had been completed, while the remaining samples shows a greater degree of irregularity which is comparable to that of the wool 3 and 1 twill fabrics.

Much streaking has occurred in the whole of this cotton group which has been made more apparent by the warp faced nature of the weave. It is this latter factor which has reduced the amount of warp spread although the change in shape of the image can be observed. Additionally warp irregularity is apparent in some of the images.

The 2/3 hopsack group numbered 55-60 (Fig 10.21) show a similar degree of irregularity as the 3 and 1 twill samples, in particular the first four numbered 55-58.

The cotton warp, like the wool, was redented for the weaving of these samples and the 8 end satin group. Because of this the colouration of the hopsack samples should have become more intense, but due to the excessive streaking the overall tone of these was not strong. The increased picking area of the samples woven with the coarser weft yarn diffused the colour still further. Some of the outer edges show a curvelinear profile as opposed to being sharply rectangled, as did the wool hopsack samples, which is a result of a change in tension of the warp after redenting. Additionally a few of the images are effected by warp irregularity. The final cotton group of 8 end satin samples numbered 61-66 (Fig 10.21) show a slightly greater degree of irregularity than any of the other constructions. Additionally twilling lines are conspicuous throughout the whole image, as opposed to just the profile (which occurred with the wool satin group) and these have become more obvious because of the excessive streaking that is apparent. The twilling effect reduces altogether as the linear density of the weft increases. The overall colour intensity should be strongest for this group because of it being a warp faced structure, but it can be seen in Fig 10.22 that this is not the case because of the failure of dyestuff penetration.

Warp irregularity has slightly effected the rectangular shape of some of the images and some outer images have taken a curvelinear form because of redenting.

10.4.3 Measurements Made

Measurements identical to those performed on the wool fabrics were carried out for the cotton samples. Appendix II lists the end and pick details of all the cotton fabrics. As mentioned in section 9.4.2 the final number of marking ends placed in the warp for the assessment of picks of the cotton and silk fabrics was reduced from seven to five. The vernier caliper was employed as a means of measurement for the ends and picks per unit length of all the samples except for the first three of the plain weave samples numbered 37-39 which were made with the piece glass and ruler.

The percentage irregularity of the image profile

Failure of Dyestuff Penetration

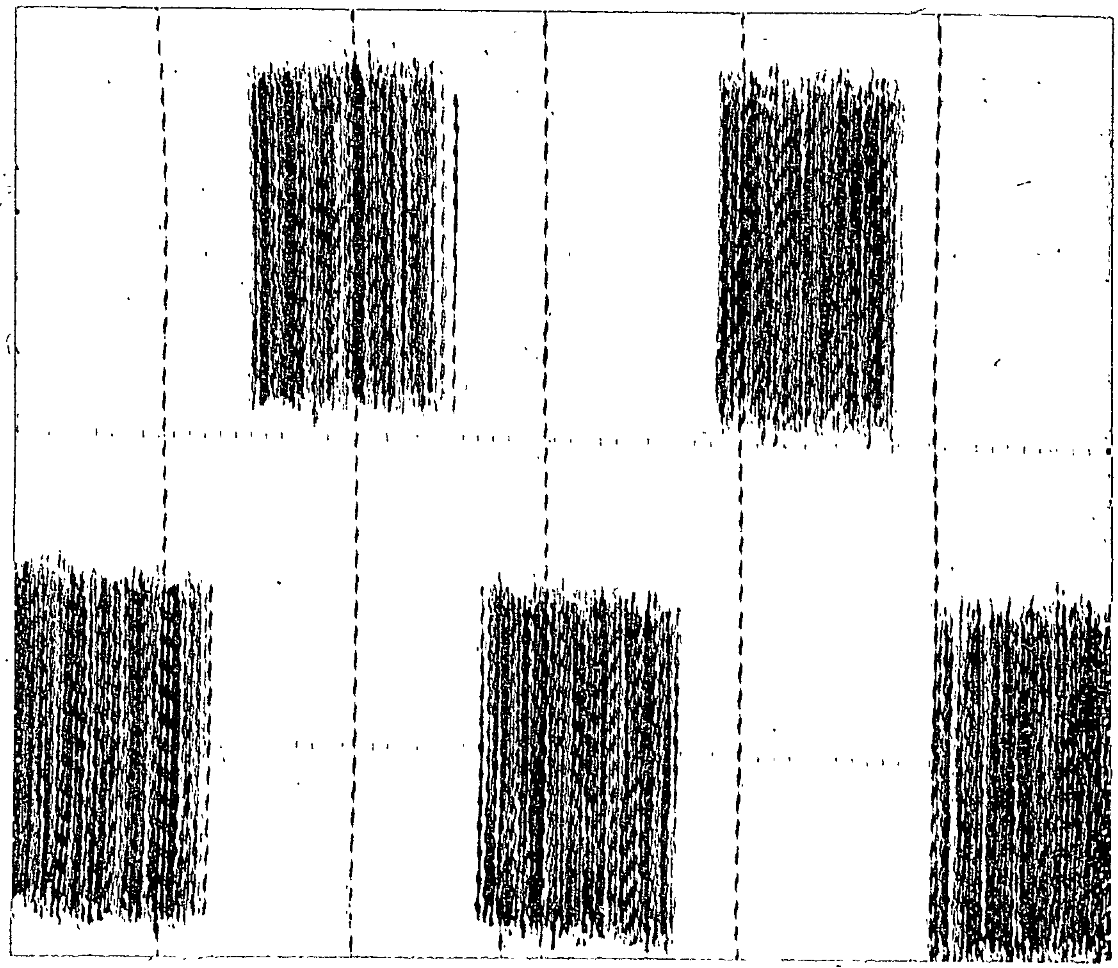


Fig 10.22

measurements were completed in an identical manner to those performed on the woven wool warp printed fabrics.

10.5 Discussion of Results from Woven Cotton Warp Printed Fabrics

10.5.1 Irregularity of Image Profile

Tables 10.3 and 10.4 give a visual representation of the range of irregularity of the image profile that occurred in the trials containing 100% cotton. Table 10.3 shows the various profiles of the plain weave, 2/2 repp and 3 and 1 twill construction groups, and Table 10.4 illustrates those of the 2/3 hopsack and 8 end satin groups. Each profile is again the top left hand printed block of each fabric and was recorded with identical information to that of the corresponding wool Tables 10.1 and 10.2. These tables clearly support the findings of the visual observations in which the plain weave group showed the least irregularity whilst the other construction groups displayed a gradual increase. Each percent of irregularity value alongside every profile supports this and shows additionally the random manner in which the irregularity occurs throughout every construction group.

10.5.2 Effect of Pick Spacing on Image Profile

Fig 10.23 - 10.27 show the results of the effect pick spacing has upon the image profile. Generally the overall degree of irregularity of the cotton samples is seen to be less than for the wool fabrics, which is due to the

Degree of Irregularity of the Image Profile of the Cotton Samples

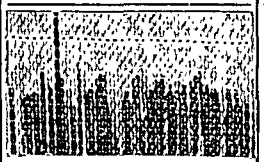
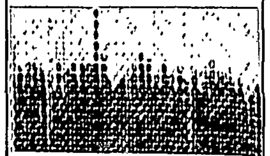
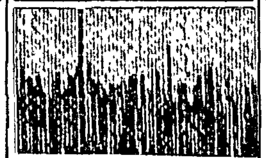
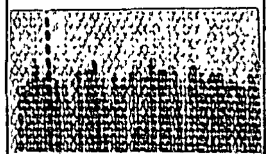
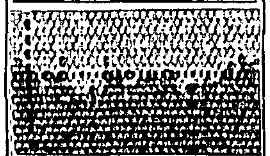
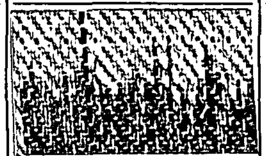
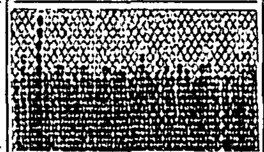
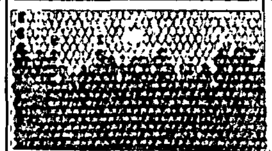
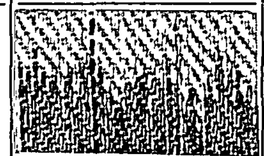
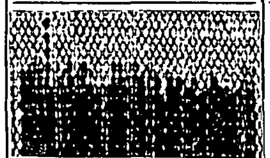
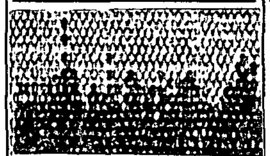
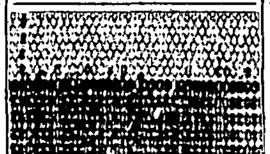
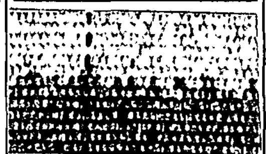
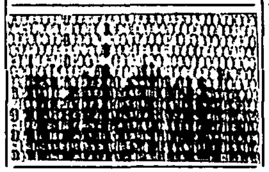
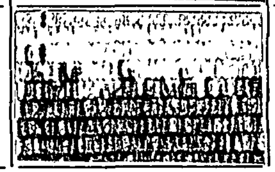
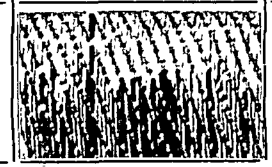
PLAIN				2/2 REPP				3 AND 1 TWILL			
Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity
37	R11.75/2		9.3	43	R11.75/2		12.5	49	R11.75/2		9.3
38	R37.5/2		9.3	44	R37.5/2		12.5	50	R37.5/2		14
39	R98/2		14	45	R98/2		12.5	51	R98/2		18.7
40	125		12.5	46	125		17.1	52	125		18.7
41	R195/2		14	47	R195/2		10.9	53	R195/2		14
42	R390/2		9.3	48	R390/2		12.5	54	R390/2		12.5

Table 10.3

Degree of Irregularity of the Image Profile of the Cotton Samples (Continued)

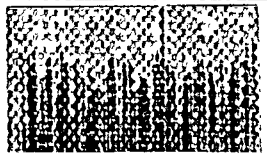
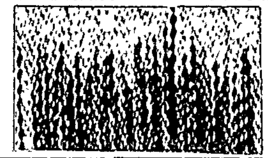
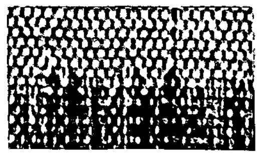
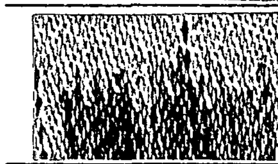
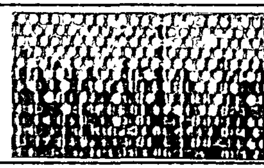
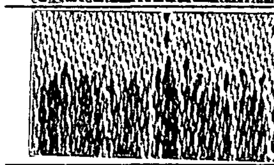
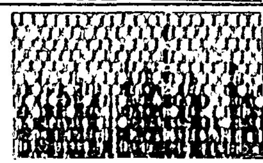
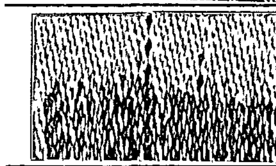
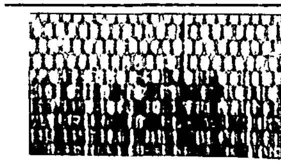
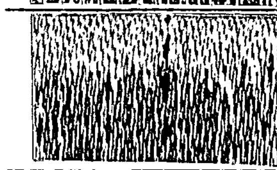
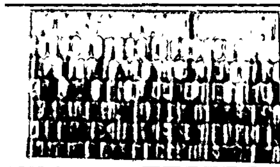
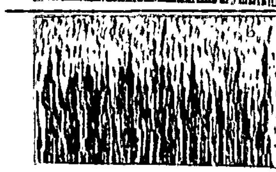
2/3 HOPSACK				8 END SATIN			
Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity
55	R11.75/2		18.7	61	R11.75/2		20.3
56	R37.5/2		6.3	62	R37.5/2		18.7
57	R98/2		15.6	63	R98/2		14
58	125		14	64	125		14
59	R195/2		9.3	65	R195/2		15.6
60	R390/2		12.5	66	R390/2		12.5

Table 10.4

Effect Of Pick Spacing On Image Profile Of The Cotton Samples

Plain Weave Group

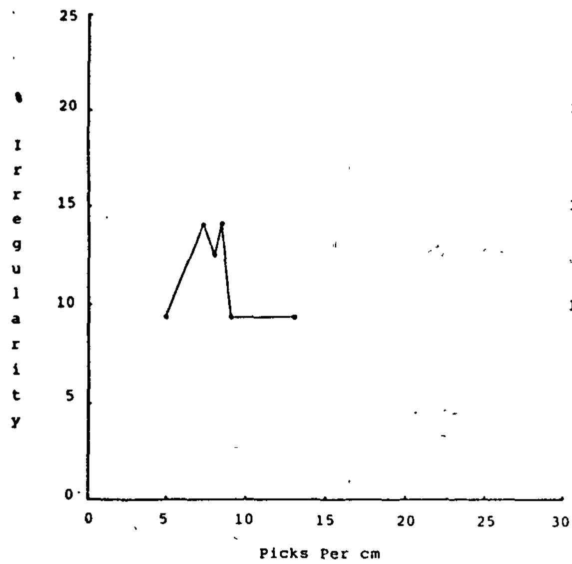


Fig 10.23

2/2 Repp Group

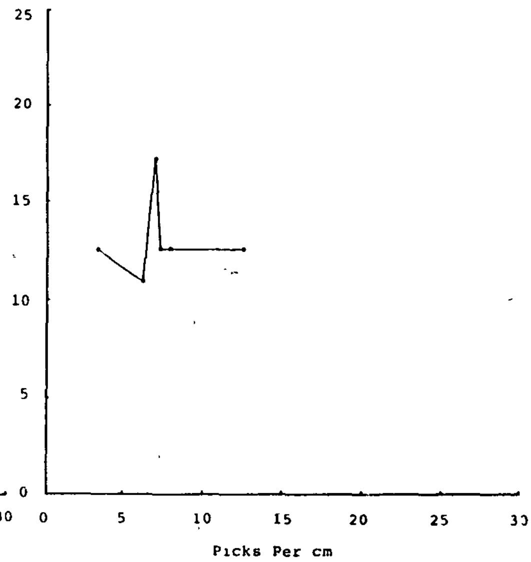


Fig 10.24

3 And 1 Twill Group

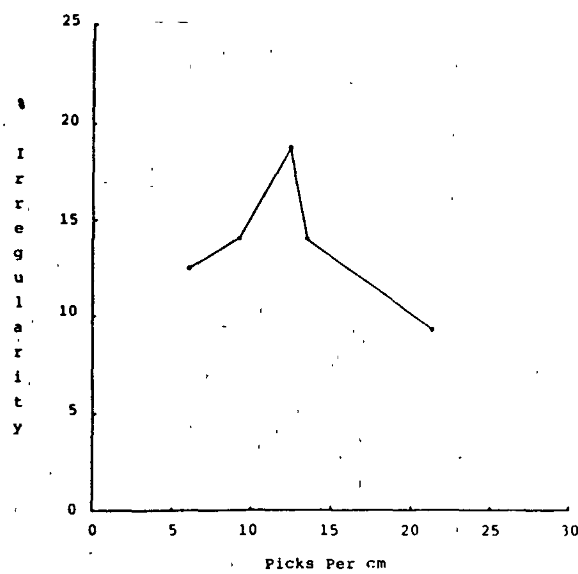


Fig 10.25

2/3 Hopsack Group

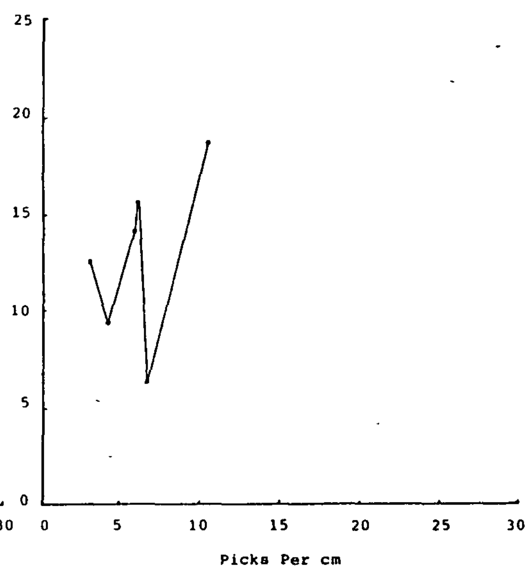


Fig 10.26

Effect Of Pick Spacing On Image Profile Of The Cotton 8 End Satin Group

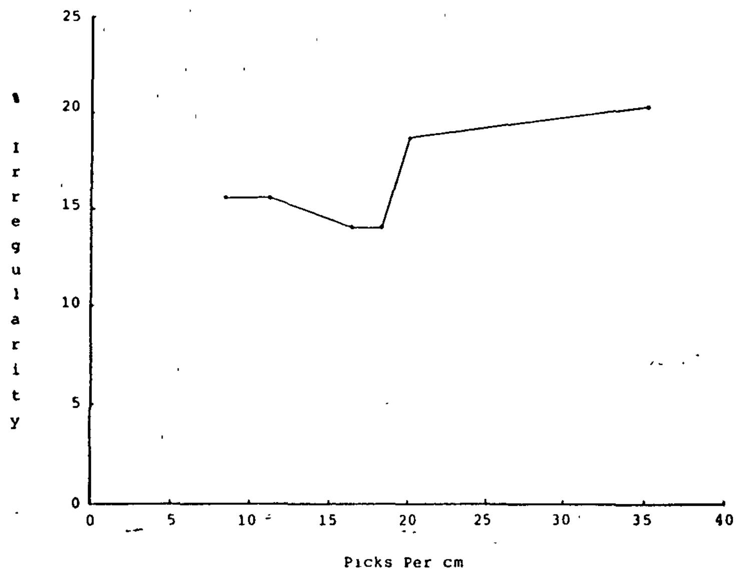


Fig 10.27

Effect Of Weft Count On Image Profile Of The Cotton Samples

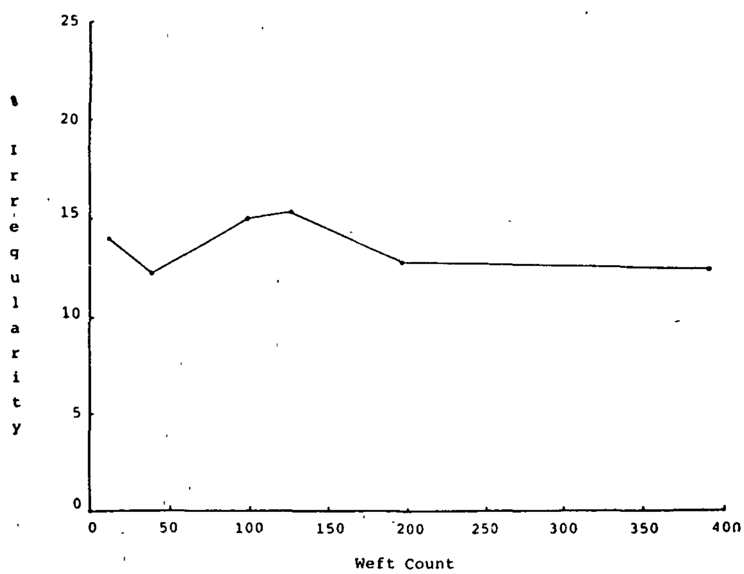


Fig 10.28

composition of the yarn itself. The differences between wool and cotton fibres are well known, one being of a fibrous nature with great stretching properties, the other generally of a more stable nature. These differences in yarn type can have a fundamental effect upon the formation of the image profile.

The mean values of Figs 23-27 show a similar trend to the wool pick spacing graphs except for the plain weave group which in this case exhibits the least irregularity. Eight end satin again measures the highest amount while 3 and 1 twill takes second place, followed by the repp and hopsack constructions, indicating that as the structure becomes more complex, irregularity increases.

Just as for the wool samples, it appears in some cases that the third and fourth samples of each construction group exhibit a peak. There were fabrics woven with 125 Tex and R195 Tex/2 weft yarns respectively and again the reason for this happening is not understood.

In conclusion however there appears to be no connection between image profile and pick spacing.

10.5.3 Effect of Weft Count on Image Profile

Fig 10.28 shows a graph of similar appearance to that seen in the corresponding wool trial (Fig 10.12). There is evidence to suggest that the overall amount of irregularity is lower than that of the wool with a mean value of approximately 13%. The greatest irregularity that occurred was on those fabrics woven with the R159 Tex/2 and 125 Tex yarns which were the same two samples that had produced the greatest irregularity in the preceding trial.

As no relationship was discovered between image profile and weft count on the composite graph, it was felt that individual analysis of each weave, which was carried out previously, was unnecessary.

10.5.4 Effect of Weave Float Length on Image Profile

The graph in Fig 10.29 shows a result similar to that of the corresponding wool graph illustrated in Fig 10.19, that there is a positive relationship between weave float length and image profile. The overall mean value of the cotton graph is between 14% and 15% and its delineation appears similar to that of the wool, but exhibiting a more acute angle.

Comparison of these levels on the float length graphs show that there is a slightly higher slope on the cotton graph. This indicates that there was an interaction of fibre and weave float length which is a surprising outcome. It was felt that in the event of an interaction between fibre and float length the wool yarn would have been the one to show an effect for reasons described in section 10.4.2.

The 8 end satin construction group again show the highest irregularity.

10.5.5 Conclusions

The trend of results from the cotton trials was found to be fundamentally similar to that of the wool with both pick

Effect Of Weave Float Length On Image Profile Of The Cotton Samples

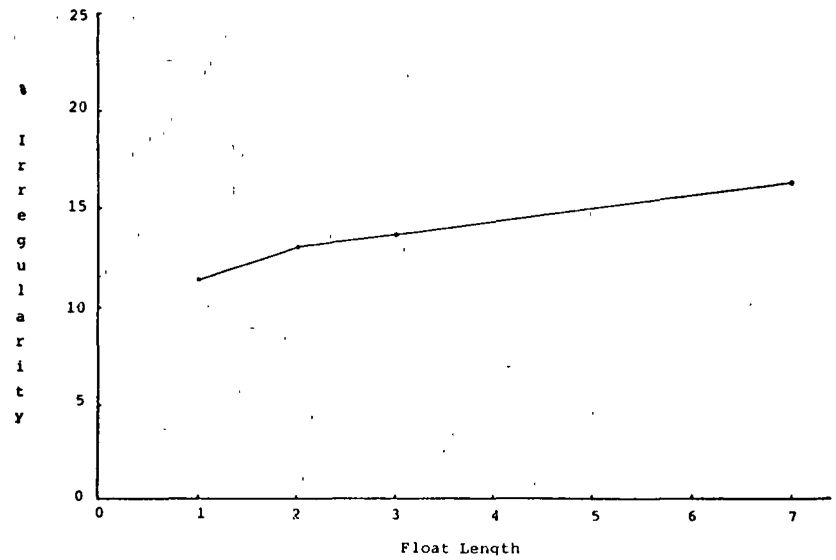


Fig 10.29

spacing and weft count appearing independent of image profile, whilst there did seem to be some relationship between weave float length and image profile.

The mean values of irregularity of image profile for all the graphs are much lower than those for the wool groups with an average level of 13.5% indicating that the yarn was responsible for the general lack of irregularity. Again it was the third or fourth samples of each construction group which displayed a peak. In this case they were woven with R98 Tex/2 and 125 Tex yarns.

Furthermore comparison of the amount of irregularity that occurred with each constructional group of the two warps produced an interesting result. Although the twill and satin groups of both warps behaved similarly, showing an increased amount of irregularity with an increase in float length, it was anticipated that the plain weave samples should show more irregularity than the repp and hopsack samples due to the larger picking area of the latter. This occurred with the wool fabrics, but the cotton results were the reverse, with the repp and hopsack constructions showing greater irregularity than the plain weave samples. It was wondered what result the silk samples would produce in this respect.

Finally the colour tone of each sample group of both warps was seen to progress from light to dark, in most cases, as the weft yarn increased in size.

10.6 Results from Woven Silk Warp Printed Fabrics

10.6.1 Introduction

The production of the woven silk warp printed fabrics was completed in an identical manner as the previous wool and cotton warps. As explained in section 9.7.2 it was necessary to produce three silk warps to complete the five construction groups and the additional experimental work.

In general however, the warp yarn used for each of the three warps proved to be suitable absorbing the dyestuff effectively with only four pulls of the squeegee necessary during printing, and provided no difficulties during weaving, which was expected as it was known from past experience to produce an excellent result.

Crossed ends appeared again in some places, which, like the wool warp indicate that they were not arranged parallel during preparation for printing.

The weaving was completed simply, although attention had to be given to the selvedge edges to ensure they formed vertically. The production of each group took proportionally longer than the wool and cotton warps due to the fine linear density of the yarns. This in turn enabled a collection of fabrics of quality to result which were not only suitable for present day manufacturing requirements, but were also representative of the types of fabric produced by the traditional Ikat weavers.

10.6.2 Results of Visual Observations of Fabrics

Fig 10.30 - 10.32 show the woven silk warp printed fabrics

Woven Silk Warp Printed Fabrics

Plain Weave Samples 67 - 72; 2/2 Repp Samples 73 - 78

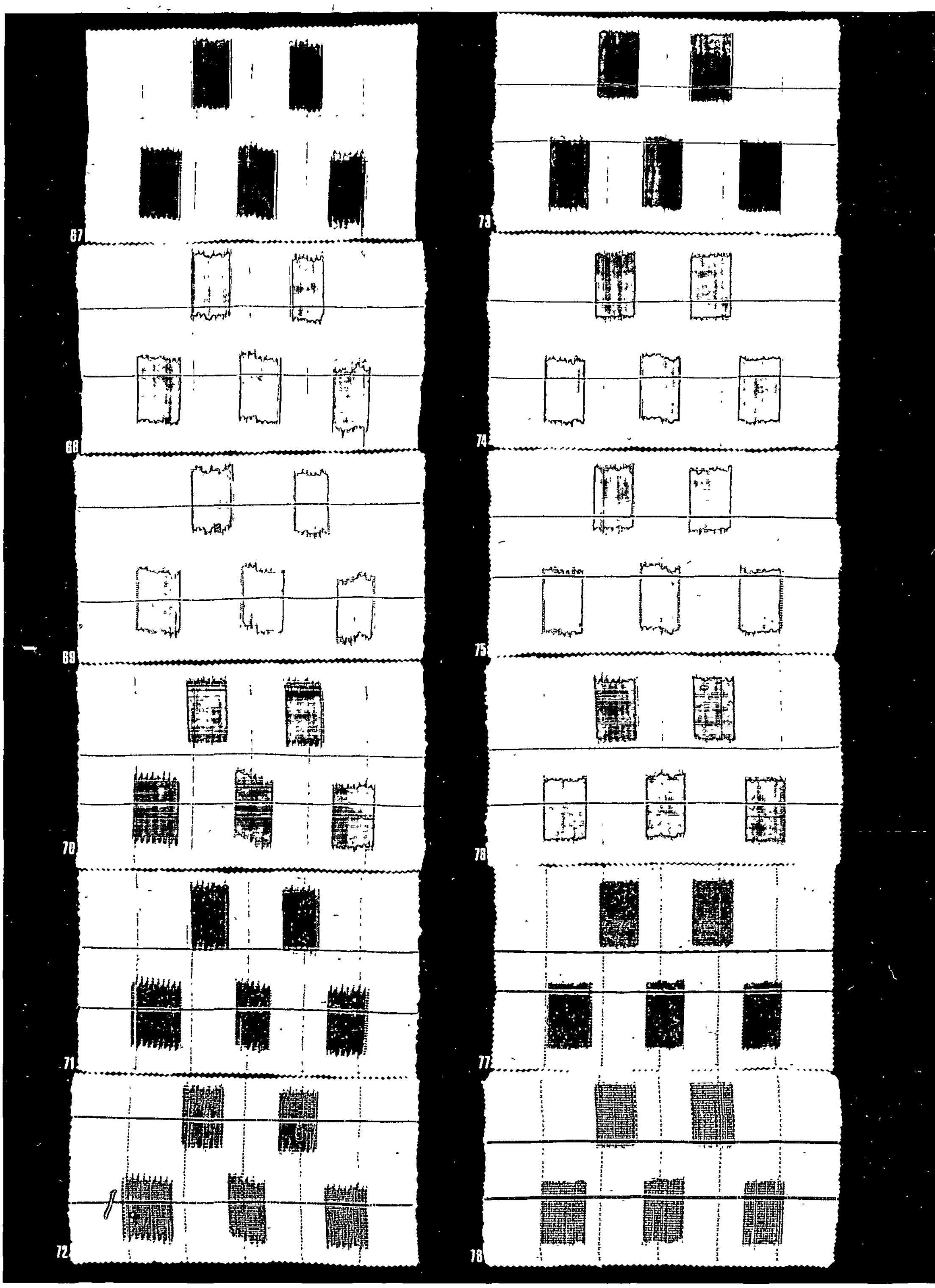


Fig 10.30

Woven Silk Warp Printed Fabrics

3+1 Twill Samples 79 - 84

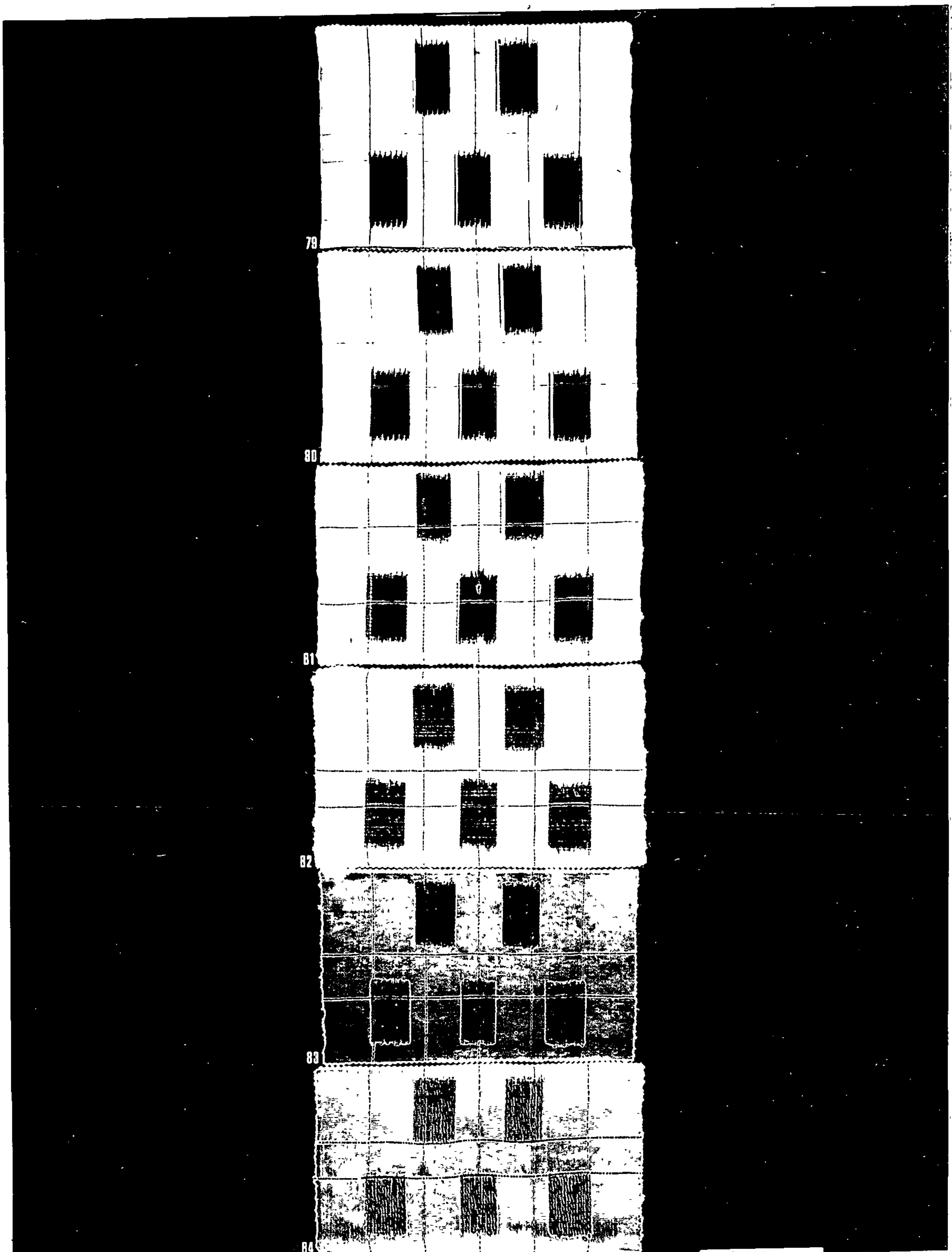


Fig 10.31

Woven Silk Warp Printed Fabrics

2/3 Hopsack Samples 85 - 90; 8 End Satin Samples 91 - 96

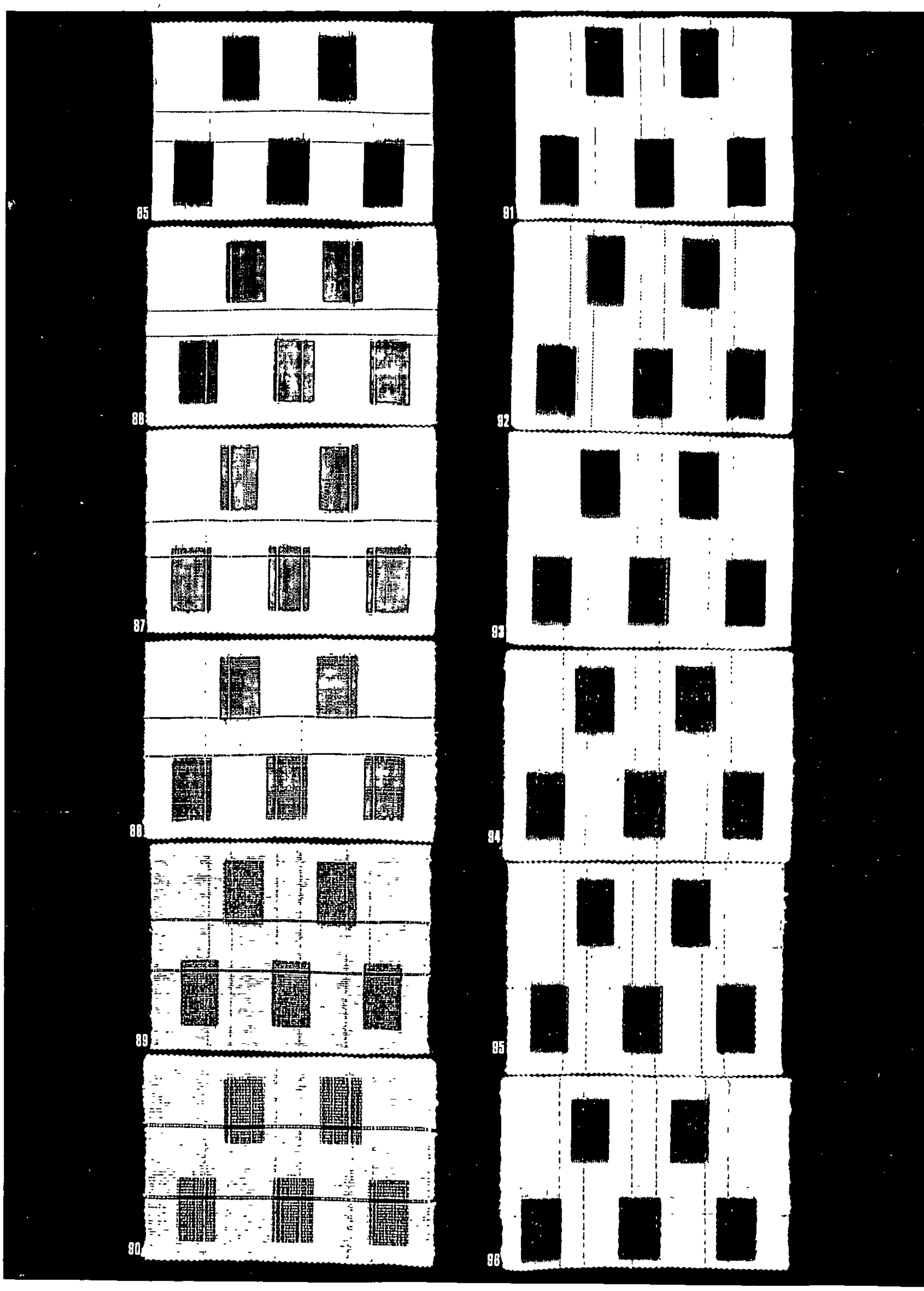


Fig 10.32

arranged in their construction groups corresponding to the information given in Table 9.12, which listed their numerical order, the weft yarns used, and end and pick measurements. Fig 10.30 shows the plain weave and 2/2 repp groups; Fig 10.31 the 3 and 1 twill group; and Fig 10.32 the 2/3 hopsack and 8 end satin groups respectively. Appendix VI displays a selection of fabric samples from the silk groups.

Many general effects are apparent due to these samples being woven from two handmade warps.

The first three construction groups show a naturally irregular image profile, while the final two groups, the 2/3 hopsack and 8 end satin shows a reduction of irregularity. This results from the first three groups being woven from silk warp number 1 (as recorded in Table 9.11) and the other two groups being the product of silk warp number 2. Of the first three construction groups the plain weave samples show the most irregularity while the 2/2 repp shows the least amount. Since warp number 2 was woven last of the three it was constructed in such a manner known to produce a controlled result. For this reason the 2/3 hopsack and 8 end satin groups should be observed separately. Very little irregularity of the image profile appears to have occurred at all.

It was thought however that the 8 end satin would have shown a high percentage of irregularity had it not been controlled. Thus it should be taken into consideration that the results given for these two groups throughout the analysis are not comparable to the other woven warp printed experiments.

Additionally it can be observed that the width of these sample groups differ from the first three, and that the black marking ends are arranged in pairs. It was discovered that the marking ends of silk warp number 1 were placed, in error, at intervals of 162 ends instead of 100. To ensure correct distribution of the markers for silk warp number 2 they were placed in pairs of 100 ends. Because of the fine linear density of the silk the effect of weave structure on the image profile appears to be less apparent than for the wool and cotton yarns, although the effect is most similar to the wool samples but on a smaller scale.

Warp irregularity is prominent in all the fabrics of the first three construction groups with at least one rectangular image being misshapen.

Additionally both shedding and stretch profiles have occurred throughout all the construction groups, but to a lesser degree with the 2/3 hopsack group, suggesting that the silk yarn was more dynamic in behaviour than the other two yarn types.

Colouration of the image appears satisfactory throughout except for the 3 and 1 twill group which was expected to show a deeper tone due to the warp faced weave structure. It is likely therefore that fewer pulls of the squeegee were completed during the printing of these samples.

Plain weave samples 67-72 (Fig 10.30) show the greatest amount of irregularity of image profile of the five construction groups. This is due partly to the presence of much warp irregularity which is apparent in each fabric, and to some shedding and stretch profiles particularly samples 68, 70 and 71.

Additionally every sample shows crossed ends to have occurred to some degree.

The warp was spread with the increase in weft count which has altered as before with the rectangular shape of the image becoming square.

Furthermore the colouration of the print appears to lighten with this increase in weft count. In comparison with the corresponding wool and cotton plain weave samples it is evident that these samples show the most irregularity of image profile, along with more warp irregularity, shedding and stretch profiles. This is either the consequence of the length of warp being prepared unevenly which results in tension loss during manufacture, or because of the smooth composition and stretching properties of the yarn itself, or a combination of the two. The 2/2 repp samples numbered 73-78 (Fig 10.30) show much less irregularity of image profile than the plain weave group particularly samples 73, 77 and 78. This was due to the more careful positioning of the print board.

It was discovered that due to the manner and position in which the board was placed during preparation for printing the ends on shafts 15 and 16 were having to travel around its sharp right angled edge (see Fig 10.33). This caused stretching to occur of those ends and after the removal of

Warp Ends Affected by Print Board Placement

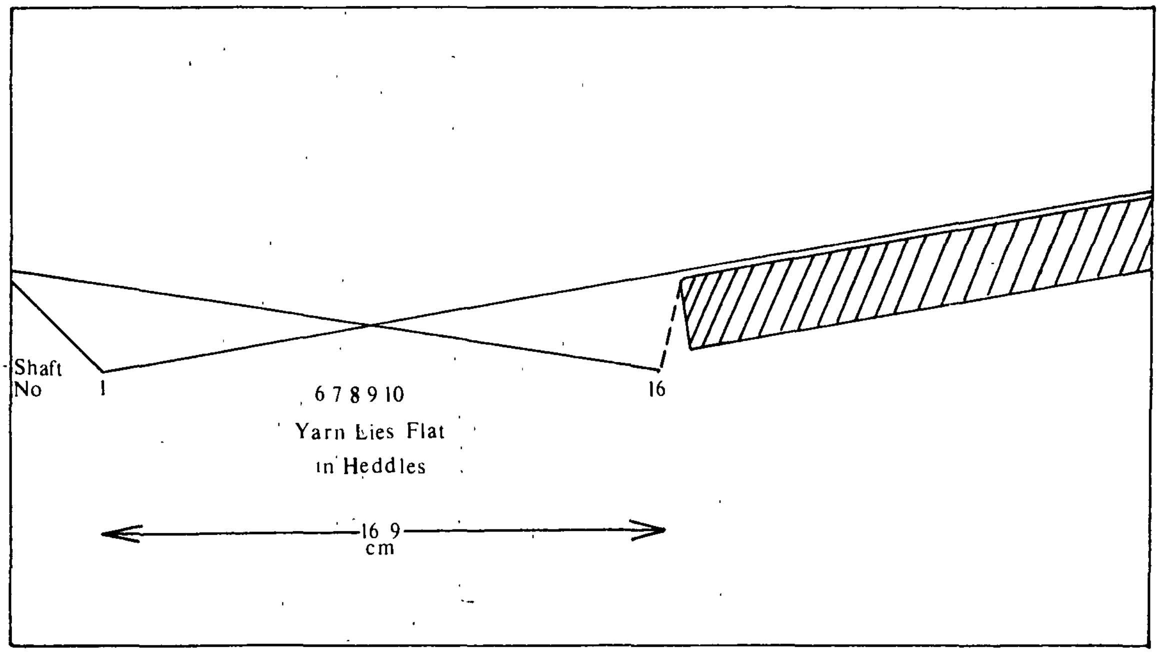


Fig 10.33

Warp Ends Unaffected by Print Board Placement

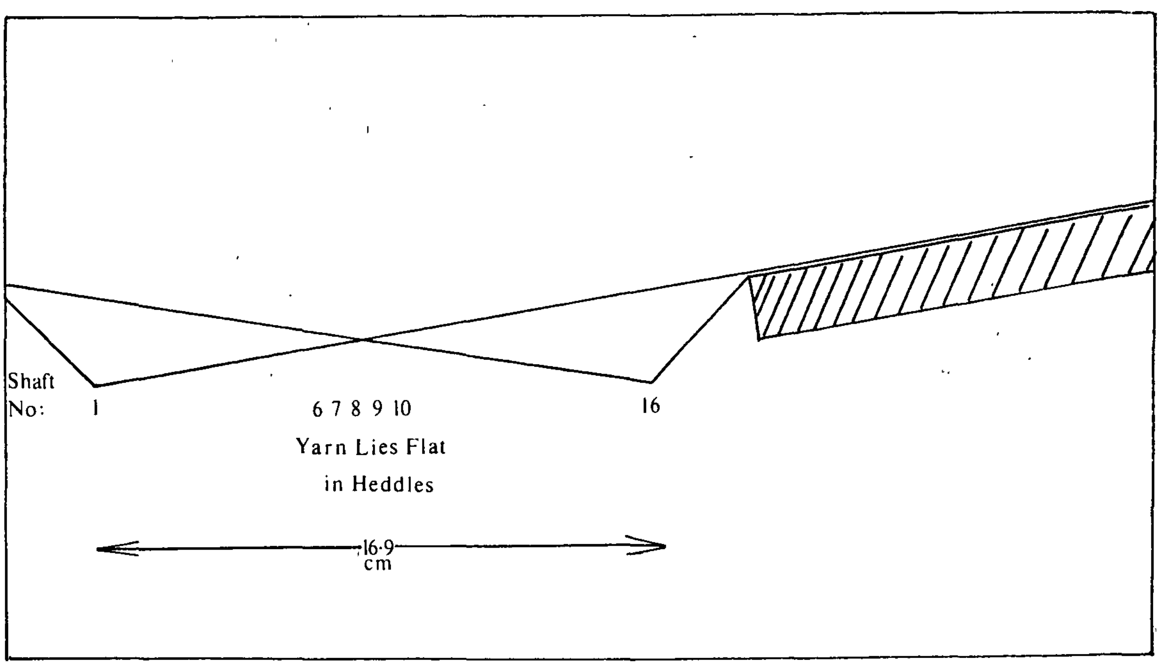


Fig 10.34

the board on completion of printing the ends returned to their original position showing immediate irregularity of the profile. Hence for printing the 2/2 repp sample group the board 'shadowed' the diagonal position of the warp so that the ends on the back shafts remained unaffected by its presence as Fig 10.34 shows. The ends on the front shafts of the bottom closed shedding dobby lie higher when the loom is stationary than the ends on the back shafts. Therefore the front ends remained in that position whilst the loom was prepared for printing after which the weight of the silk screen compressed all the ends against the printing board.

Returning to the discussion of the 2/2 repp samples, warp irregularity has occurred throughout the group, but shedding and stretch profiles are not evident. A few crossed ends have occurred, as has the spreading of the warp with increased size of weft count. Again the colouration of the print alters from dark to light throughout the group.

In comparison with the preceding warps it appears that these samples show as similar an amount of irregularity of image profile as the corresponding fabrics, with the wool showing the greatest irregularity of all.

However the silk group shows more warp irregularity than the other two.

The image profile of the 3 and 1 twill group of samples numbered 79-84 (Fig 31) shows slightly more irregularity than the 2/2 repp group, and reduces as the weft count increases. The profiles of samples 79-82 exhibit distinct irregularity while samples 83 and 84 demonstrate very little. This is the result of weft count ratio in combination with weave structure, the coarser picks covering the three weaving ends while only the fourth end remains conspicuously on the surface.

Some warp irregularity has occurred throughout predominantly in the centre of the fabrics while samples 79 and 80 exhibit obvious stretch profiles and some crossed ends. No shedding profiles appear in this construction group however.

As mentioned in the general observations at the start of this section, this group shows a poor shade of colouration for the structure suggesting that perhaps less pulls were given than for the other groups, or that the dyestuff itself was weak. Additionally the shade of the print has deepened with increase in yarn count which is the opposite outcome of the two preceding groups. Due to the fineness of the yarn the image profiles of the silk fabrics seem clearer in general than those of the other yarn types.

In fact together the wool fabrics show the greater degree of irregularity due partly to warp inconsistencies having occurred, followed by the cotton, and the silk fabrics. Although there is little difference between these two, the cotton shows slightly more irregularity than the silk fabrics.

Additionally the colouration of the print of the three yarn types deepens with increase of weft count.

As already mentioned the 2/3 hopsack samples numbered 85-90 (Fig 10.32) were the product of the second handmade warp, and were woven along with the 8 end satin samples after all the additional experimental work, yet to be discussed, had been completed. Hence control of the printed image had been understood by this time therefore the results for these fabrics are not strictly comparable with those of all preceding experiments. The images of samples 89 and 90 can be seen to be near perfect in form. Warp irregularity and shedding profiles have not occurred throughout the group suggesting that overall warp tension was static, but minute stretch profiles are present in samples 85 and 86. These occurred as a result of the print being placed too close to the beginning of the warp, but their small size is due to the warp being drawn-in over 8 shafts instead of 16. Additionally no crossed ends are apparent. As with the preceding group the colouration of the print of this group darkens with increase in weft count.

The 8 end satin samples numbered 91-96 (Fig 10.32) show a continuation of the shape of the image being retained. Stretch profiles have occurred this time on every image of the whole group and increase in size fractionally as the weft yarn has increased in count. As with 2/3 hopsack samples 85 and 86 this is the result of the impression being printed too close to the start of the warp which in this case was approximately 30 cm. It is usual to weave approximately 30 cm at the start of a warp before printing to allow the warp to settle itself, but it was necessary to use the yarn economically. Additionally the fact that the warp was threaded over 8 shafts instead of 16 has reduced the size of the stretch.

Close examination of these fabrics has revealed that the size of stretch on the left of the centre line is slightly greater than that on the right, suggesting that there was a minimal difference in warp tension at these points. It is intended to explain the manipulation procedures carried out on these samples in chapter 12 which comments on control of the printed image.

To conclude the visual observation of the 8 end satin samples the strong colouration helped by the lustre of the yarn is as it should be, and grows in intensity with increase in weft yarn count.

10.6.3 Measurements Made

Measurements for both the ends and picks per centimetre and the percent of irregularity of the image profile were completed in an identical manner to the wool and cotton fabrics. Appendix III lists the end and pick details of the five constructional groups. The five marking ends of the first warp for the plain weave, 2/2 repp and 3 and 1 twill samples were altered for the second warp to six, as five placed at intervals of 100 ends were positioned too much in the centre of the fabric for a varied range of measurements. Thus three pairs of markers at 100 ends apart were placed across the second warp. Again all measurements were taken with the aid of a vernier caliper measuring tool.

10.7 Discussion of Results From Woven Silk Warp Printed Fabrics

10.7.1 Irregularity of Image Profile

Tables 10.5 and 10.6 give a visual representation of the range of irregularity of the image profile that occurred in the trials containing 100% silk yarns. Table 10.5 shows the profiles of the plain weave, 2/2 repp and 3 and 1 twill groups, while the 2/3 hopsack and 8 end satin group profiles are shown in Table 10.6.

As for the wool and cotton fabrics each profile was the top left hand printed block of each sample, and was recorded with its number, Tex weft count and percent of irregularity value. These tables clearly illustrate the results of the visual observations as it can be seen that the plain weave profiles do show a greater range of irregularity than the other groups. It might be thought that the 8 end satin group shows an equal irregularity but it can be seen that the range is fairly static in comparison.

10.7.2 Effect of Pick Spacing on Image Profile

Fig 10.35 - 10.39 show the results of the effect of pick spacing upon the image profile. There is no evidence to suggest that the irregularity of the image profile is effected by pick spacing.

The mean values of these graphs show a different trend from the wool and cotton pick spacing graphs. Plain weave

Degree of Irregularity of the Image Profile of the Silk Samples

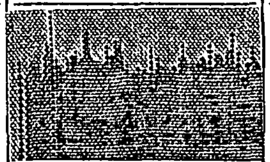
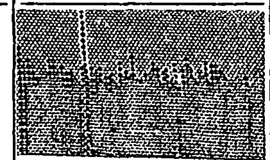
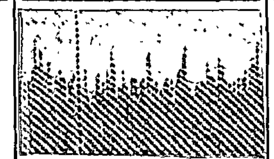
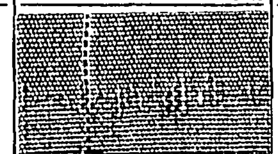
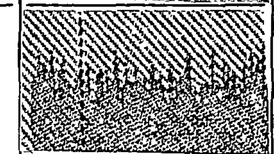
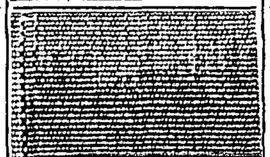
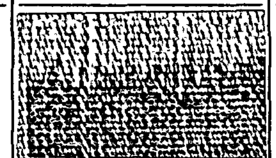
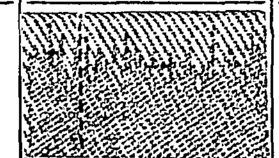
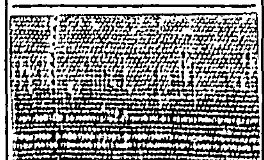
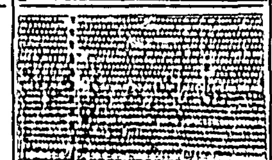
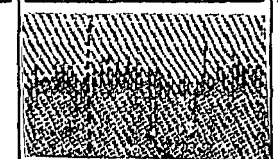
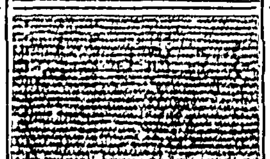
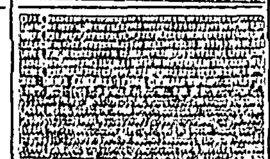
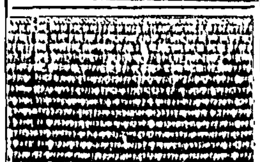
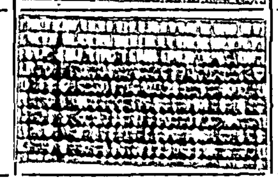
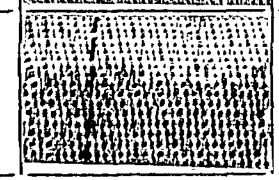
PLAIN				2/2 REPP				3 AND 1 TWILL			
Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity	Sample Number	Tex Count of Weft	Profile	% Irregularity
67	R12.5/2		17.1	73	R12.5/2		12.5	79	R12.5/2		14
68	R40/4		18.7	74	R40/4		12.5	80	R40/4		15.6
69	R96/2		21.8	75	R96/2		14	81	R96/2		15.6
70	118		23.4	76	118		12.5	82	118		15.6
71	140		17.1	77	140		7.8	83	140		13.8
72	R340/2		15.6	78	R340/2		9.3	84	R340/2		14

Table 10.5

Degree of Irregularity of the Image Profile of the Silk Samples (Continued)

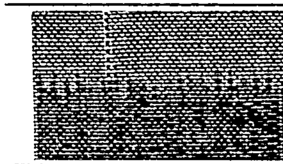
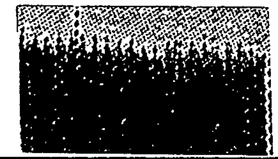
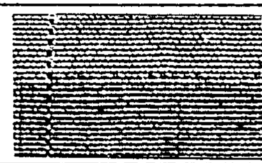
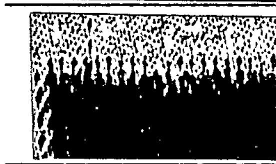
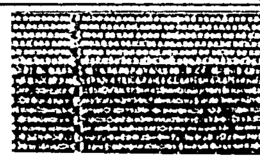
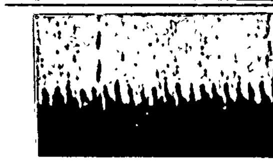
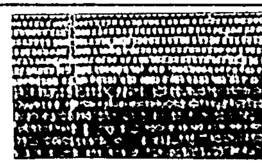
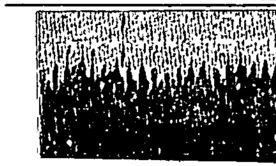
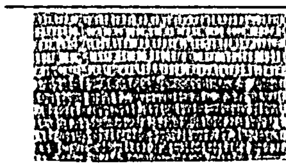
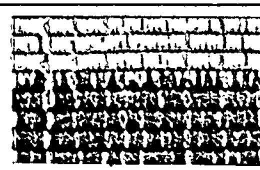
2/3 HOPSACK				8 END SATIN			
Sample Number	Tex Count of Weft	Profile	% Irre-gularity	Sample Number	Tex Count of Weft	Profile	% Irre-gularity
85	R12.5/2		12.5	91	R12.5/2		10.9
86	R40/4		7.8	92	R40/4		12.5
87	R96/2		7.8	93	R96/2		9.3
88	118		12.5	94	118		14
89	140		7.8	95	140		9.3
90	R340/2		6.2	96	R340/2		10.9

Table 10.6

Effect Of Pick Spacing On Image Profile Of The Silk Samples

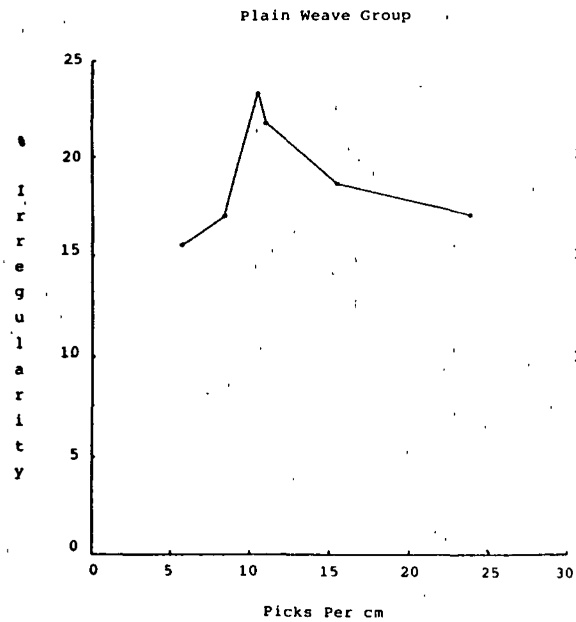


Fig 10.35

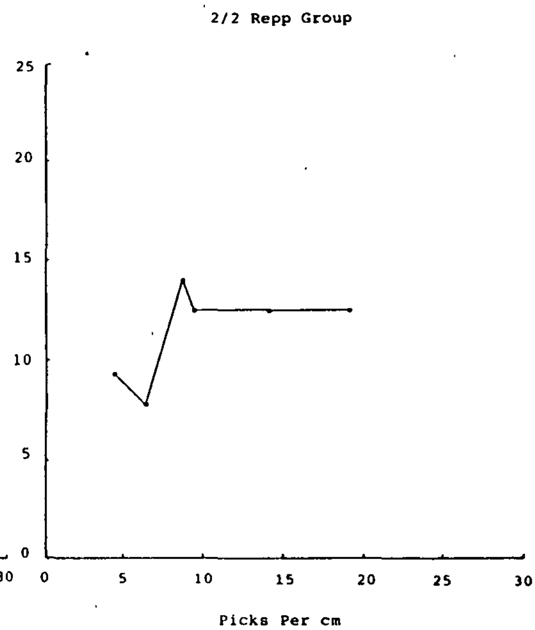


Fig 10.36

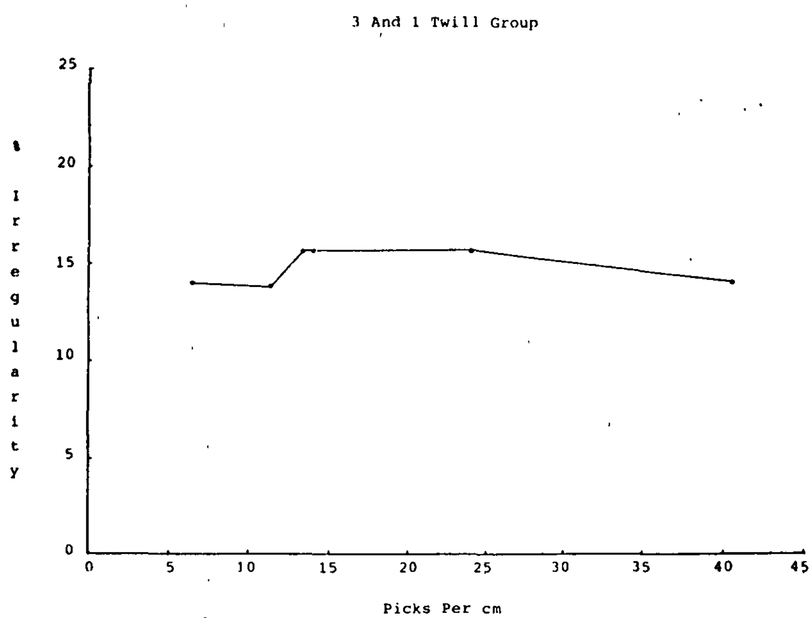


Fig 10.37

Effect Of Pick Spacing On Image Profile Of The Silk Samples

2/3 Hopsack Group

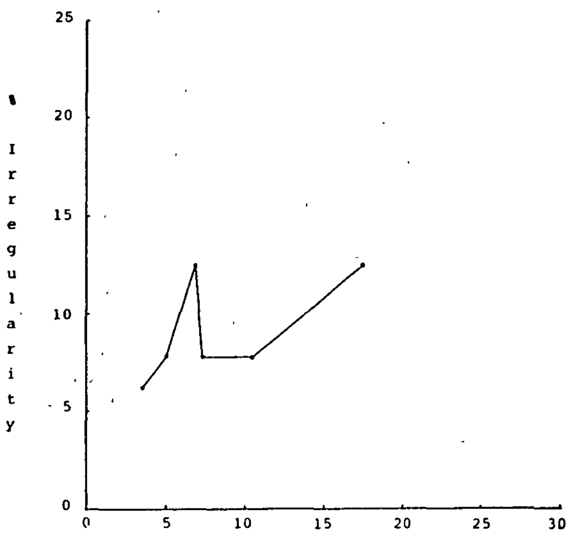


Fig 10.38

8 End Satin Group

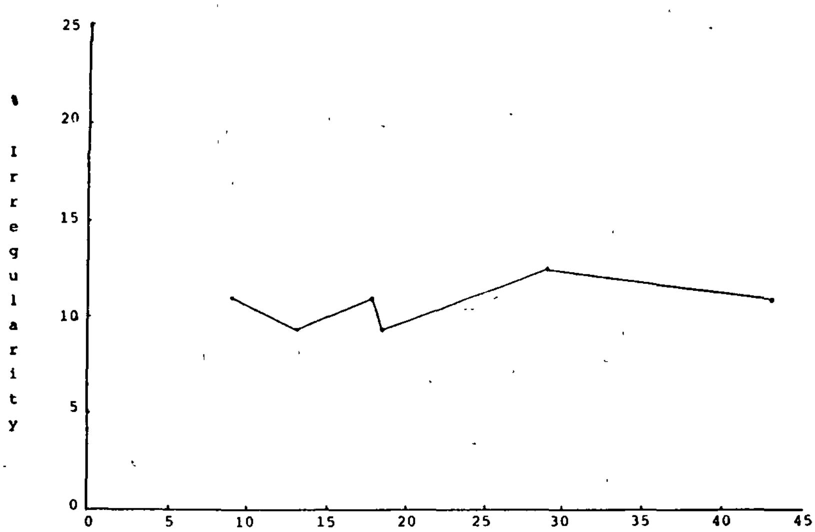


Fig 10.39

exhibits the highest level of irregularity followed by 3 and 1 twill, and 2/2 repp. The 8 end satin and 2/3 hopsack groups show a lower level of irregularity.

Again a peak is shown in some cases on each graph for the third and fourth samples of each constructional group. These were fabrics woven with R96 Tex/2 and 118 Tex weft yarns respectively, but the reason for this outcome is not understood.

In comparison with the corresponding wool and cotton graphs it appears that the level of irregularity of the silk fabrics is less than the other two, wool showing the highest level, and silk at a level only fractionally less than cotton. It is likely a different result would have developed had the 2/3 hopsack and 8 end satin samples not been controlled. Additionally there is less scatter of results here than for the other graphs which is partly due to the careful production of the 2/3 hopsack and 8 end satin samples suggesting that there was less discrepancy in beat up rate of the silk fabrics.

10.7.3 Effect of Weft Count on Image Profile

From Fig 10.40 it is possible to see that weft count has no effect on the image profile. Additionally the overall amount of irregularity is lower than both the wool and cotton weft count graphs at a level of approximately 12%. It is apparent too from Fig 10.40 that on average the greatest irregularity occurred on the fourth sample of each group followed by the third. This is a result similar to

Effect Of Weft Count On Image Profile Of The Silk Samples

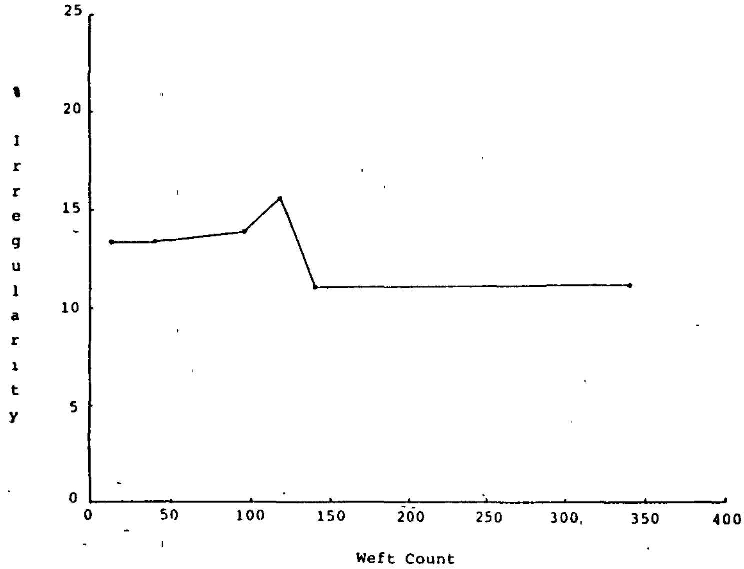


Fig 10.40

Effect Of Weave Float Length On Image Profile Of The Silk Samples

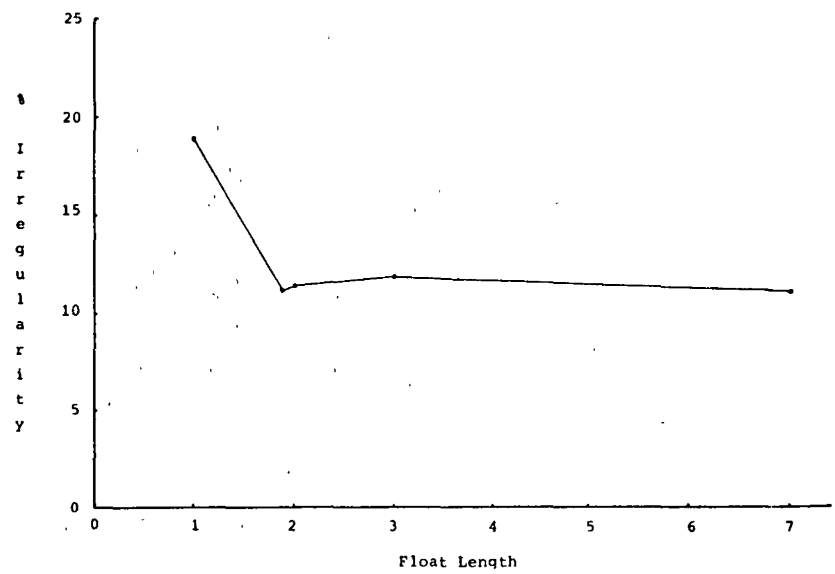


Fig 10.41

that which occurred with the wool and cotton samples.

10.7.4 Effect of Weave Float Length on Image Profile

Contrary to the two previous results it appears from Fig 10.41 that float length has no effect on the image profile. It is likely that this result was effected by the 2/3 hopsack and 8 end satin groups being specially controlled.

The overall mean value is 12% with the greatest irregularity being the plain weave group. Additionally in comparison with the wool float length graph it appears there is a higher slope on the silk graph at the point of plain weave which indicates that there was an interaction of fibre and weave float length. It is thought that the smooth structure of silk was not the only factor in producing this result, uneven tension in the warp at the time of preparation causing most effect.

10.7.5 Conclusions

The trend of results from the silk trials is similar to those of the wool and cotton ones with regard to pick spacing and weft count which appear independent of image profile. Weave float length however has produced a different result from the wool and cotton and appears independent also of image profile. It is expected that this latter result is due to the controlled production of the 2/3 hopsack and 8 end satin weaves.

In addition the mean values of irregularity for all the silk graphs are on average lower than wool, but of a similar level to cotton at 13%. Similarly it appears in most cases the samples showing the most irregularity comprise the fourth and third respectively.

Comparison with the two preceding warps on the amount of irregularity that has occurred in each constructional group shows a trend similar to wool with the plain weave samples exhibiting the most. The repp and hopsack constructions show less irregularity than plain weave which was not the case with the cotton fabrics.

Additionally the colour tone of each sample group is seen, like the wool and cotton fabrics, to progress from light to dark in all but one instance.

10.8 Comparison of Results from the Three Weaving Trials

10.8.1 Common Features

On the basis of this experiment there appears to be no evidence that pick spacing changes the profile irregularity. There is evidence however that the fibre, in particular wool, effects the overall level of irregularity, and that there is a relationship between float length and irregularity.

Additionally it can be seen from Table 10.7 that in general the colouration of the print progresses from light to dark in each fabric type.

10.8.2 Differences in Behaviour

The main differences in behaviour are that the cotton repp

Comparison of Colouration Behaviour of Each Construction Group of the Three Woven Warp Printed Fabric Experiments

(L to D = Light to Dark ; D to L = Dark to Light)

Construction	Yarn Type		
	Wool	Cotton	Silk
Plain Weave	D to L	D to L	L to D
2/2 Repp	D to L	L to D	D to L
3 + 1 Twill	L to D	D to L	L to D
2/3 Hopsack	L to D	L to D	L to D
8 End Satin	L to D	L to D	L to D

Table 10.7

and hopsack fabrics show more irregularity than the plain weave group and that in general cotton is a more stable fibre than either wool or silk producing in this case a relatively indistinct image profile.

The wool fibre shows not only the most warp irregularity, but most irregularity of the image profile also. Clarity of colouration of the printed image appears in the silk fabrics due to the lustrous quality of the yarn.

10.8.3 Slub Fabrics

It appears that the irregularity of image profile of those fabrics woven with the slub yarns behaves similarly to those of the other weft yarns, but in some cases show higher levels of irregularity particularly the wool 2/3 hopsack and 8 end satin groups and the majority of the silk fabrics.

It is intended to examine the effects of slub yarns upon the image profile in the following chapter.

10.9 Conclusions

It appears from the analyses carried out in this chapter that the main factors affecting the irregularity of the image profile are types of yarn and weave float length.

CHAPTER 11 RESULTS FROM WEAVING TRIALS ON WOVEN WARP PRINTED FABRICS USING SLUB WEFT YARNS

11.1 Introduction

Before progressing to the next stage of the inquiry it was felt that a brief account of those fabrics woven with the slub weft yarns was necessary to determine if and how the irregular composition of the yarn affected the formation of the image profile. Although discussion of these fabrics took place with the others in the preceding chapter no detailed observations were recorded and no conclusions drawn specifically to this end.

11.2 Range of Samples

A total of 20 fabrics was produced with slub weft yarns from the three woven warp printed trials. This number included the extra five repeated for the additional wool plain weave group (see Table 9.5). Since these fabrics were identical to the original plain weave group their inclusion here was considered unnecessary.

Each slub fabric was one of the five construction groups. For simple reference everyone was identified with an 'S' in Tables 9.5, 9.9 and 9.12 which numerically listed the fabrics in their order of construction, and gave the relevant linear density and end and pick measurements. They were illustrated also in Figs 10.1 - 10.3, Figs 10.20 - 10.21 and Figs 10.30 - 10.32 respectively.

11.3 Results of Visual Observation of Fabrics

11.3.1 Woven Wool Warp Printed Slub Fabrics

It mentions in section 9.2.1 regarding the warp and weft yarn details, that the slub yarn of 1525 Tex was chosen for its wide range of variant. This yarn, (shown in Table 9.1), displayed a regular slub which measured 18 cms in length interspersed by intervals of comparative fineness measuring 3 cms in length. The combination of both coarse and fine linear densities was hoped to produce an interesting effect upon the printed image and its profile. This it did as examination of the five fabrics together showed. The images of the plain weave, repp, and hopsack fabrics have all been effected by the slub weft, whereas the two warp faced weaves, the twill and satin appear not to be effected at all due to the amount of warp on the surface of the fabric.

The result that did occur caused the image to distort from its original rectangular shape. This was the result of the warp spreading in the coarse areas and condensing in the fine areas of which the latter had the effect of restricting the true shape of the image as well as darkening the colouration of the print. It is suspected that the extent of this effect would be reduced considerably with the use of an irregularly slubbed yarn. Additionally it is noteworthy that this could be an interesting design area potentially suitable for manufacturing development.

This visual observation of the five wool slub fabrics does not reflect the results discovered in the mathematical examination of the whole series of wool warp printed fabrics discussed in the previous chapter. However separate examination of the slub results gives some definite conclusions.

With regard to the effect the weft count had on the degree of irregularity of the image profile the slub yarn had a value of 17% which was a relatively high level in general, but average in comparison with the other yarns.

Additionally analysis of the pick spacing and weave float length graphs in relation to the irregularity of the image profile showed the highest value to be that of the 8 end satin. Observation of this fabric showed warp irregularity to have occurred to some degree, which had also effected the 3 and 1 twill fabric. It was established primarily in section 10.2.4 that this was infact the result of the weave float length which was found to have an effect on the image profile. The 2/3 hopsack and plain weave fabrics followed with the third highest value, and then the 2/2 repp fabric which showed the lowest value of the sequence (see Table 10.1 and 10.2). The results of these latter three were due to the degree of variant of the slub. Thus both visual observation and the mathematical results were related in this case.

11.3.2 Woven Cotton Warp Printed Slub Fabrics

In contrast the natural grey cotton 125 Tex (Table 9.6) comprised an irregularly slubbed yarn of fine linear density which was anticipated to give an acceptable appearance and feel to the end product. Since the yarn was fine and irregularly slubbed it was not expected to produce the same dramatic effects as the wool yarn. Observations of the fabrics together support this hypothesis as none of the images appear to have been effected by the irregular composition of the yarn. Misshaping of the image has occurred in some cases, but this is the result of warp irregularity.

With regard to the mathematical interpretation it is of interest that Fig 10.28 showed that the cotton slub had the greatest effect on the image profile with an approximate value of 15%. This was the reverse result of the wool slub yarn which had shown a lower value than most of the other wool weft yarns, but a higher value than the cotton slub at 17%.

The results of the pick spacing and weave float length graphs showed that the 3 and 1 twill slub, followed by the 2/2 repp had the most effect on the image profile followed by the 8 end satin, 2/3 hopsack and lastly the plain weave. This arrangement differed from the wool slub result and the entire woven cotton group which suggested that some other factor was effecting the image profile. Warp irregularity was presumed responsible.

11.3.3 Woven Silk Warp Printed Slub Fabrics

The singles silk 118 Tex was selected for the same reasons as the cotton yarn, to give an acceptable appearance and feel to the end product. It was not possible to locate a yarn of coarser linear density and this yarn, although regularly slubbed every 135 cms, was interspersed with smaller non-uniform slubs.

It was not expected to have any great effect on the shape of the image. However it was thought that the fineness of the warp and the uneveness of the weft could effect the image profile.

Study of the five fabrics revealed that this hypothesis was again correct. The overall shape of the image was not effected by the slub but the degree of irregularity was effected when the maximum density of the yarn coincided with the profile. This occurred to some extent with the plain weave, repp, and hopsack samples, but the twill and satin fabrics showed only a slight ridging throughout which did not interfere with the profiles themselves. Interestingly, due to the spacing of the slub the 2/3 hopsack fabric showed little slubbing at all, but displayed an appearance more associated with a broad rib effect, and additionally exhibited a very accurate image profile.

From a technical viewpoint it was possible to see from Fig 10.40 that the 118 Tex effected the image profile least of all the silk yarns with a value of just over 11%, the lowest level of the three fibres. With regard to the pick spacing and weave float length tests the construction which showed the highest irregularity was the plain weave fabric, a result primarily caused by warp irregularity. The twill and satin constructions respectively showed a decreased level of irregularity followed lastly by the repp and hopsack fabrics. It must be remembered that the warp used for the satin and 2/3 hopsack fabrics was deliberately controlled during manufacture and therefore effected the accuracy of these results. It is for this reason that the 2/3 hopsack showed very little profile irregularity.

11.4 Conclusions

It may be concluded that slub yarns behave in a similar manner to smooth yarns and have little effect on the image profile. Regularly slubbed yarns of coarse linear density and maximum variant effect the overall shape of the image particularly when woven with plain weave, repp, and hopsack constructions.

CHAPTER 12 RESULTS OF THE SECOND WEAVING TRIALS ON WOVEN SILK WARP PRINTED FABRICS

12.1 Introduction

From Chapter 10 it was learnt that not only were fibre and weave float length the main factors affecting the irregularity of the image profile, but that other distinctive features affected it such as the tension changes due to warping, shedding and stretching irregularities which appeared to be experienced to a greater degree with the silk warp. Accompanying this evidence was the knowledge that the traditional Ikat weavers could control, according to requirement, their Ikat patterned yarn to obtain precise images with very little profile irregularity.

As yet this aspect of controlling the yarn to such precision has not been examined practically, and since the main aim of this inquiry was to explain the cause of the image profile and its irregularity it was felt that further experimentation was required. Additionally the apparent slipperiness or lack of control of the silk yarn during weaving necessitated investigation.

Having attained this information a wide spectrum of knowledge would be gained regarding the behavioural properties of the image profile which it was intended, would be suitable finally for design development.

12.2 Range of Samples

The fabrics produced to examine control of the irregularity of the image profile were repeats of the first silk weaving trial. To facilitate clarity of the results and enable comparison to occur they were manufactured in a manner similar to that already described in Chapter 9. Silk was the fibre specifically selected for these tests because it had appeared to be the most slippery yarn to control in respect of the image profile. To confirm the intuitive view that silk fibre was the most difficult to control the coefficient of friction was tested using waxed and unwaxed yarn around a matt steel rod. The values were recorded on a Rothschild friction meter. The results are given in Table 12.1.

It was felt that if the irregularity could be reduced completely using silk yarn similar principles would apply to all other yarn types. Additionally its fine composition produced a distinctive profile thus aiding the examination process.

In total five experiments were carried out which produced a total of 15 fabrics. Plain weave was the construction employed for the first four experiments being the most elementary weave with the maximum number of heald movements and the one which had shown a consistently high degree of irregularity of the image profile in the comparative analysis. Subsequently 3 and 1 twill was tested to ascertain whether the manipulative principles used on the plain weave samples applied also to a warp

Coefficient of Friction

Silk Handwoven Samples

Yarn	Unwaxed	Waxed
Worsted	0.22	0.18
Cotton	0.20	0.19
Silk	0.19	0.18

Table 12.1

faced construction.

Table 12.2 gives details of all the samples produced and shows the construction, end and pick measurements and linear yarn density of each fabric. To conclude these experiments five samples (numbered 112-116 in Table 12.2) were produced in order to assess whether the principles discovered could be applied successfully to a range of constructions.

12.3 Second Weaving Trials

12.3.1 Introduction

The purpose of the following experiments was to establish a method of controlling the image profile. Before experimentation could begin certain aspects of loom behaviour in conjunction with the warp during weaving (as opposed to its stationary behaviour) required further exploration since here it was felt that a solution might be found. It was stated in section 9.2.3 that the sampling handloom employed for all the weaving trials was fitted with a single lift bottom closed shedding dobby. The majority of handlooms work on the bottom closed shedding principle whereby the warp lies at the bottom of the shed when stationary (see Fig 12.1). When the loom is activated the weaving shafts lift the selected yarn which becomes the top shed and then return it to the bottom shed upon completion of the pick (see Fig 12.2). Hence the nature of bottom closed shedding is that the selected ends must travel twice the depth of the full shed in one operation

Numerical Order of the Silk Samples of the Second Weaving Trial Showing the Variations of Construction, End and Pick Measurements and Linear Yarn Density

Sample Number	Construction	EPC	Weft Yarn Count	PPC
97	Plain Weave	34.3	R12.5 Tex/2	26.1
98	" "	34.6	"	25.2
99	" "	34.3	"	27.2
100	" "	34.2	"	23.6
101	" "	34.2	"	25.2
102	" "	34.7	"	38.6
103	" "	34.0	"	26.0
104	" "	33.3	"	25.3
105	" "	34.2	"	24.3
106	" "	34.6	"	23.9
107	" "	33.7	"	24.6
108	" "	34.0	"	25.0
109	3 and 1 Twill	35.0	R12.5/2	41.8
110	" "	34.6	R96/2	18.1
111	" "	31.5	R340/4	6.8
112	Plain Weave	34.9	R12.5/2	26.2
113	2/2 Repp	33.7	"	23.9
114	3 and 1 Twill	34.6	"	39.5
115	2/3 Hopsack	25.7	"	18.1
116	8 End Satin	52.4	"	55.6

Table 12.2

Bottom Close Shedding - Stationary

Fig 12.1

Bottom Close Shedding - Weaving

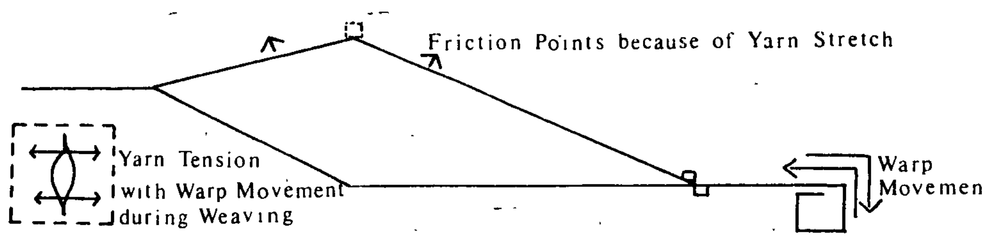


Fig 12.2

Centre Close Shedding - Weaving

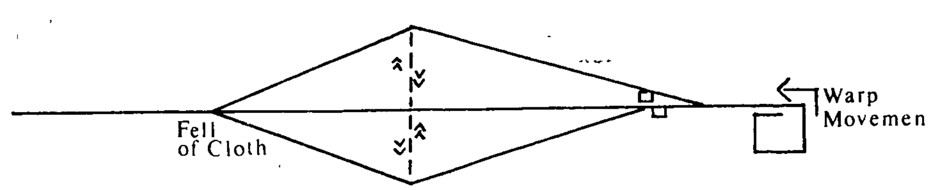


Fig 12.3

which makes for a slow production rate. Additionally it puts great strain on the yarn which is accentuated further on the dobby loom by the rocking movement of the warp beam caused by the shedding motion as weaving continues (see Fig 12.2).

In addition to bottom closed shedding there are two other principal shedding types known as centre closed shedding and open shedding.

With centre closed shedding the warp occupies a position at the centre of the shed when stationary. Upon selection all the ends move either up or down, but return to the centre upon completion of each pick all having travelled half the full shed distance (see Fig 12.3). Some handlooms such as the counterbalance and countermarch looms use this type of shedding. The most significant feature of the industrial loom using centre closed shedding is that the yarn is retained at a constant horizontal position infront, through and behind the healds and is used mainly in the production of certain jacquard fabrics such as fancy brocades. Disadvantages of this type of shedding are that all the ends are set in motion for every pick, and that the yarn undergoes further tension changes upon beat up as it is in a slack condition at this time. Additionally it is possible to detect reed marks in the finished fabric[241] and abrasion of crossing occurs.

In the case of open shedding[242] the ends which form the top and bottom parts of the shed remain in an open position continually (see Fig 12.4). This includes situations when the warp is stationary. Upon weaving the ends move continually and simultaneously from these points to form the new shed. Hence this type of shedding is undoubtedly the most efficient since the rate of production is rapid and the strain on the yarn reduced to a minimum besides being the best shed for giving 'cover' to a fabric. In the main this is the type of shedding used extensively on power looms in industry.

12.3.2 First Experiment

Consideration of these types of shedding system led to an initial weaving experiment where some of the principles learned were used.

Initially the print was applied to the warp in the manner already outlined in Chapter 9 whereby the printing board was placed under the warp as it lay in the stationary position for bottom closed shedding (see Fig 12.1). After printing had been completed, but before weaving commenced the back support rail over which the warp runs onto the back roller was heightened approximately 7 to 8 cms. Similarly the front rail over which the woven fabric passes was heightened approximately 2 cms. This adjustment of the warp seen illustrated in Fig 12.5 caused the ends which form the bottom shed to become tight and the ends which form the top shed to become as loose as possible i.e. the reverse of normal. Such practice reduced tension on the raised ends which it was thought was assisting the image profile to become more irregular.

Open Shedding - Weaving

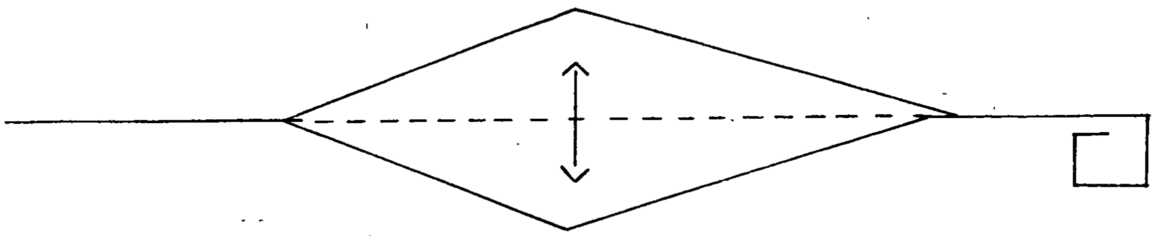


Fig 12.4

Position of Warp when Stationary when Adapting Bottom Closed Shedding Dobby (Front and Back Raised)

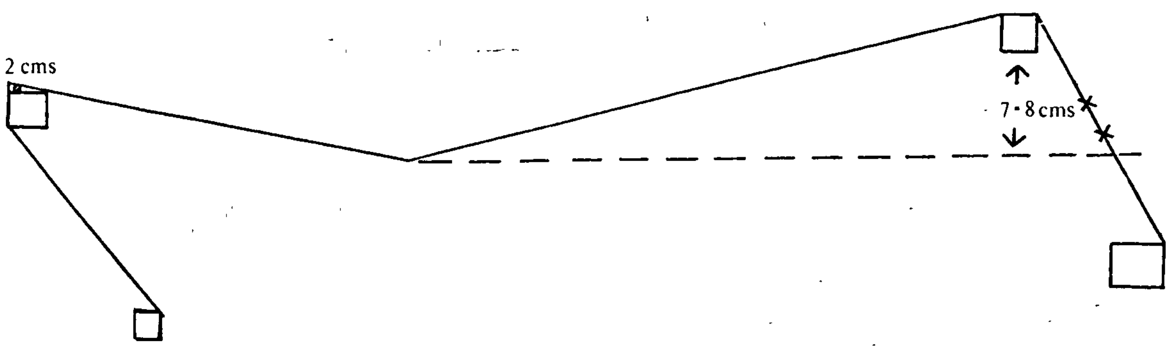


Fig 12.5

On weaving, the first sample number 97 (Fig 12.6) was affected by the previous series of fabrics with the image profiles of the first row of blocks showing regularly irregular ('stretch') profiles. By the second row of blocks the profiles began to lose the regular outline becoming more irregular in formation.

This continued with the second sample number 98 (Fig 12.6) which showed a decreased stretch profile. Warp irregularity occured in the central portion of the fabric.

By the third sample number 99 (Fig 12.6) the stretch profiles had disappeared completely showing a naturally irregular image profile, but warp irregularity was still present in places.

Although the degree of irregularity of the image profile was barely reduced in this series the stretch profiles encountered at the beginning of weaving were gradually lost as the fabric length increased which was the result of the type of warp manipulation described prior to weaving.

Table 12.3 gives a visual representation of the range of irregularity of the top left hand printed block of these three samples. It can be noticed that the degree of stretch profile of sample 97 gradually becomes less apparent with samples 98 and 99, but it is of interest to note that the percent irregularity value increases with each sample. This is due partly to the stretch profile becoming irregular and partly to increased warp irregularity.

It should be noted additionally that for these fabrics the

Second Weaving Trials on Woven Silk Warp Printed Fabrics

First Experiment Plain Weave Samples 97 - 99

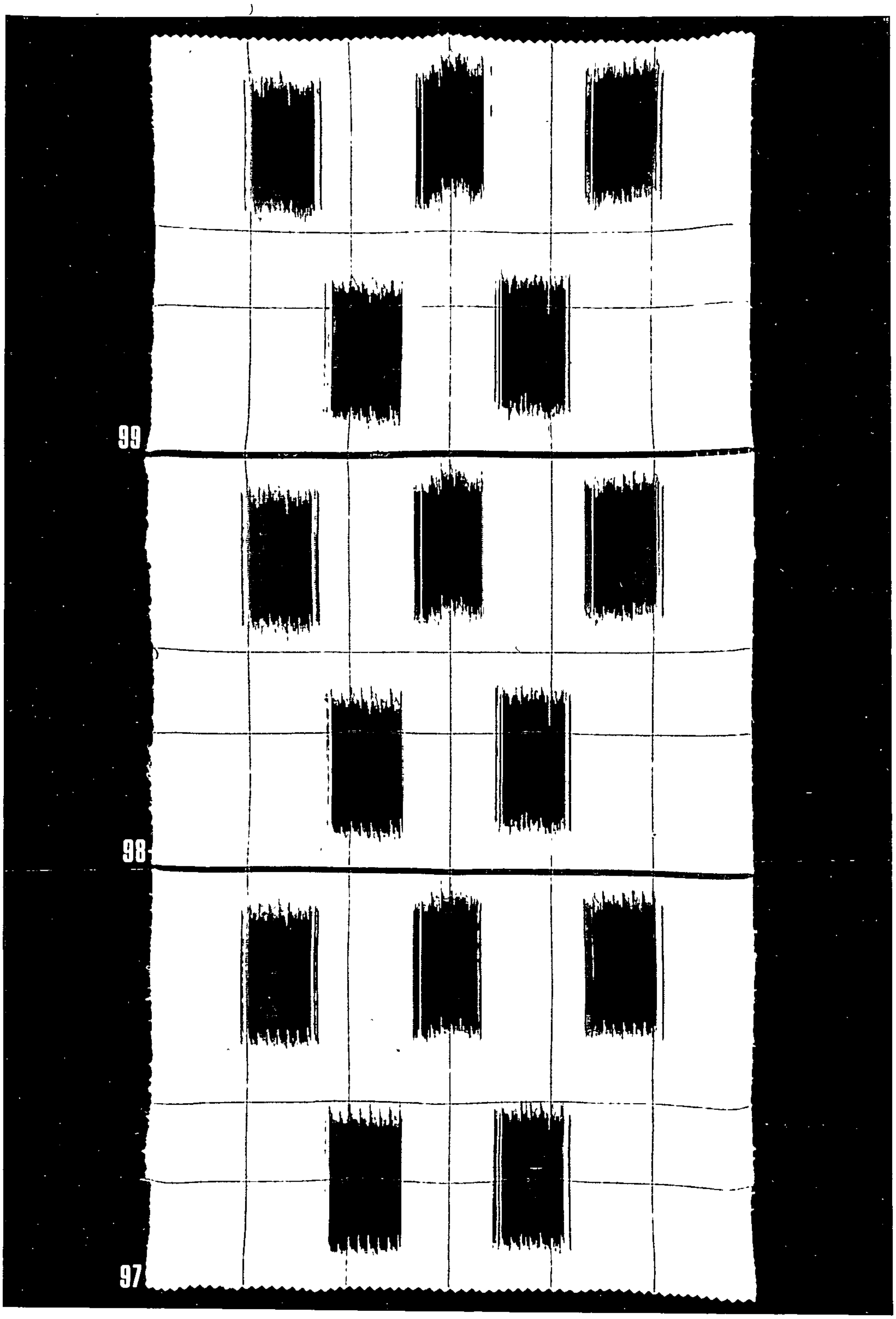


Fig 12.6

Degree of Irregularity of The Image Profile of The Second Weaving Trials on Woven Silk Warp Printed Fabrics

First Experiment

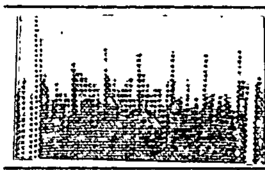
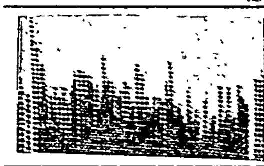
Sample Number	Weft Count (Tex)	Profile	Percentage Distortion	Picks per cm
97	R12.5/2		20.7	26.5
98	R12.5/2		22.9	25.6
99	R12.5/2		24.2	27.6

Table 12.3

warp was threaded over 16 shafts as it had been for all the previous experiments which was to become an important consideration as regards control of the image profile.

12.4 Second Experiment

It was discovered that visually the degree of irregularity of the image profiles of the first experiment samples gradually became more uniform as the fabric was woven. The purpose of the next experiment therefore was to discover whether the irregularity could be controlled in this way to a precise degree.

Hence three samples (still threaded over 16 shafts) were printed behind the healds with the warp remaining in the raised front and back rail position. Care was taken to ensure that the print board was placed under the warp in preparation for printing without disturbing it. Additionally a further sample was printed in the area at the front of the loom between the fell of the fabric and the reed. These fabrics are seen illustrated in Fig 12.7.

Printing completed, the ends which form the top shed were found to be too loose for weaving as not only had the yarn stretched with the expanding action of the printing dyestuff, but the raised level of the warp meant that the lifting ends were under little tension also. Hence the back rail was lowered approximately 2 cms to accommodate this problem.

Due to this adjustment stretch profiles immediately occured on the first sample number 100 which had been printed in

Second Weaving Trials on Woven Silk Warp Printed Fabrics

Second Experiment Plain Weave Samples 100 - 103

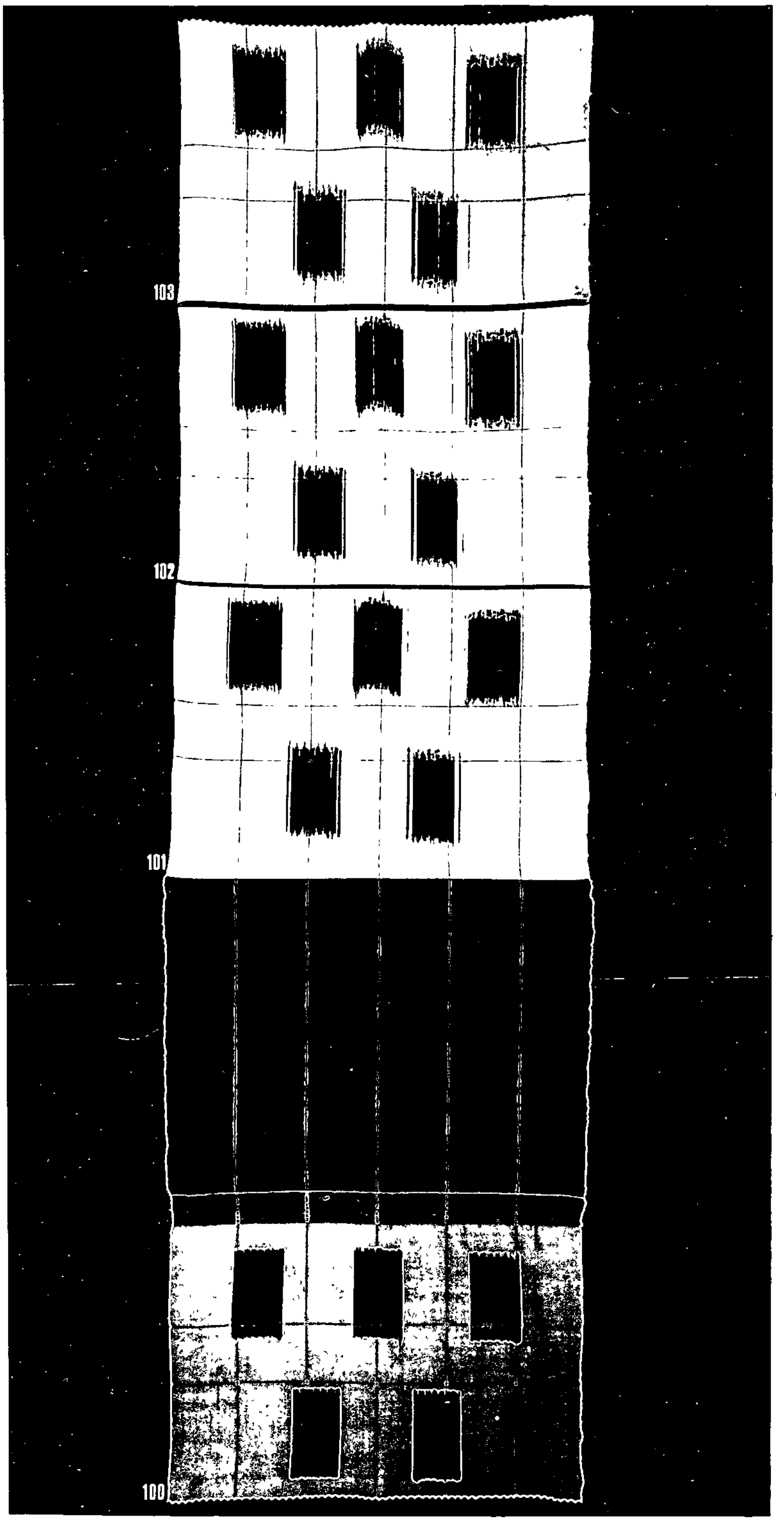


Fig 12.7

Degree of Irregularity of The Image Profile of The Second Weaving Trials on Woven Silk Warp Printed Fabrics

Second Experiment

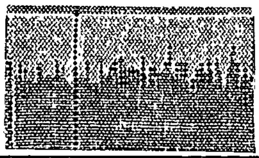
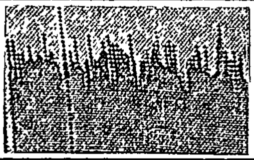
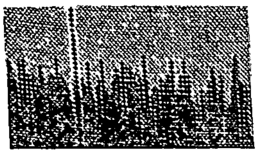
Sample Number	Weft Count (Tex)	Profile	Percentage Distortion	Picks per cm
100	R12.5/2		8.6	24.0
101	R12.5/2		18.8	25.6
102	R12.5/2		21.2	29.1
103	R12.5/2		22.8	26.4

Table 12.4

front of the healds, but the degree of irregularity was greatly restricted due to the small amount of shedding and warp movement that took place before the sample was woven. The following three samples numbered 101-103 were woven with the warp in the same position. Visually the degree of irregularity appears to increase with each sample which is supported by the evidence given in Table 12.4 which gives a visual representation of the degree of irregularity of the image profile. Additionally it should be taken into account that warp irregularity occurred in the centre of the fabric with the right hand images of each sample being effected by shedding profiles i.e. loss of tension.

In conclusion it was felt that if weaving had been possible in the position the yarn had been printed in then the image profile would have been completely controlled.

12.5 Third and Fourth Experiments

Two further experiments were performed to discover at which point the profile irregularity was being lost. This was achieved by printing the warp threaded on the front eight shafts separately with one impression followed by a similar separate print on the back eight shafts. This gave the resulting image a striped appearance. It was thought that by breaking down the print in this way a more accurate assessment could be made of where the irregularity was being accentuated. The first of the two experiments comprised a group of three samples numbered 104-106 (Fig 12.8) which in the warp was printed on the front eight

Second Weaving Trials on Woven Silk Warp Printed Fabrics

Third Experiment Plain Weave Samples 104 - 106

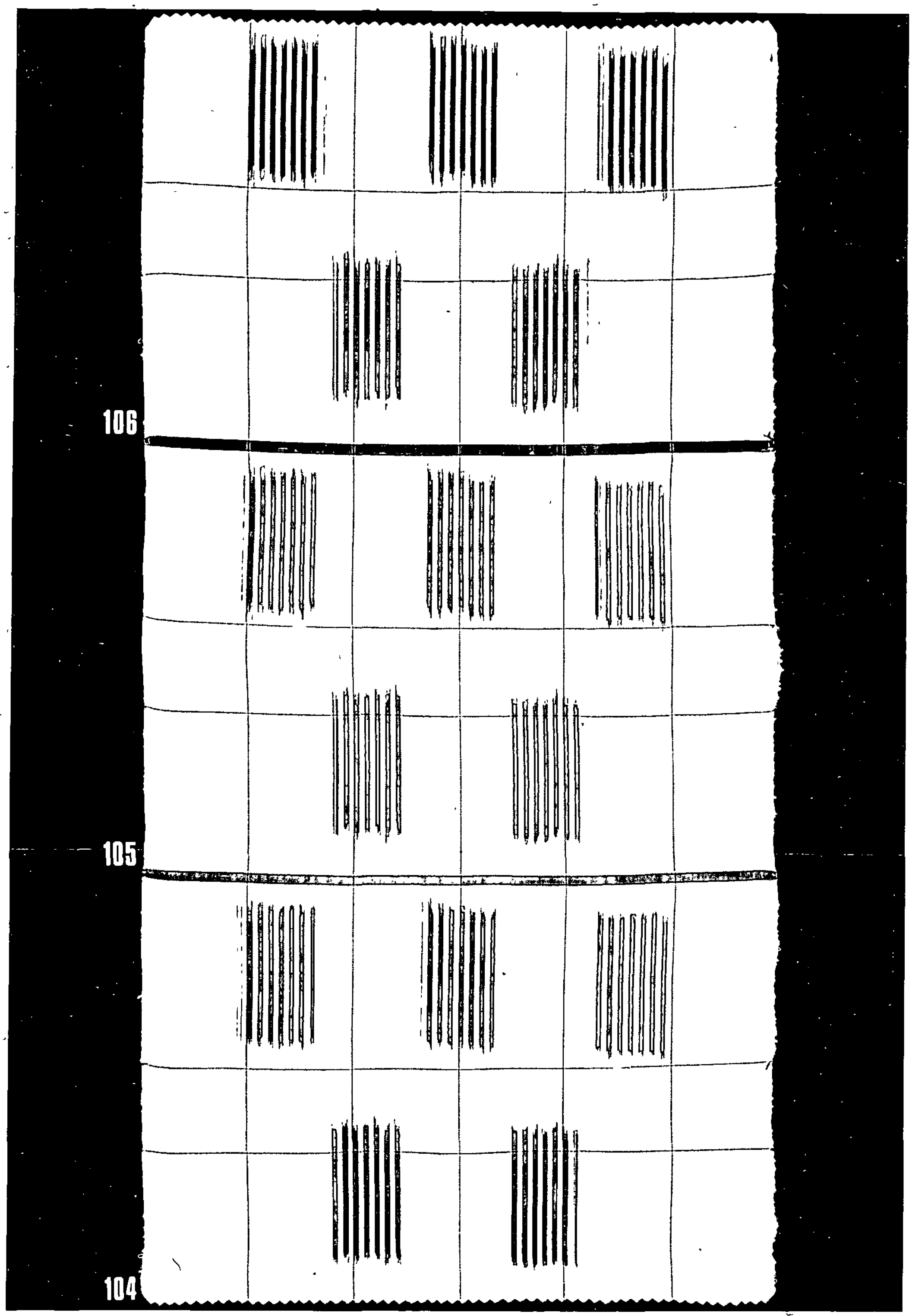


Fig 12.8

Degree of Irregularity of The Image Profile of The Second Weaving Trials on Woven Silk Warp Printed Fabrics

Third Experiment

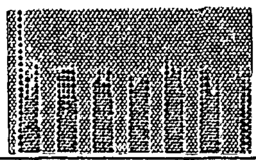
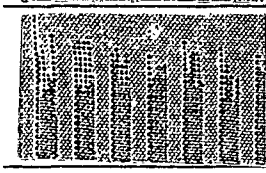
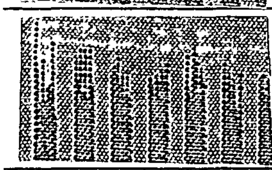
Sample Number	Weft Count (Tex)	Profile	Percentage Distortion	Picks per cm
104	R12.5/2		11.9	25.7
105	R12.5/2		16.2	24.7
106	R12.5/2		17.9	24.2

Table 12.5

shafts only.

This was achieved by lifting the first eight shafts and placing the print board in the shed opening before the shafts were lowered to their stationary position. Thus the yarn was printed and dried in the normal manner before the board was removed.

The effect shown in sample number 104 shows that the irregularity of the image profile is fairly reduced although slight warp irregularity can be detected in places. The second two samples show a gradual increase of these effects with sample 106 showing the greatest degree of irregularity. These findings are supported by the mathematical evidence shown in Table 12.5 where a value of irregularity of 11.9% for sample 104 can be contrasted with a value of 7.9% for sample 106. From this experiment it was not possible to learn anything regarding the point of accentuation of the image profile. It became apparent that to achieve a positive result a further print was required on the back eight shafts which would enable comparison to occur. Hence the fourth experiment comprised two samples numbered 107 and 108 (Fig 12.9).

Initially these were identically printed on the front eight shafts to those of the third experiment. Subsequently a further print was made in red dyestuff on the second eight shafts in the same position as the first so a red and blue image resulted. After combining the two printed sheds by removing the print board it was discovered that the red print was 3 mm out of registration with the blue one. Upon

Second Weaving Trials on Woven Silk Warp Printed Fabrics

Fourth Experiment Plain Weave Samples 107 - 108

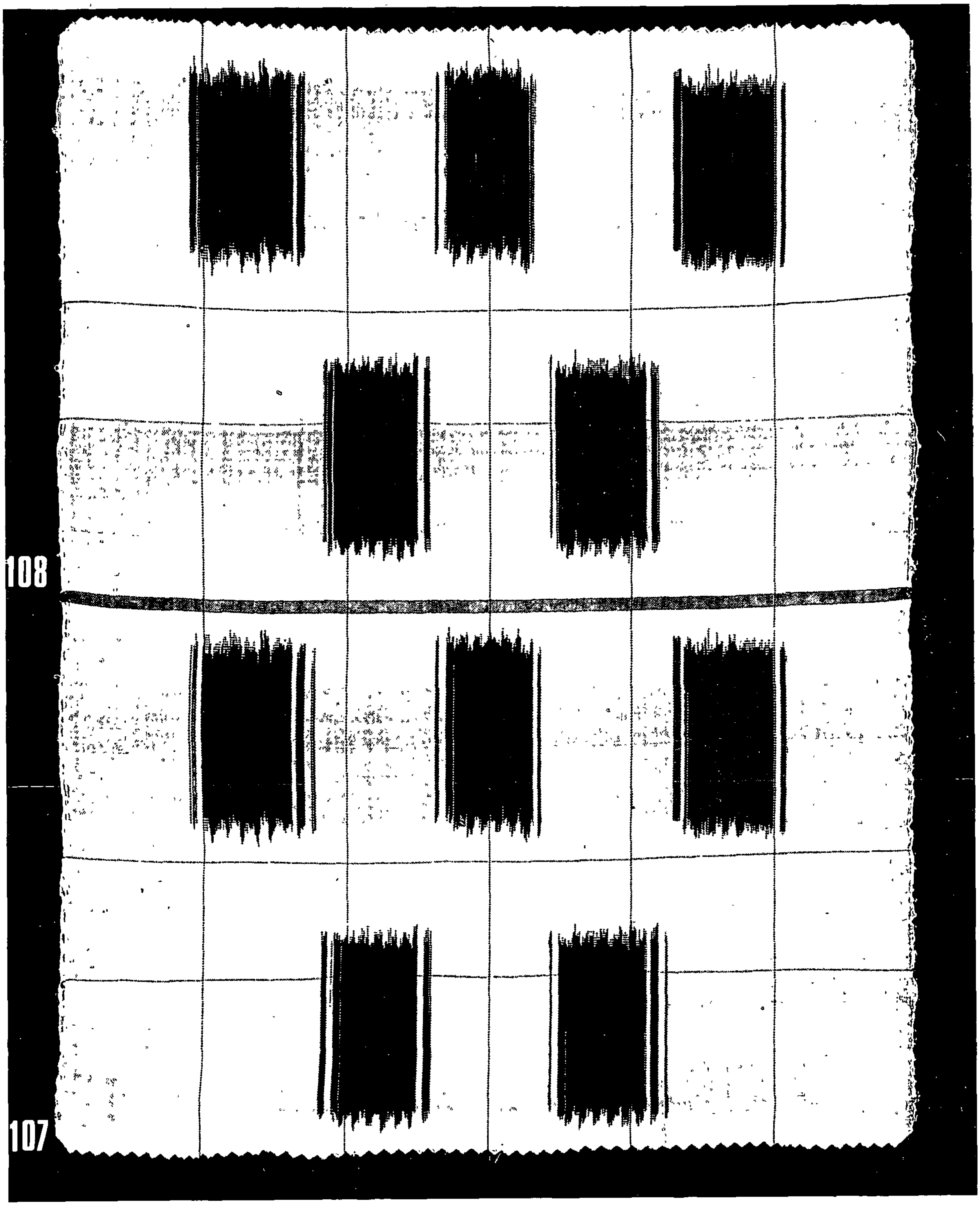


Fig 12.9

Degree of Irregularity of The Image Profile of The Second Weaving Trials on Woven Silk Warp Printed Fabrics

Fourth Experiment

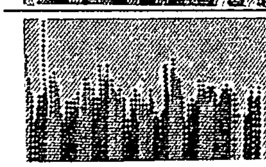
Sample Number	Weft Count (Tex)	Profile	Percentage Distortion	Picks per cm
107	R12.5/2		16.3	25.0
108	R12.5/2		19.3	25.4

Table 12.6

shedding, but before weaving occurred the red print had stretched to 5 mm out of registration. From Table 12.6 it is possible to see that the irregularity value increased from 16.3% to 19.3% as shedding continued.

From this experiment it could be established which set of ends were pulling the image out of alignment as it could be demonstrated that the ends on the back eight shafts were being pulled forward.

12.6 Fifth Experiment

In addition to experimenting with manipulative techniques using plain weave it was decided that a warp faced structure, in this case 3 and 1 twill, should be tested also. The warp remained in the same front and back rail position, but this time threaded over 16 shafts. A length of approximately 5 cms was woven to enable the warp to settle before three samples were printed behind the healds. Upon removal of the print board it was noticed that the yarn on shafts 15 and 16 had stretched toward the back beam showing two ends out of fourteen to be out of place.

It was revealed after examination that these ends were affected by the positioning of the print board which had become pushed up too close to shaft 16 a condition described in full in section 10.6.2. This was how the images of samples numbered 109 and 110 (Fig 12.10) showed stretch profile type outlines. Warp irregularity is again prevalant in all the fabrics which in turn has effected the irregularity of the image profile.

Second Weaving Trials on Woven Silk Warp Printed Fabrics

Fifth Experiment 3 and 1 Twill Samples 109 - 111

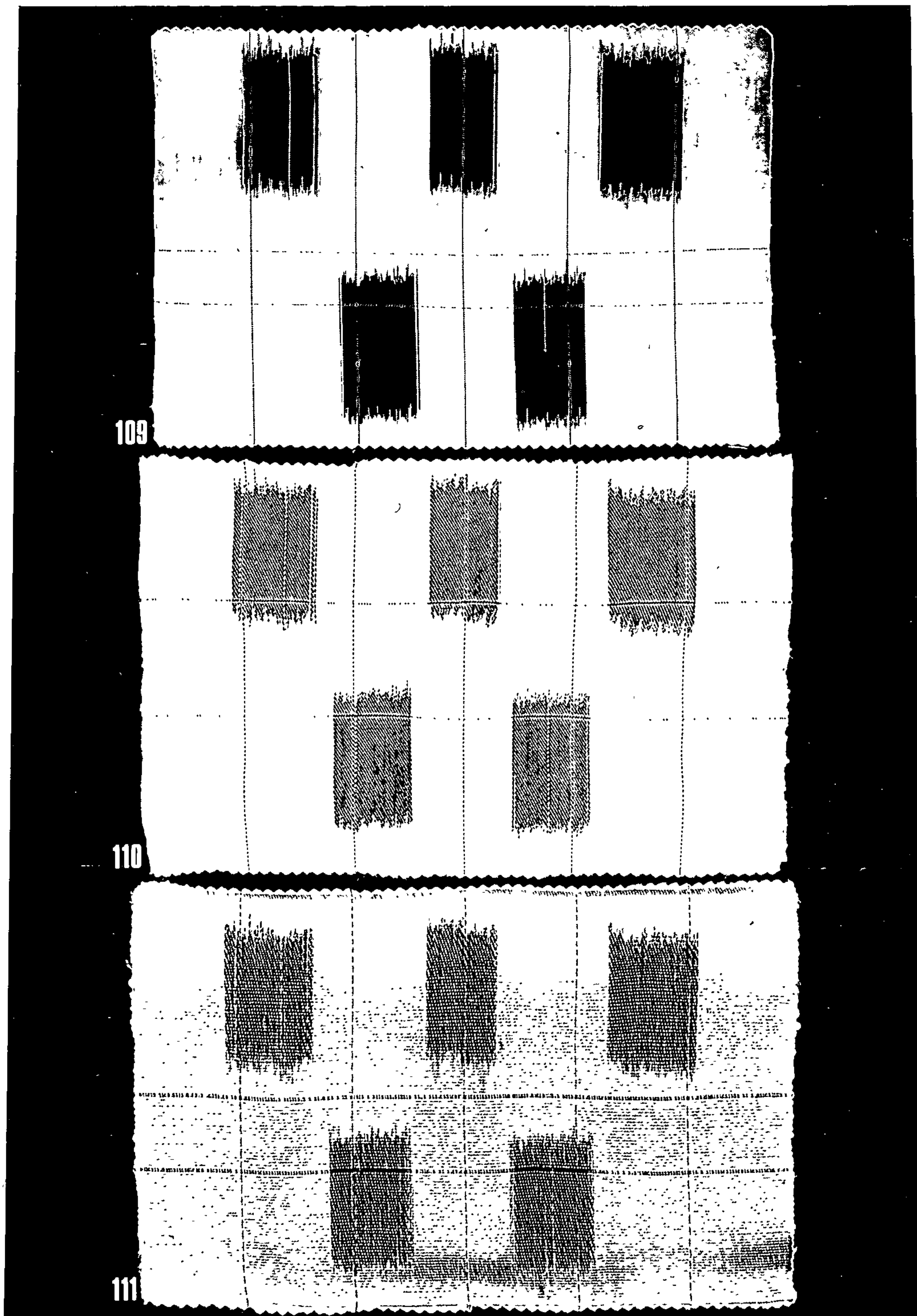


Fig 12.10

Degree of Irregularity of The Image Profile of The Second Weaving Trials on Woven Silk Warp Printed Fabrics

Fifth Experiment

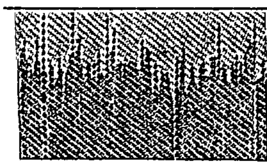
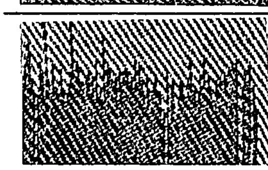
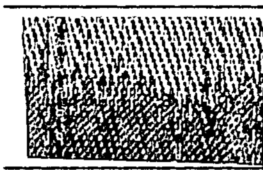
Sample Number	Weft Count (Tex)	Profile	Percentage Distortion	Picks per cm
109	R12.5/2		17.9	42.4
110	R96/2		18.4	18.4
111	R340/2		18.8	6.9

Table 12.7

From a visual viewpoint sample 111 (Fig 12.10) woven with the silk R340/2 Tex showed the least image profile due to the coarseness of the weft. Measurement however confirmed that this sample showed the greatest irregularity of the three samples since the effect of the warp irregularity was accentuated by the thickness of the weft (see Table 12.7). In conclusion it was felt that by applying the same manipulative principles as for the plain weaves samples the image profile of fabric woven with a twill construction could be successfully controlled.

12.7 Experiment to Verify the Conclusions by Production of Further Samples

12.7.1 Introduction

From the five preceding experiments it was learnt that it was possible to reduce the image profile to a minimum using manipulative procedures. It was necessary now to apply these principles to produce an example of each construction with a very reduced profile in order to demonstrate control of the irregularity to a minimum and show that the method is successful as it was with certain traditional Ikat weavers discussed in the historical survey.

12.7.2 Warping Details

Table 12.8 gives the warping details of the third silk warp which was identical in composition to the first two silk warps except that in this case it was prepared on a power driven sectional warping mill as opposed to being made by

Warping Details of the Third Silk Warp

	Plain, 2/2 Repp, 3 and 1 Twill	2/3 Hopsack 8 End Satin
Ends Per Centimetre	31.5	48
Width of Warp	30.5 cm	20.3 cm
Length of Warp	1.7 metres	
Reed Size Spaces per Centimetre	16	
Total Number of Ends	1440	

Table 12.8

hand.

It was understood that a handmade warp was full of tension changes due to human inexactness in the winding. This inconsistency was increased by the variations in the yarn itself which was a result of the spinning system. Hence to reduce this behaviour to a minimum it was decided that the warp for the final fabric group should be made on a power driven warper, so it was constantly controlled in its preparation. Additionally two further changes were made.

Firstly the warp was threaded to repeat over 8 shafts instead of 16 as it had been learnt that this reduced the size of the profile.

Secondly the black marking ends were repositioned to be in three pairs across the warp with 100 ends between each pair. From the preceding silk samples it was decided that the marking ends must be spread sufficiently across the fabric width to give a suitable range of results.

As for all the preceding warps it was rereeded for the production of the 2/3 hopsack and 8 end satin samples.

12.7.3 Methods of Manufacture

The warp was positioned for printing in a similar manner to the previous five experiments with the front rail raised 2 cm and the back rail raised 5 cm instead of 7-8 cms. This latter adjustment meant that the back rail did not have to be lowered after printing as had been the practice to facilitate weaving with the preceding manipulative experiments. This was beneficial since this action had caused immediate irregularity to occur.

The printing board was placed with care under the yarn ensuring that none of the ends were stretched or moved. Additionally the samples were printed one or two at a time thus reducing the chances of shedding movement affecting the profiles. Hence every care was taken to ensure that the warp was not disturbed during its preparation or weaving.

12.7.4 Conclusions

Visual and mathematical comparisons of these fabrics (see Fig 12.11 and Table 12.9) and equivalent fabrics in Chapter 10 confirm that by controlling a single warp in its preparation and production a near perfect image profile can be achieved using a variety of weave structures.

Second Weaving Trials on Woven Silk Warp Printed Fabrics

Experiment to Verify Conclusions; Samples 112 - 116

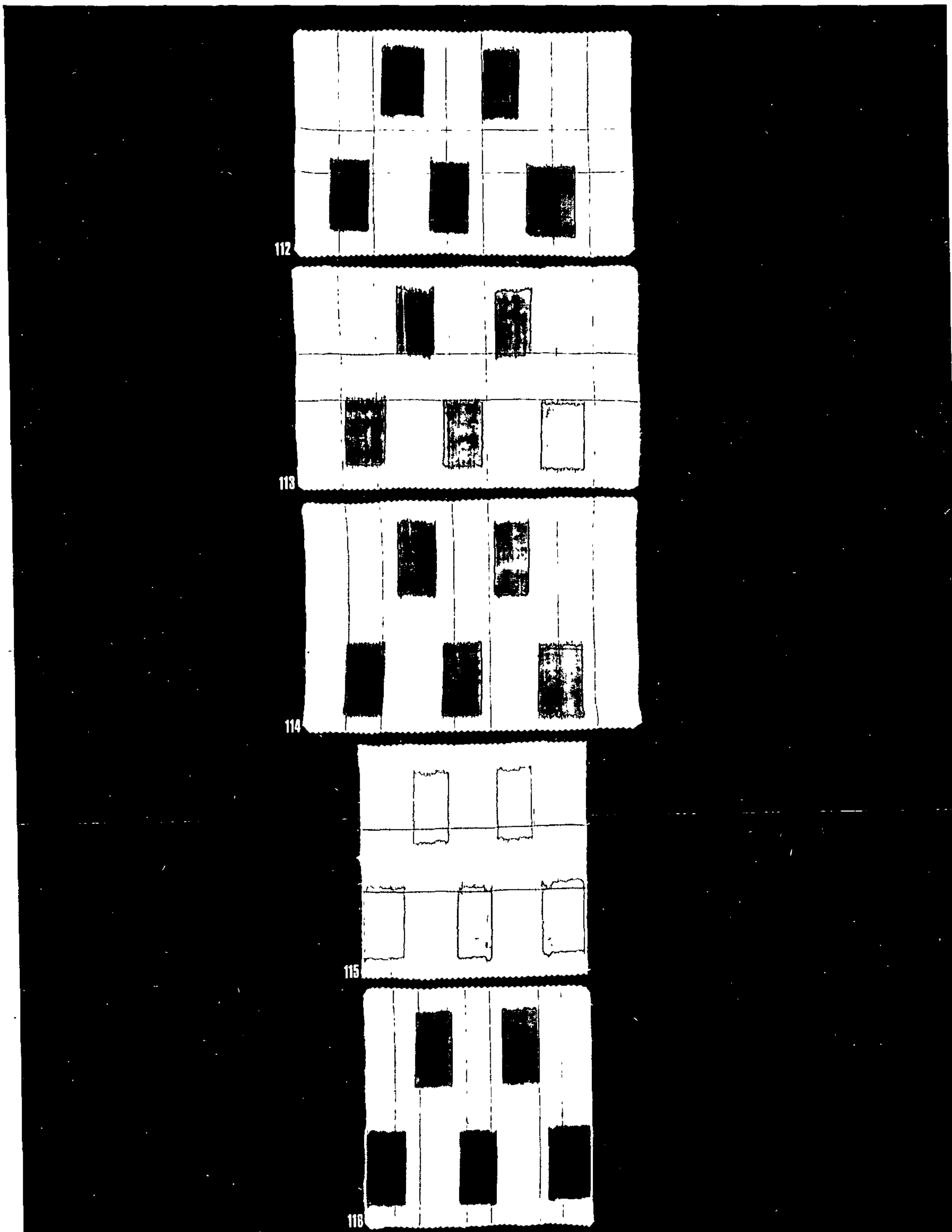


Fig 12.11

Degree of Irregularity of The Second Weaving Trials on

Woven Silk Warp Printed Fabrics

Experiment to Verify Conclusions

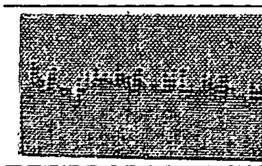
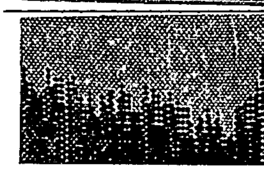
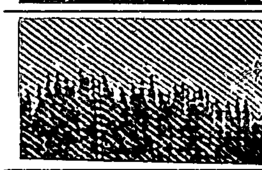
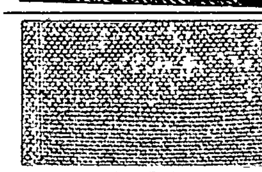
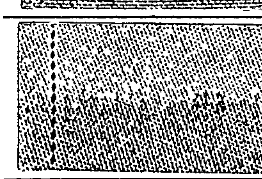
Sample Number	Weft Count (Tex)	Construction	Profile	Percentage Distortion	Picks per cm
112	R12.2/2	Plain		10.2	26.6
113	R12.5/2	2/2 Repp		14.0	24.2
114	R12.5/2	3+1 Twill		10.7	40.1
115	R12.5/2	2/3 Hopsack		10.5	18.4
116	R12.5/2	8 End Satin		8.5	56.4

Table 12.9

Chapter 13 Design Experiments Involving Warp Printed Handwoven Fabrics from a Double Warp

13.1 Introduction

It was established in Chapter 12 that by controlling the warp tension it was possible to determine the image profile. Having studied the effects of irregularity of the image profile from a single warp i.e. on one beam only, it was felt to be instructive to investigate an experiment using two warps at different tensions. This would enable observation to occur of a combination of constructions working side by side instead of individually. Hence a double warp was prepared for this purpose.

13.2 Design and Constructions Chosen

The imagery chosen for the first experiment was deliberately selected to be linear in composition and comprised an abstracted section of a sailing boat hull, the stencil of which can be seen in Fig 13.1. This covered the entire fabric width of 61 cms and measured 46 cms in depth. It was decided that the fabric width should be increased for these experiments due to the number of weaves being used together, and for the design element of the test.

The secondary experiment was evolved from the first and the image chosen for this was a horizontal line of 2.5 cms in depth. The image was printed at intervals of 50 cms-70 cms apart in order to enable observation of the behaviour of

Stencil Image of Preliminary Design Experiment

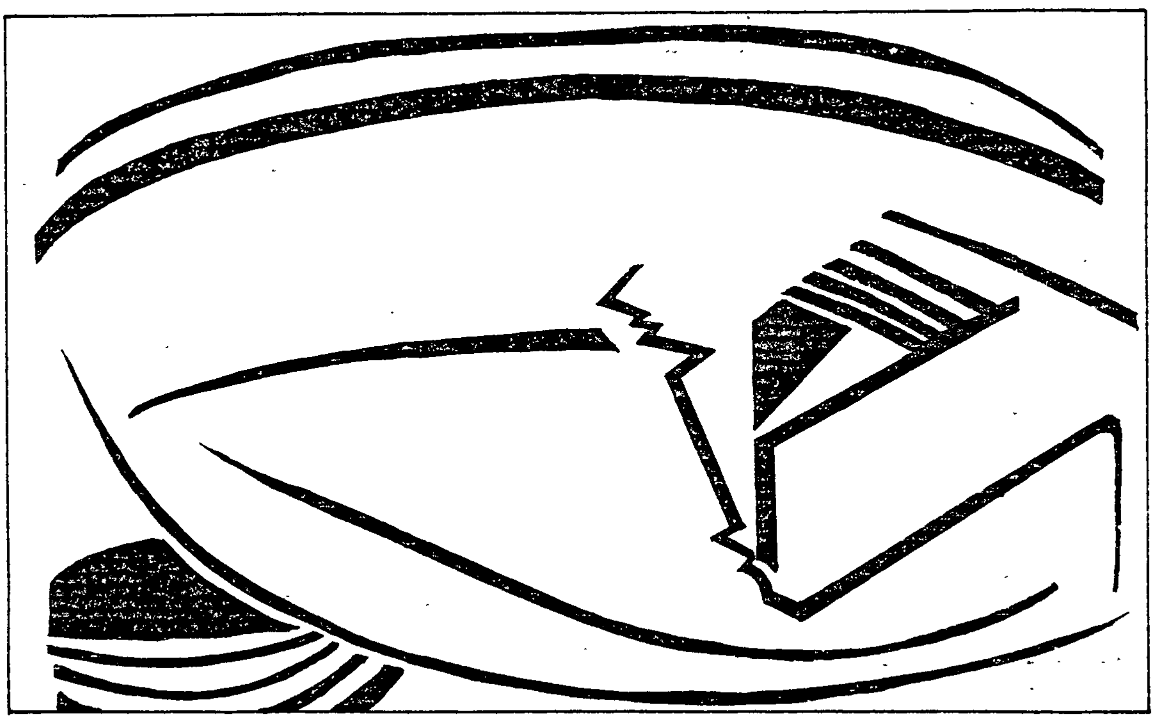


Fig 13.1

the image profile over a distance of approximately 3.5 metres to occur. It was decided that the weaves selected for this warp had to be of different float numbers and in each warp plain weave must be included since this was the only weave with the most and shortest interactions. Hence three constructions were selected all of which had been employed for the initial weaving trial namely plain weave, 3 and 1 twill and 8 end satin.

13.3 Materials and Methods

For reasons of availability and economy a 37 Tex carded cotton was employed which was known to produce a suitable fabric.

This was used as both warp and weft yarn, there being no increase in linear density of the latter for these experiments.

Table 13.1 identifies the warping details for the double warp. Since the width of the warp was to be 61 cms it was felt simpler to divide it into sections for winding. This was to avoid the build up of yarn on the warping pegs as the warp was made which prevented tension loss occuring on one side of the fabric. Hence initially the plain weave, 3 and 1 twill sections were prepared followed by the satin sections which were mounted onto a separate warp beam.

Fig 13.2 gives the drafting plan showing all plain weave sections threaded onto shafts 1-4; the 3 and 1 twill sections were threaded onto shafts 5-8; and all satin sections were threaded onto shafts 9-16.

Warping Details of the Double Warp

	Warp No: 1		Warp No: 2	
Construction	Plain	Twill	Plain	Satin
Ends Per Centimetre	19		19	29
Width of Warps	15 cm	15 cm	21 cm	9.6 cm
Length of Warps	9.14 cm			
Reed Size Spaces per Centimetre	9.6			
Total Number of Ends	1248			

Table 13.1

Double Warp Drafting Plan

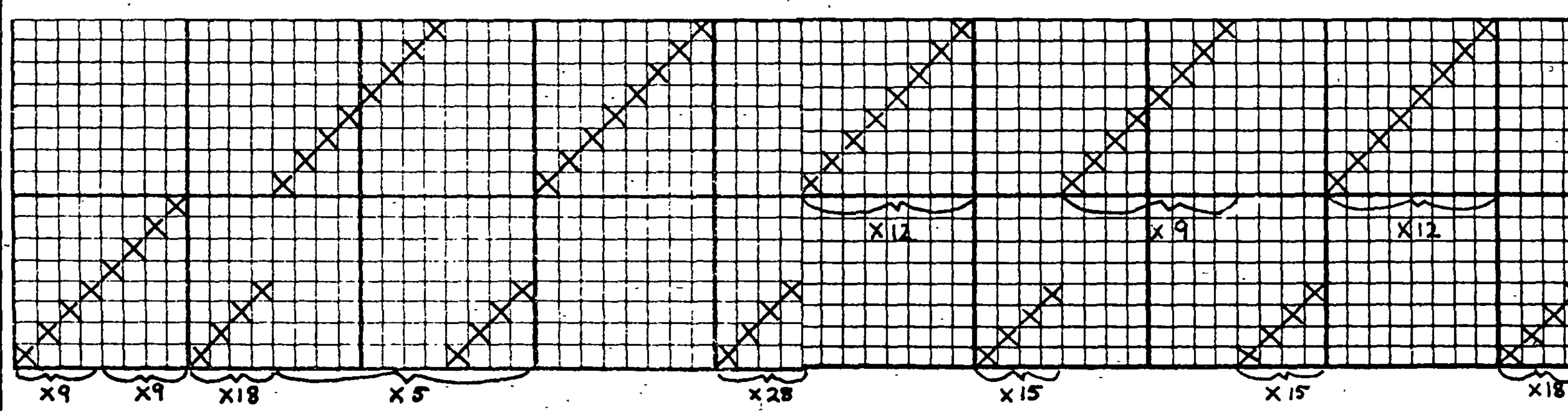


Fig 13.2

The preparation for and printing procedures were performed in an identical manner as all the preceding experiments although slight adjustment was made to the method for positioning the warp. Due to the warp being 61 cms wide and the satin sections being on a separate warp beam which caused them to be situated at a different level from the plain weave/3 and 1 twill warp, the weight boxes instead of being allowed to rest on the ground during the printing process which was the usual practice were left suspended as for weaving. Subsequently a pitch baulk comb (a metal baulk similar to a reed) which spanned the warp's width was run through it from behind the healds to the back rail to which it was secured to ensure that the ends were evenly distributed and that the warp was held down flat and taught.

Finally being a cotton yarn the same direct dystuff recipe outlined in Table 9.8 was used for printing.

13.4 Preliminary Design Experiment

Fig 13.3 illustrates the preliminary design experiment. It had been learnt from Chapter 12 that both warp tension effects and weave float length effects influence the shape of the irregularity of the image profile. Hence this initial experiment was performed to enable observation of an abstract image printed onto a blocked warp to occur, since it could not be foreseen what the outcome would be.

Three identical samples were produced over a length of 1.60 metres, and each impression was carried out after the

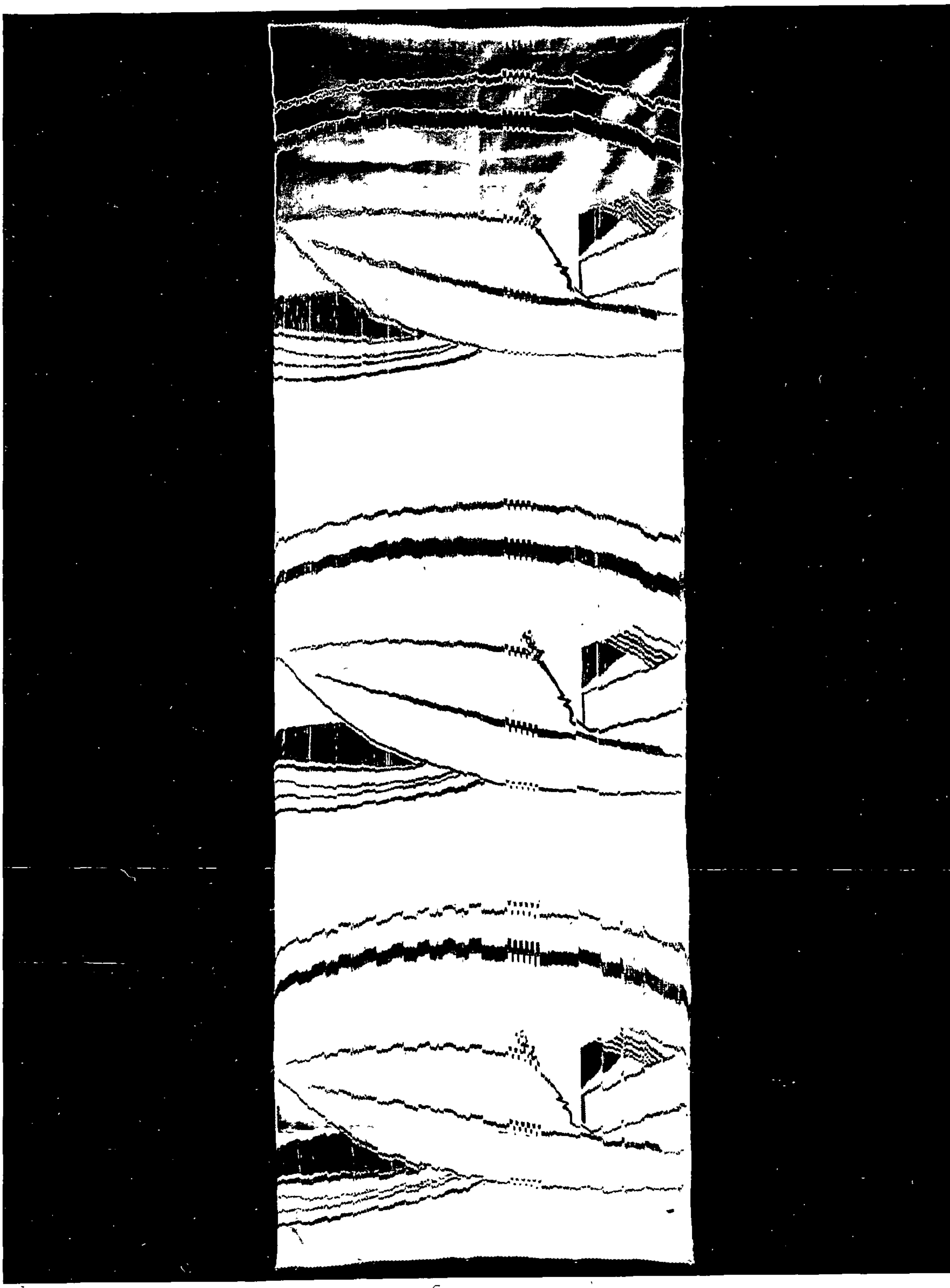


Fig 13.3

preceding print was partially woven.

The first sample was woven as planned with plain weave interspersing the twill and satin constructions, of which the latter was woven on four ends in an attempt to improve yarn cover since the satin areas of the preceding samples were unstable in this respect. Inspection of this sample showed the printed areas of the plain weave sections to have pulled toward the fell of the fabric due to there being more float intersections. The areas woven with twill and satin have behaved similarly since there was the difference of only one intersection between the two constructions. However it can be seen towards the end of this sample that the printed satin areas have increased in juxtaposition indicating that float length began to have an effect as distance increased.

The second sample was pegged to weave twill between the satin areas instead of plain weave. This alteration was made to see the effect such a change had on the printed areas in comparison with the preceding sample.

Additionally the plain weave and twill stripes on the left hand side of the fabric were reversed which initially had an effect on the behaviour of the print. In consequence at the beginning of the sample the printed twill areas pulled towards the fell of the fabric and the plain weave sections remained fractionally behind. Such a result was due to reversed pegging of the sections since the plain weave stripes of this sample were, at this stage still affected by the twill stripes of the preceding sample. As weaving continued the printed areas of the plain weave sections gradually pulled toward the fell of the fabric and finished, at the end of the sample, infront of the twill areas.

The percentage of movement in this sample between the printed twill and satin areas was of a similar amount to that shown in the preceding sample.

The third and final sample of this experiment was woven to make use of the block draft.

The lags were pegged to alternate every 26 ends so that the plain weave/3 and 1 twill sections instead of forming stripes formed squares and the plain weave/satin sections formed rectangle shapes.

Since the plain weave and twill sections counter balanced each other little juxtaposition of image occurred. The satin areas however wove as for the preceding samples and moved out of alignment with the rest of the print due to the continuous formation of the construction and its length of float.

Aesthetic observation of the fabric as a whole gives the feeling of movement and excitement due partly to the juxtaposition of imagery and construction and partly to the feathered outline of the image profile. Focusing on particular areas, the two dimensional effect of the satin construction is notably pleasing due to it being a warp faced weave giving clarity of colouration, and the fact that it was pulled out of alignment with the rest of the print adds interest.

The overall arrangement of the stripes and the weave effects that result from them create continual excitement since each part of the print is altering constantly hence no section is identical.

Additionally on the right hand side of the fabric there is a small area of narrow printed stripes. Due to them coinciding with three of the satin sections, and some plain weave and twill sections the resulting effect is one of irregular diffusion of form (see Fig 13.4).

In conclusion the rules learnt in the previous chapter can be applied in all cases with this warp. If a particular end result or effect is required the knowledge of what to do in the design and print stages to obtain such an effect can be defined.

Thus from all the previous experience it is possible to allow compensation for the changes in irregularity of the image profile which occur on the warp. Whereas this is instinctive to the designer and craftweaver who may not be aware that such a compensation was made as a result of the analyses undertaken in Chapter 10 and 12, the reasons for this instinctive behaviour are now becoming understood.

13.5 Second Design Experiment

13.5.1 Introduction

Arising out of the preliminary design experiment it was realised that the behaviour of two warps and contrasting weaves required a more precise study. Hence it was decided to continue with the same warp, but to simplify the image

Diffusion of Imagery Caused by Weave Effects

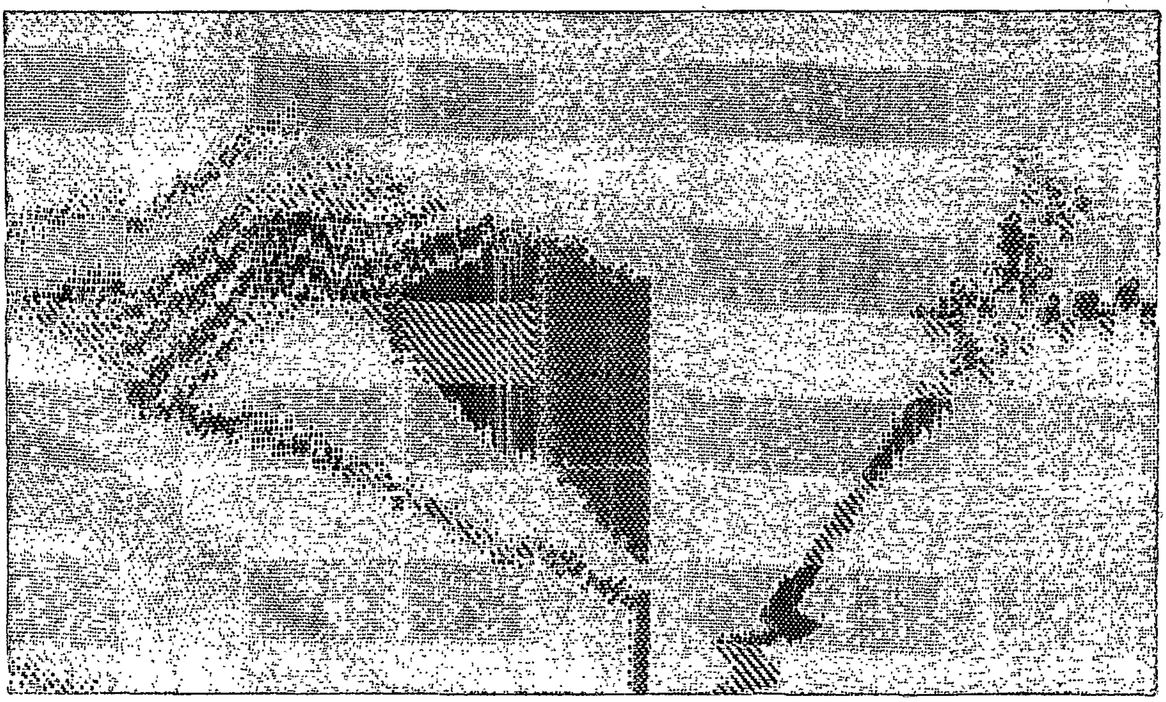


Fig 13.4

to a horizontal line of 2.5 cms in depth.

As mentioned in section 13.2 the fabric measured 3.5 metres and was printed at intervals of 50 cms - 70 cms. The preparation of the warp for printing and the printing procedure itself were carried out in an identical manner to that described in section 13.3. Fig 13.5 illustrates the finished result.

The difference between this experiment and the first was that for weaving the satin construction the pegging of the lags was reversed so that the weave was formed face down instead of right side up. Additionally it was changed from a four end to an eight end construction. When weaving such warp faced weaves a better cover is achieved hence a more stable fabric results due to less movement on the ends which form the bottom shed. Hence it may be noticed that the overall layout of the warp stripes in Fig 13.5 are in reverse to those of Fig 13.3. This is due to the secondary design experiment being turned over on completion of weaving.

Although the satin construction was reversed, by mistake the 3 and 1 twill was not, so when the fabric was finally removed from the loom the twill had become weft faced instead of warp faced. This diffused the image profile of these sections somewhat and toned down the colour intensity of the print proportionally.

With the satin stripes uppermost the fabric shows clearly the repetitive result of such an image printed in this manner. As with the preceding experiment the plain weave

Second Design Experiment

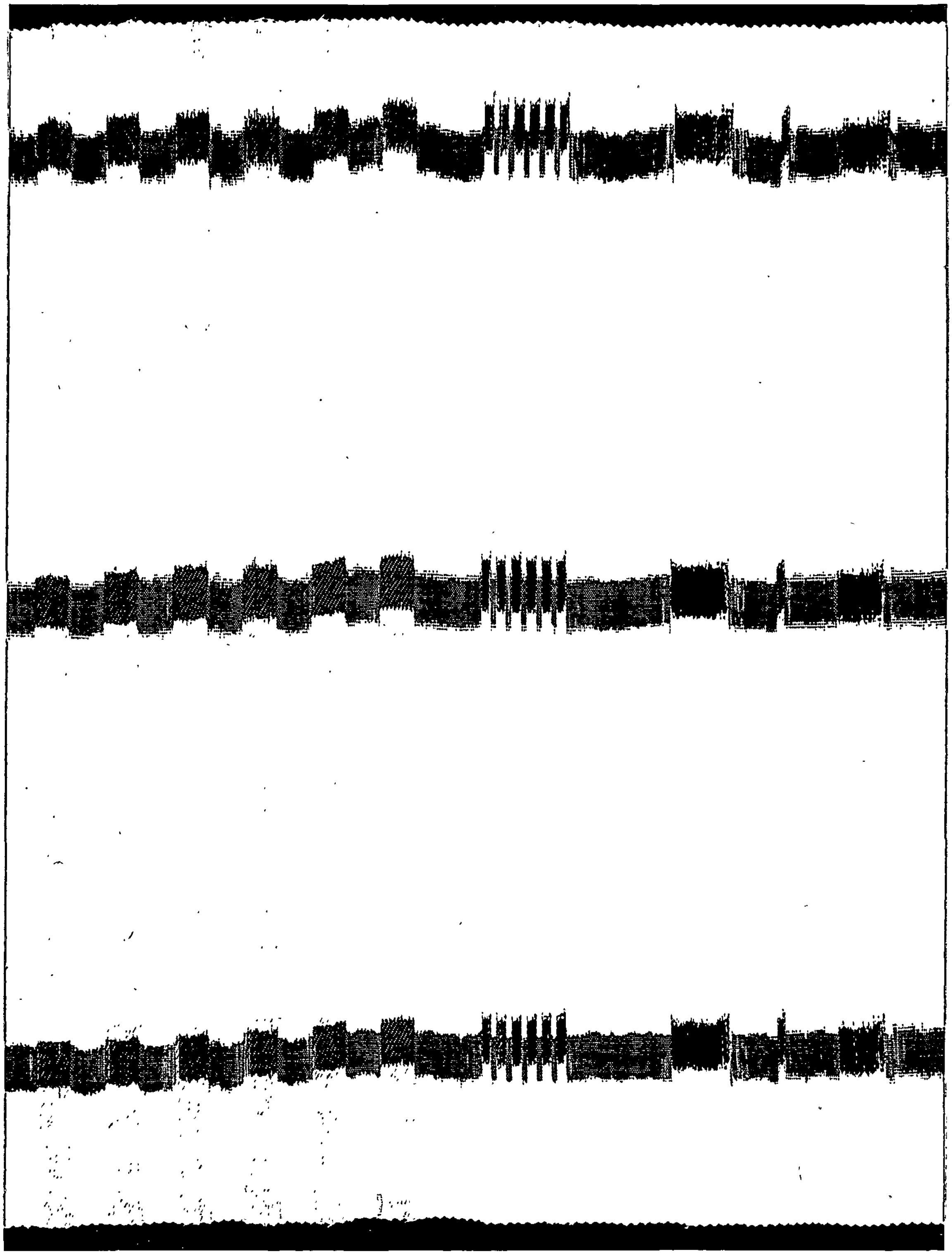


Fig 13.5

sections have pulled toward the fell of the fabric whilst the satin stripes have moved in an opposite direction leaving the twill sections in a position inbetween. The juxtaposition of image in each stripe is not identical and it is possible to detect printed areas which have been effected by warp irregularity or an idiosyncratic beat up. The result of the final printed horizontal line on this fabric is seen to have become completely effected by a shedding profile type outline particularly with regard to the twill/plain weave sections (see Fig 13.6). The satin areas are not greatly effected in this way although a certain amount of irregularity can be clearly detected. The reason for this outcome was that since the warp was nearing its conclusion, the end looped through the apron stick became unevenly disengaged whilst unwinding from the warp beam. This was accentuated by the rocking and vibratory movements of shedding which in turn caused the remaining warp yarn to shift. It would be unlikely therefore that an identical result could be achieved upon repetition.

13.5.2 Visual Image Profile Comparison of Single Weaves with Comparable Single Weaves from Chapter 10

Examination of the image profiles of the single weaves of the second design experiment with those of comparable single weaves discussed in Chapter 10 shows that despite the introduction of a double warp their behaviour is virtually identical. In general the profiles are of a

Final Horizontal of the Second Design Experiment

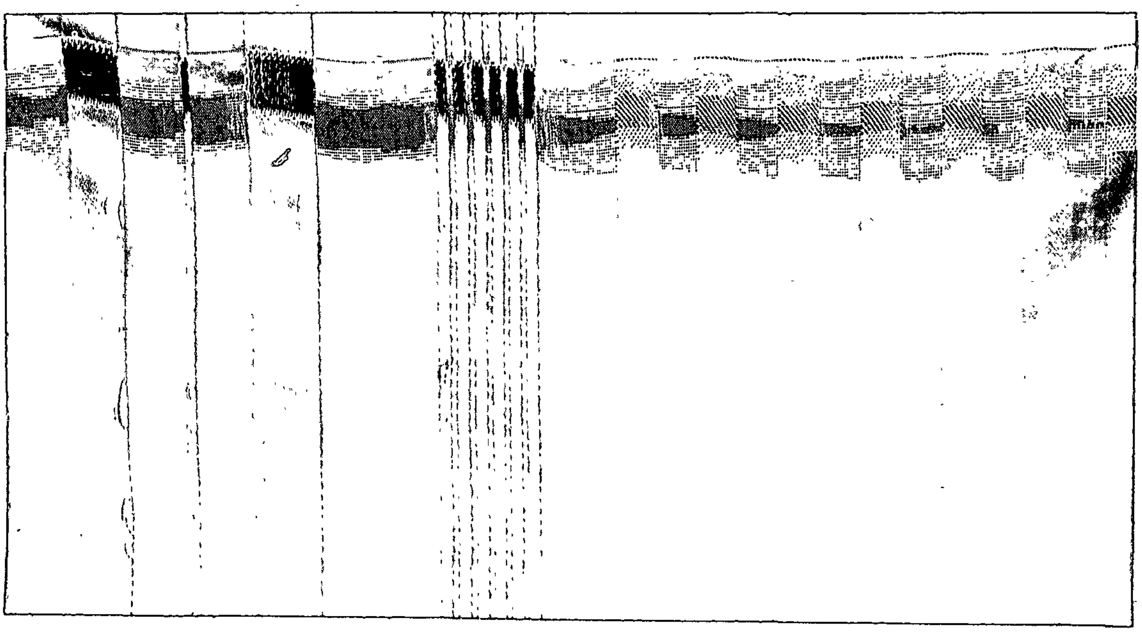


Fig 13.6

restricted nature as they were for the initial woven warp printed cotton samples. This is due to the type of cotton employed which for this experiment was a carded yarn of 37 Tex. It is likely a finer yarn would have produced a more distinct image profile.

In addition effects such as warp irregularity can be detected, but due to the narrow porportions of the stripes this type of tension loss is minimised. Shedding profiles have occurred throughout the length to a certain degree particularly on the plain weave sections that intersperse the satin stripes. This is the result of warp tension loss either while the warp was wound or while it was being mounted onto the loom.

13.5.3 Concept of Composite Image Profile

Having considered warp printing effects individually from a double warp and a combination of weaves, it was felt that now the resulting outline should be examined visually as a whole. Hence the introduction of a new concept - the composite image profile.

In its simplest form the composite image profile results from the juxtaposition of two weaves, and in its most complex it results from a juxtaposition of multiple weaves such as a jacquard.

The concept of taking a simple warp printed image and using construction to alter its shape to obtain a further form was not practised a great deal by the traditional Ikat weavers, but as the technique became developed in Europe at the end of the 18th century such methods of 'designing' were used to some degree.

13.5.4 Composite Image Profile of the Second Design Experiment.

The composite image profile is the result of warp tension changes caused by the difference in take up rate of the varying constructions.

Analysis of the printed sections shows a difference of approximately 5% in take up between plain weave and satin caused by the number of weave intersections. This was reduced to approximately a 2% difference between the twill and the plain weave. Depending on the type of yarn used these values increase or decrease by approximately 1%. This is due to the yarn being more highly twisted in some cases than others i.e. with a higher twisted yarn such as a worsted the less compression of it there is during weaving in comparison with a more loosely spun yarn such as a woollen spun one.

Viewing the composite images of the whole fabric there is little difference between the first six outlines although a more detailed examination would have shown slight variations within each.

As already mentioned however the final outline was subject to being too close to the end of the warp hence the composite image profile lost much of its original shape.

From an aesthetic viewpoint all the outlines evoke a pleasing reaction for varying reasons. The printed areas of the plain weave and twill stripes create a castelated image which is accentuated by the differing surfaces of the two constructions and the image profiles. The chief attraction of the remaining sections is their uneveness in width in combination with surface dimension of the construction, and image profile. This interest within the outline gives the whole an exciting, everchanging quality lending itself well to design aesthetics, which include intellectual, visual and tactile viewpoints.

13.6 Formation of Governing Principles for Composite Images

13.6.1 Introduction

From the two experiments performed it has been possible to develop principles for the behaviour of the composite image profile. Hence by applying these principles the shape or image to be printed onto the warp in the initial stages of production to achieve a particular end result can be formulated. This may be explained with regard to the preliminary design experiment.

13.6.2 From Design Concept Backwards to Result in Fabric

It is known now that in all cases a printed area woven with a plain weave construction pulls forward out of alignment with the remainder of the print due to the number of weave intersections. In contrast it is known that a printed area woven with an 8 end satin construction moves in a backward direction again due to the number of weave intersections.

This range of movement can be regarded as the maximum at which the printed image will travel due to most constructions being formulated over 8 ends. When woven with all other constructions the movement of the printed image falls somewhere between these two parameters depending on the length and order of float.

From this knowledge it can be understood for example how undulating linear images can be attained in the finished fabric when those of the original print were neatly and evenly divided.

Hence from understanding all the preceding analysis regarding the image profile it is possible to apply these governing principles to enable a great range of design possibilities to occur. By altering the warp structure, float length, and imagery in this way differing design effects can be achieved.

13.6.3 Relationship of Experiments to Previous Practices

Consideration of the technical data discussed in Chapter 12 in combination with the principles defined here would, it was felt, increase design potential. This, coupled with the knowledge formulated from the historical survey would enable such potential to be fulfilled, since all the factors defined by this programme of work would be drawn together.

It is known now that the range of irregularity of the composite image profile can be controlled more precisely or less, dependent upon loom adjustment, which gives rise to a number of design possibilities that may be achieved in one fabric.

For example some sections could have a very controlled image profile by threading those sections over 2, 4 or 8 shafts and by making the requisite loom adjustments. Other sections could be designed to have deliberately uncontrolled image profiles achieved by not so careful preparation of those sections of the warp incorporated with loom adjustments. Naturally this would necessitate the use of two warp beams which may increase in number with the use of particular constructions such as a satin or extra warp effects.

Hence in one fabric two or more different 'Ikat' appearances can be achieved relating directly to those from geographical areas already discussed. For example a very controlled profile was achieved by the Bali Aga tribe of Bali, Indonesia in their weaving of the sacred Gringsing fabrics. Yarn type, colouration, method of production and design were all used and achieved in a specific manner indigenous to that particular community due to cultural and social requirements. This was true also of the Uzbegs of Turkestan who were an example of a peoples who prefered a more natural configuration of the image profile.

In comparison, due to the magnitude of the social and cultural environment of todays world the potential influence upon design is vast and to combine this with the foregoing technical considerations would undoubtedly enable a fabric of aesthetic distinction to be produced.

13.7 Possible Design Solutions and their Application

13.7.1 Introduction

It was felt that some of these design theories should be tested by producing a small number of fabrics in order to substantiate the foregoing conclusions.

This entailed preparation of a second double warp which comprised the same 37 Tex carded cotton yarn. It was threaded in a similar type of block layout to the first double warp, but the proportions were reduced for practical purposes and to save time. The images chosen related to those used previously, constituting an arrangement of rectangle shapes and stripes.

13.7.2 Woven Fabric Designs

Fig 13.7 shows the first design to be, in effect, a variation of the two preceeding design experiments from a double warp. Satin stripes interspersed with plain weave are the constructions employed to give maximum visual effect to the images. The satin stripes of the top printed images show slightly more misalignment than those of the bottom due to the continued weaving action. Additionally the tonal differences of the weave dimensions add to the overall interest of the fabric.

Fig 13.8 comprises a design which is a further variation on this theme. The constructions are again 4 end satin and plain weave to which a 4 end satinette has been included. The plain weave and satinette have been woven in weft stripes of varying proportions adding a more complex

First Woven Fabric Design

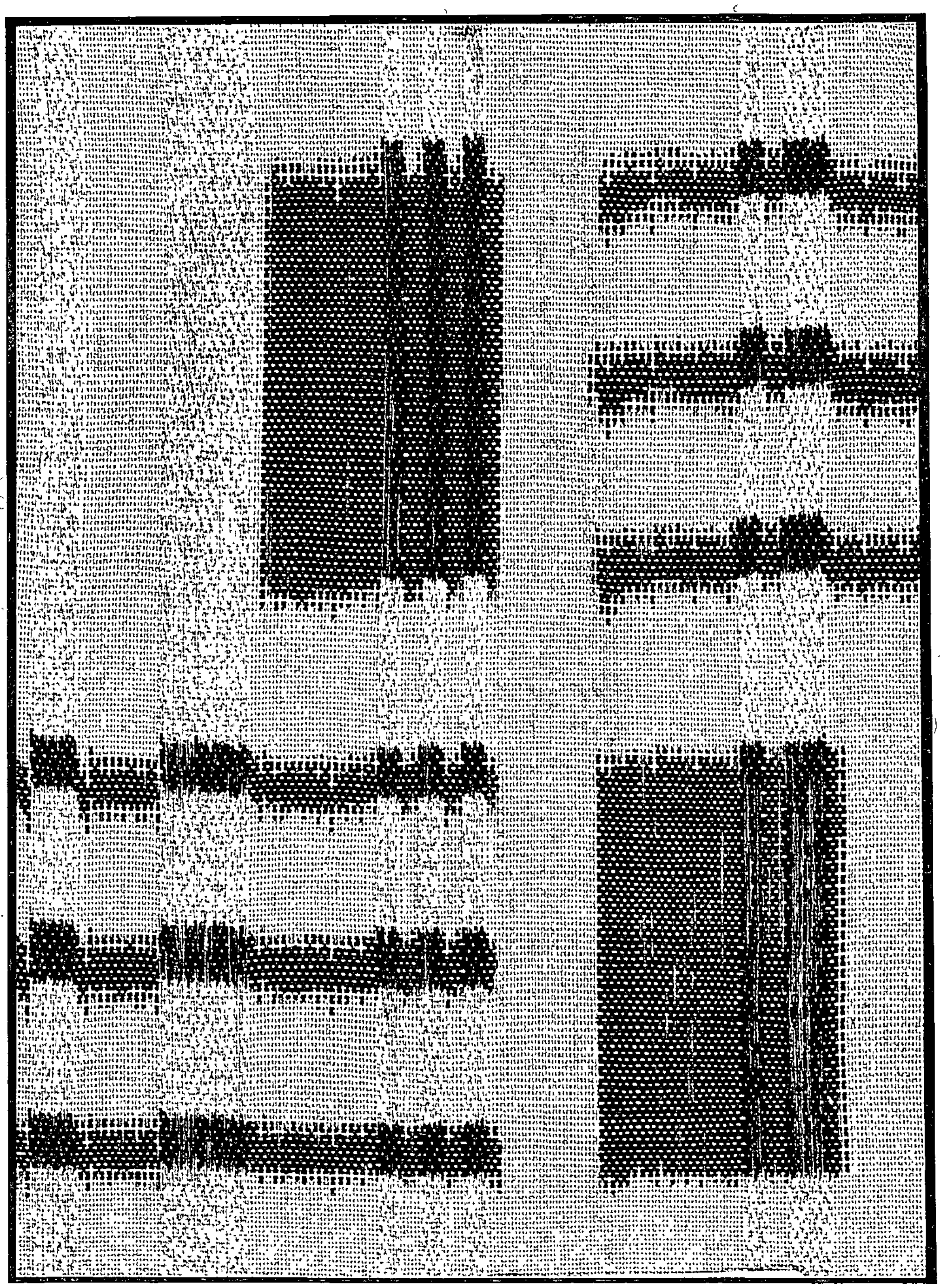


Fig 13.7

Second Woven Fabric Design

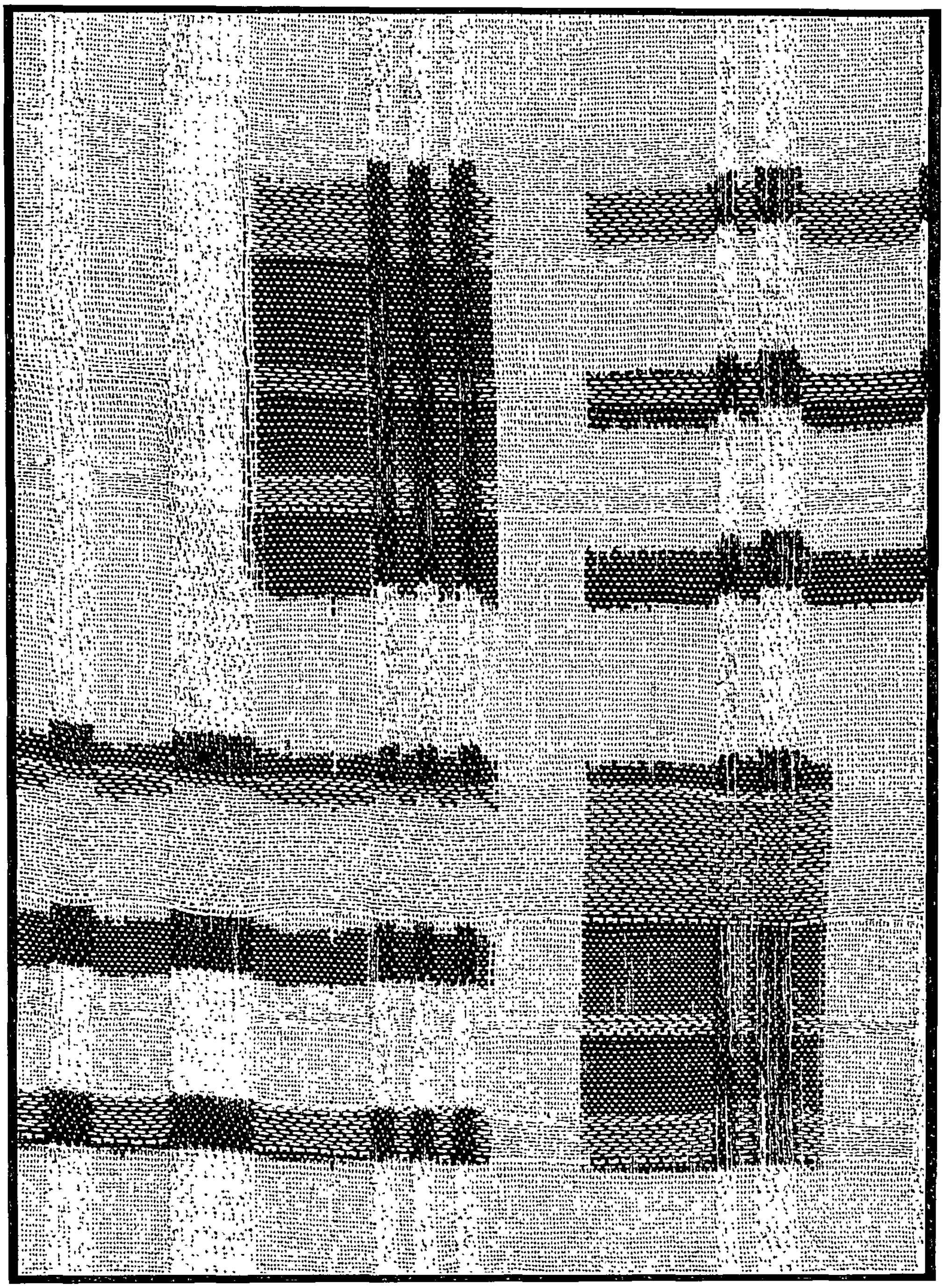


Fig 13.8

appearance to the overall fabric.

The satin stripes of the top printed image have pulled out of alignment in a manner similar to that of the first design, in comparison with the bottom image. The use of the satinette in irregular proportions has effected the colouration of the printed areas dramatically, giving the whole an everchanging quality.

The design shown in Fig 13.9 comprises a different distribution of the printed rectangular shapes and stripes. The fabric was woven with alternating stripes of warp faced and weft faced 3 and 1 twill which affected the colouration of the print dramatically. In addition the right hand side of the fabric incorporates narrow satin stripes woven over 4 ends intersected by plain weave. From an aesthetic viewpoint the most striking feature of the fabric as a whole is the raised effect the warp faced constructions produce in conjunction with colour differentials of the image, as well as the degree to which the print has moved in shape away from the original. Additionally the diagonal intersections of the twill constructions add interest.

Fig 13.10 shows the layout of image in the final design to be of an irregular nature in comparison to the preceding three. Woven in narrow alternating warp stripes of 3 and 1 twill, 1 and 3 twill, and plain weave interesting construction effects have resulted, although the movement of the images are only slightly affected. The area of most interest in this respect is the narrow vertical printed stripe towards the centre of the fabric, part of which has

Third Woven Fabric Design

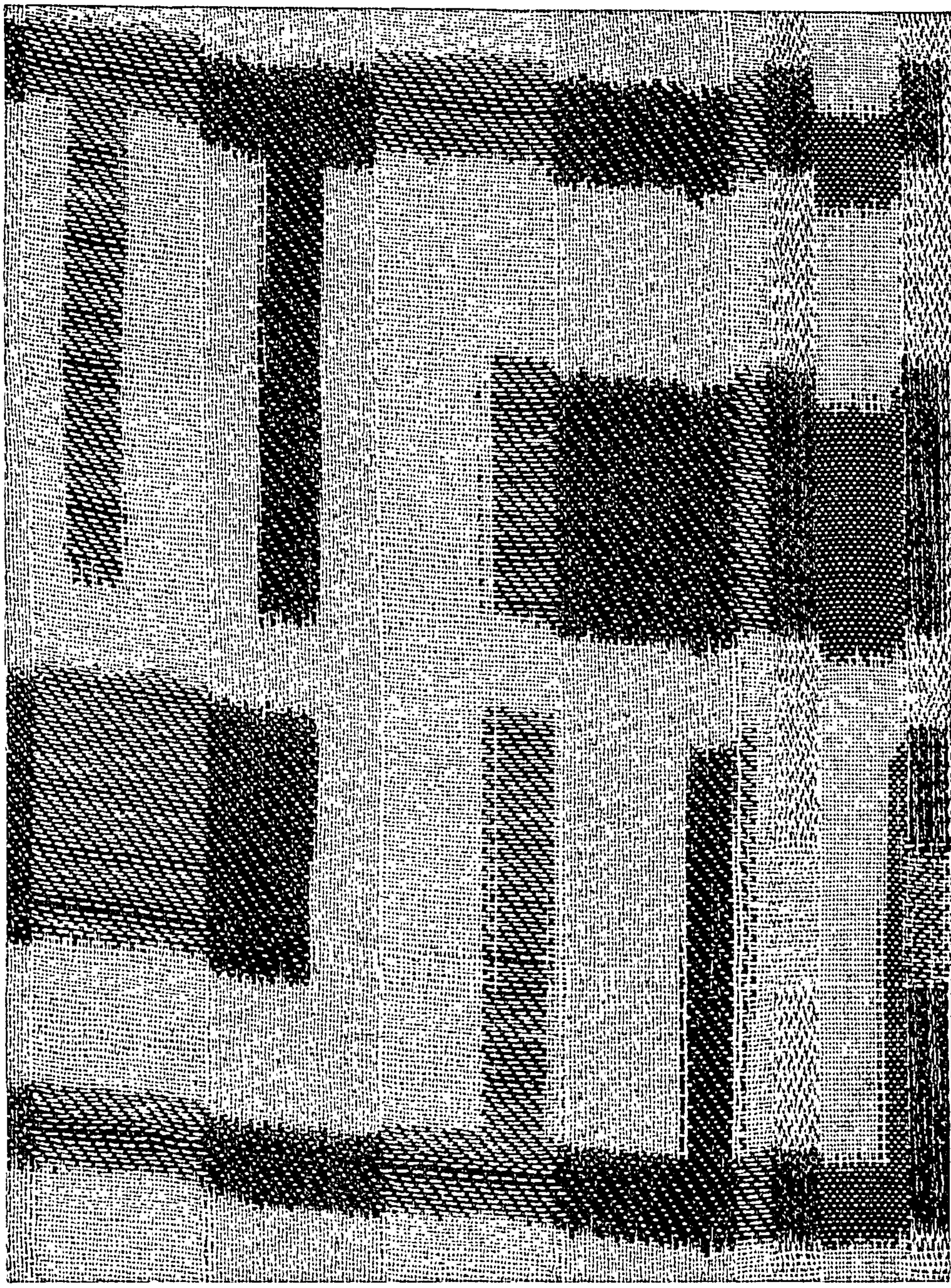


Fig 13.9

Fourth Woven Fabric Design

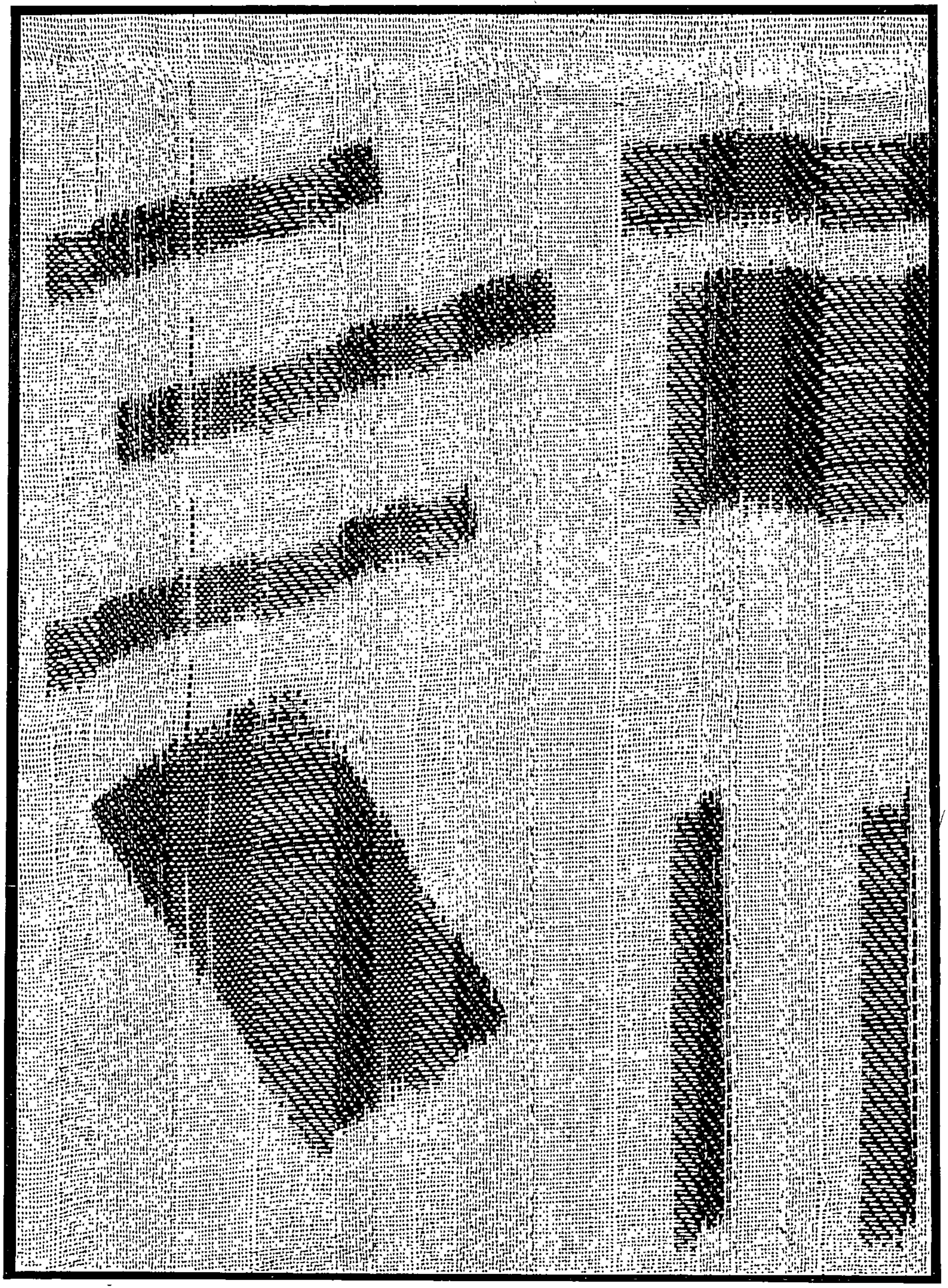


Fig 13.10

pulled out of alignment with its neighbouring construction. Additionally the textural and tonal effects of the rectangle image and the diagonal stripes illustrate well how the use of a blocked threading draft and simple constructions enable results of interest to be achieved. These simple ideas demonstrate the range of design potential possible by using the composite image concept.

13.8 Conclusions

It has been learnt that combination of warp tension effects with weave float length in a double warp produces image profiles in juxtaposition. Through analysis of take-up rate it is possible to predict the required image to be printed onto the yarn in order to achieve a predetermined end result, which can be accentuated further by warp tension control.

Hence it has been found that it is possible to produce fabrics which encompass fully the aesthetic and technical information evaluated.

CHAPTER 14 SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

14.1 Summary

14.1.1 Introduction

The aim of this thesis was to produce a collection of woven fabrics related to an investigation of Ikat and Warp printing techniques and to assess their possible relevance to present day manufacturing and design requirements.

The work covered four areas, an historical appraisal; initial handwoven experiments based on the foregoing; a second series of handwoven experiments which enabled criteria to be defined for establishing control; and a third series of experiments to test the design possibilities of the information gathered.

Hence both technological and design aspects were investigated and eventually combined to create a new understanding and potential exploitation of this design technique.

14.1.2 Historical Survey

From a technical viewpoint it was established in the historical survey that geographical location, fibre and skill of the weaver all contributed to the appearance of the image profile of traditional Ikat fabrics, but the exact cause could not be defined from this examination alone. From a design viewpoint it was discovered that the imagery of the four areas discussed South America, Southern Russia, Bali and Japan, each fell into distinct groups which comprised geometric, figurative and floral representation. However it was established that geometric patterns were used in preference to figurative and floral designs because it was simpler to devise symbolic representation from a more complex pattern. Historically it can be noted that a simple geometric symbol acquired meanings beyond its form and was thus far easier and more convenient to reproduce than a figurative equivalent.

14.1.3 First Handwoven Experiments

Results from the preliminary handwoven experiments performed to determine which aspect governed the image profile and its irregularity, showed that types of yarn and weave float length were the two main factors.

Experiments showed that wool yarns effected the overall level of irregularity most, followed by the cotton and silk yarns respectively.

Examination of the slub yarns of each fibre led to the conclusion that they behaved in a manner similar to smooth yarns, and had little effect on the image profile.

On the basis of this experiment pick spacing was found not to effect the image profile at all.

Throughout these trials constant attention was given to the tactile and aesthetic properties of the fabrics as a whole, taking as a measure their acceptability and suitability for present day design requirements.

14.1.4 Second Handwoven Experiments

Investigation into control of the image profile through manipulative experiments confirmed that by controlling the warp in its preparation and production a near perfect image profile could be attained with any type of weave structure. Conversely alteration of the principles discovered enabled an image profile to be produced with an exaggerated degree of irregularity.

14.1.5 Third Handwoven Experiments

The design experiments on the double warp using a combination of warp tension effects with weave float length produced results of great interest from both aesthetic and technical viewpoints.

Juxtaposition of image profiles created movement and excitement which was enhanced further by the textural effects of the different constructions.

To test the extent to which both aesthetic and technical inputs could in the light of these experiments create new and different design effects a series of design studies was completed to demonstrate this end.

14.2 Conclusions

Prior to this programme of research Ikat and warp printing techniques had been only superficially investigated. Although a degree of historical knowledge had been acquired, particularly from a visual viewpoint, it was neither detailed nor broad. Since the approach of a designer is to innovate and produce rather than to theorise and analyse almost all woven experience gained had been based upon instinctive emotional behaviour rather than fact and the design effects achieved resulted from trial and error. The reason for their formation were only slightly understood.

Additionally knowledge of current Ikat designs on the market today from third world countries, and warp printed designs from Europe produced a feeling of boredom and dissatisfaction from an aesthetic viewpoint since the majority lacked the richness and excitement of the traditional fabrics. This feeling promoted the need for a more detailed study.

The geographical areas of the historical survey were specifically selected since they were not adjacent nor connected in any way, and such a selection formed a good basis from which to develop new work. Thus, technological theories were developed and tested in order to define principles of manufacture and aesthetics. As a result it became apparent from the historical survey that the Ikat weavers were familiar and well practiced within the traditional design limits of their craft and they did not attempt to acceed beyond these boundries.

Analysis of the technological data revealed those factors that governed the characteristic Ikat effect and allowed parameters for its control to be defined. This coupled with the introduction of basic design aesthetics could enable new and more advanced effects to be developed. A great deal of work could be continued in the technological and design areas to develop this concept. By further exploring the outlined methods of achieving and controlling a composite image profile, resulting from an effective combination of warp printing and weave constructions, it is believed that original and aesthetically pleasing designs could be produced. These designs evolving from an understanding of original handcrafted Ikat fabrics, rather than from copying them, could provide new images relevant to the requirements of a contemporary culture.

14.3 Suggestions for Further Work

Further to the work discussed in this thesis much additional experimental work was carried out which time has not allowed analysis or inclusion of here. Hence it is intended to briefly outline this before making recommendations for further work.

The initial studies to be omitted was a fairly comprehensive investigation into the history of warp printing techniques. This involved documentation and analysis of a number of collections of warp printed fabrics from a number of sources such as The Bankfield Museum, Halifax; Warners Archive, Braintree; The Victoria and Albert Museum, London; The Public Records Office, Kew to name but a few. Most analysis was completed however, from an industrial sample book of the late 19th century belonging to the author.

Detailed analysis was undertaken of the many warp printed fabric samples, from which a classification system of construction combinations was established. The fabrics consisted mainly of jacquard constructions, but included a small number of dobby combinations in addition to these. The printed imagery for both types of construction was in general, either floral or abstract.

With regard to the constructions themselves it was discovered that the main jacquard combinations were a plain coloured warp floating over a warp printed plain weave or repp ground. It was found that warp satin was sometimes included. None of the fabrics were woven with textural yarns and constructions, instead all had a uniform fineness and smoothness characteristic of the design requirements and possibilities of the time.

In addition to this analysis of historical warp printed fabrics, experiments were omitted which involved warp printed fabrics woven on a power loom as opposed to a hand loom.

There are fundamental differences between weaving by hand and weaving by power. Although the principles of technique are similar, weaving by hand can be considered as somewhat unpredictable as regards the human element, whereas weaving with machine eradicates the irregularities, but relies upon predetermined production information. For example, a warp made on a machine warping mill will be even and constant in tension, whereas a warp made by hand will be constantly uneven in tension. In the weaving process, machine woven fabric has a regular weft beat up with continual automatic warp release, therefore preventing unevenness in picking. Handwoven fabric has constant irregularities as the weaver does not use the beater in a regular, even manner. This irregularity can be observed by holding the fabric before the light.

These points are extremely relevant when considering the effect production methods have on printed yarn, and it is necessary to become familiar with these differences, so that technical allowances can be made in relation to whatever machine is being used.

A number of questions thus became evident, that were quite different from those raised in the comparative analysis of the initial weaving trials:

(i) what happens to an even printed image over a long distance when woven in a constant, regular manner;

(ii) does the print remain unaffected by the weaving actions, or does it begin to become misshapen after a certain time;

(iii) what happens if an irregular unbalanced image is printed over a certain length of warp;

(iv) as some parts of the yarn are largely covered in dye and other parts are hardly covered, does this, with the weaving actions effect the shape of the image, and its profile; and

(v) what happens if a whole series of different weaving actions are added to an irregularly printed warp?

These were just some of the questions raised which needed answering, and led to two initial power woven experiments.

These can be seen illustrated in Figs 14.1 and 14.2.

The intention of these two experiments was to observe and compare the effects power weaving actions had on printed yarn, over varying lengths, using different printed motifs.

Returning to the recommendations for further work much time could be spent devising a reliable identification system of warp printing techniques of which there are many, giving a variety of visual effects. At present it is understood that no such system exists which has led to much confusion by historians and manufacturers alike. Research into this area, in a manner similar to this work, would help dispel some of the mysteries and perhaps enable new production methods to be devised. A great deal of interesting work could be carried out using the composite image principle. Innumerable possibilities are available by combining all or some of the following examples. Using manipulative techniques the amount of irregularity of the image profile could be accentuated or controlled singly or in combination to produce two types of effect.

The type of yarn employed is a vital factor for handle, drape and aiding colouration, as well as accentuating or reducing the clarity of the irregularity. With the inclusion of elasticated or shrink yarns in the weaving further design effects could be achieved.

Variation of colour in both the warp print and the weft yarns in combination with yarn type could produce interesting results.

The images themselves require further investigation. Due

Initial Powerwoven Experiment: Regular Layout of Image

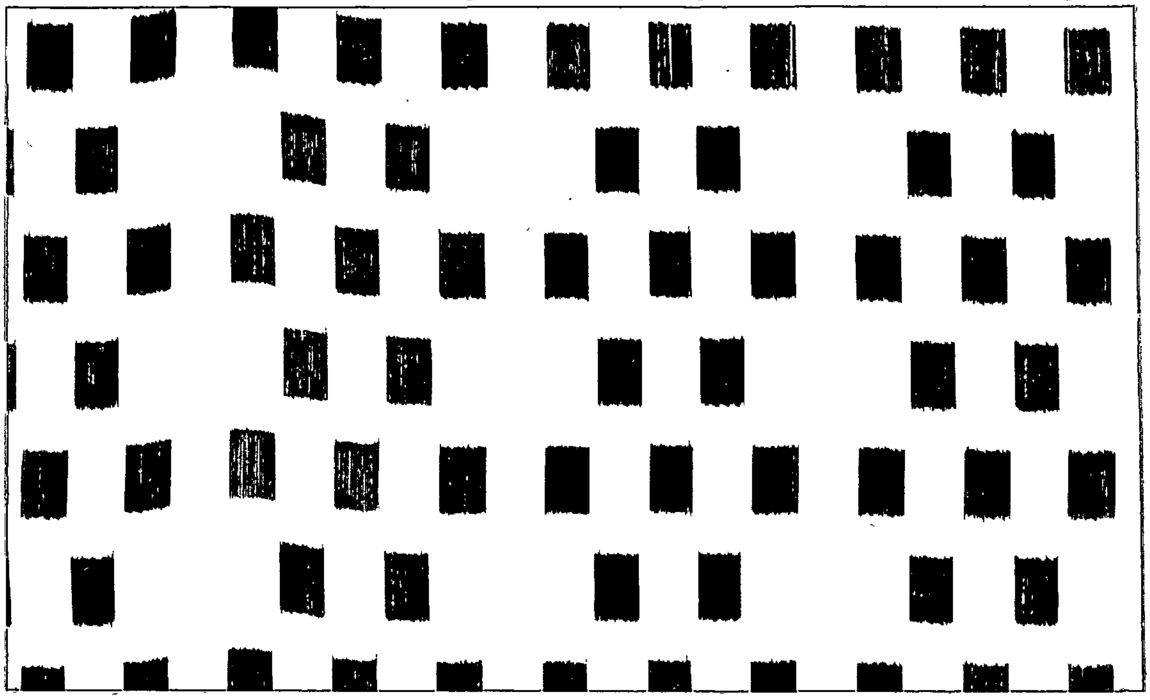


Fig 14.1

Second Powerwoven Experiment: Haphazard Layout of Image

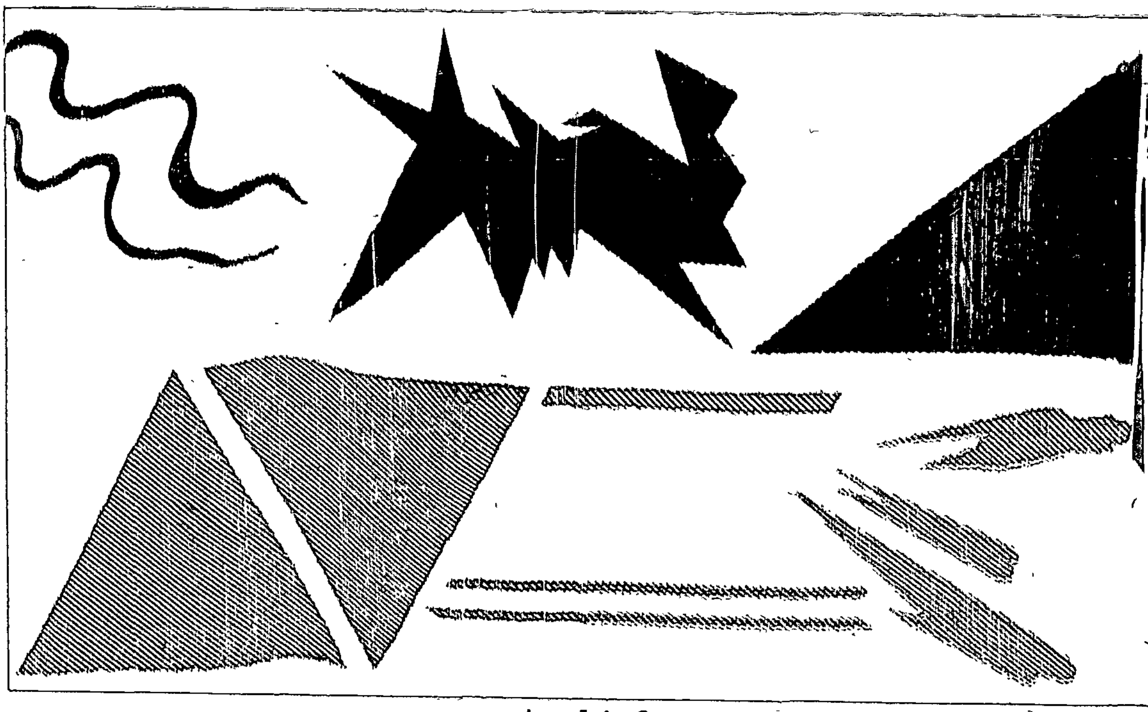


Fig 14.2

to the time factor it has not been possible to experiment to any degree in this area in order to achieve a variety of shapes from one form. Ultimately this could result in a quantity of images with a number of derivative forms.

Extensive but careful use of construction could change, accentuate, reduce or hide the printed imagery. Used in combination with the type of jacquard techniques discussed at the beginning of this section, or a 24/32 shaft loom with computerised dobby mechanism the range of possibilities would be vast.

Finally the type of printing technique selected would enable interesting variations to be produced.

Hence by incorporating the information discovered in this investigation with technical weaving and printing knowledge, supported by interesting visual ideas, the field of constructed textile designing would be extended.

REFERENCES

1 Kamus Pelajar Federal Learners Dictionary. Singapore 1973. p. 179.

2 Bhusham, J. B., The Costumes and Textiles of India. Bombay 1958. p. 13, 19.

3 Larsen, J. L., The Dyes Art: Ikat, Batik, Plangi. Van Nostrand Reinhold, New York 1976. p. 135.

4 Idem. p. 135.

5 Leix, A. Periods and Civilisation and the Development of Dress in India. p. 13.

6 Langewis, L. and Wagner, F., The Decorative Art in Indonesian Textile. C.P.J. Van Der Peet, Amsterdam 1964. p. 15.

7 Schuster, C., Remärks on the Design of an Early Ikat Textile in Japan. Basler Beiträge zur Geographie und Ethnologie, Ethnologische Reihe, 2, Basle, 1965. p. 340.

8 Nahum, P., Private Communication. National Museum, Tokyo. February 1983.

9 Nishimura, M. Kasuri. Nippon No Kyoshi o Sasou orimono. Nippon No Senshoku 4. Tokyo 1975. Frontpiece.

10 Idem. p. 26-29.

11 Idem. p. 26-29.

12 Japan. The Official Guide. Tourist Industry Bureau Ministry of Transportation. Tokyo 1961. p. 736, 737.

13 Nishimura, M. Kasuri. Nippon No Kyoshi o Sason orimono. Nippon No Senshoku 4. Tokyo 1975. p. 26-29.

14 Schuster, C., Remarks in the Design of an Early Ikat Textile in Japan. Basler Beiträge zur Geographie und Ethnologie, Ethnologische Reihe, 2, Basle, 1965. p. 339.

15 Nishimura, M. Kasuri. Nippon No Kyoshu o Sason orimono. Nippon No Senshoku 4. Tokyo 1975. Frontpiece.

16 Textile Department National Museum. Private Communication. Tokyo, February 1983.

17 Stein, Sir A., Ancient Khotan 1907, Serindia 1921, and Innermost Asia. Clarendon Press, Oxford 1928.

18 Bühler, A., Materialien zur kenntnis der Ikat technik. Internationales Archiv Für Ethnographie, supplement to Vol. XLIII. E. J. Brill, Leiden, Holland 1943.

19 Iklé, Fritz. Ueber Flammentücher. In Festschrift Für Marie Andree-Eysu. Munich 1928.

20 Harcourt, Raoul d'. Peruvian Textile Techniques. Ciba Review, 136, Basle, 1960. p. 2.

21 Linné, S., Archaeological Researches at Teotihnacan. Mexico. The Ethnographical Museum of Sweden. New Series Publication. No. 1. Stockholm 1934. p. 166.

22 Idem. p. 164.

23 Titiev, M., Araucanian Culture in Transition. Occasional contributions from the Museum of Anthropology of the University of Michigan. 15, University of Michigan Press 1951. p. 8.

24 Klein, O., Textile Arts of the Araucanians. Ciba Review. 6, Basle, 1961. p. 15.

25 Idem. p. 7.

26 Idem. p. 7.

27 Smith, E. R., The Araucanians. New York 1855. p. 55.

28 Titiev, M., Araucanian Culture in Transition. Occasional Contributions from the Museum of Anthropology of the University of Michigan. 15, University of Michigan Press 1951. p. 16.

29 Klein, O., Textile Arts of the Araucanians. Ciba Review. 6, Basel, 1961. p. 15.

30 Museum of Mankind Archives, Private Communication. Museum of Mankind, London 1982.

31 Klein, O., Textile Arts of the Araucanians. Ciba Review 1961. 6, p. 8.

32 Joseph, C., Los Tojidos Araucanos. Padre los Casas: Impreuta "San Francisco" 1928, plt. 26.

33 O'Neale, L. M., Weaving. IN: Handbook of South American Indians, 5, Bureau of American Ethnology, bulletin 143. Washington 1949. p. 115.

34 Idem. p. 115.

35 Klein, O., Textile Arts of the Araucanians. Ciba Review 1961. 6, p. 15.

36 Idem. p. 15.

37 Idem. p. 9.

38 Klein, O., Textile Arts of the Araucanians. Ciba Review 1961. 6, Basle. p. 10, 11.

39 O'Neale, L.M., Weaving. IN: Handbook of South American Indians. 5, Bureau of American Ethnology, bulletin 143. Washington 1949. p. 115.

40 Titiev, M., Araucanian Culture in Transition. Occasional contributions from the Museum of Anthropology of the University of Michigan. 15, University of Michigan Press 1951. p. 9.

41 Klein, O., Textile Arts of the Araucanians. Ciba Review 1961, 6, Basle. p. 19.

42 Lothrop, S. K., Polychrome Guanaco Cloaks of Patagonia. Contributions of the Heye Museum of the American Indian. Vol. 7, No. 6. New York 1929. p. 21.

43 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 50.

44 Leix, A., Turkestan and its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1441.

45 Idem. p. 1441.

46 Idem. p. 1441.

47 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 50.

48 Leix, A., Turkestan and Its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1441.

49 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 50.

50 Idem. p. 50.

51 Idem. p. 50.

52 This piece is in the collection of the author and was purchased in London in 1977.

53 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 51.

54 Idem. p. 52.

55 Idem. p. 72.

56 Leix, A., Turkestan and Its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1448, 1449.

57 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 72.

58 Nomad Exhibition, Castle Street, Cambridge, April 5th 1982.

59 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 51.

60 Leix, A., Turkestan and Its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1447.

61 Idem. p. 1447.

62 Idem. p. 1447.

63 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 52.

64 Leix, A., Turkestan and Its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1446, 1447.

65 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 50.

66 Idem. p. 46.

67 Leix, A., Turkestan and Its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1443.

68 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 48.

69 This piece is in the collection of the author.

70 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 46, 50.

71 Idem. p. 47.

72 Idem. p. 47.

73 Idem. p. 48.

74 Idem. p. 48.

75 Leix, A., Turkestan and Its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1450.

76 Idem. p. 1450.

77 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 7.

78 Leix, A., Turkestan and Its Textile Crafts. Ciba Review 1941. 40, Basle. p. 1437-1440.

79 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 7.

80 Watson, W., Cultural Frontiers of Ancient East Asia. Edinburgh University Press. Edinburgh, 1971. p. 39.

81 Tillman, G., Uzbek: The Textiles and Life of the Nomadic and Sedentary Uzbek Tribes of Central Asia. Exhibition catalogue with sections written by Thomas Knorr, David Lindahl, Bernard Dupaigne and others. Basle, 1975. p. 9, 52.

82 Idem. p. 52.

83 Idem. p. 52.

84 Idem. p. 52.

85 Iklé, F., Ikat Techniques and Dutch East India Ikats. Bulletin of the Needle and Bobbin Club. XV, New York 1934. p. 46. Footnote.

86 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 114.

87 Gittinger, M., Splendid Symbols. The Textile Museum. Washington DC 1979. p. 139.

88 Iklé, F., Ikat Techniques and Dutch East India Ikats. Bulletin of the Needle and Bobbin Club. XV, New York 1934. p. 18.

89 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 34 + plate 37.

90 Newman, T. R., Contemporary South East Asian Arts and Crafts. Crown Publishers. New York 1977. p. 76.

91 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 120.

92 Idem. p. 129.

93 Langewis, L. and Wagner, F. A., Decorative Art in Indonesian Textiles. C.P.J. Van Der Peet, Amsterdam 1964. p. 15.

94 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 114.

95 Idem. p. 56.

96 Idem. p. 58.

97 Idem. p. 57.

98 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1591.

99 Bühler, A., Turkey Red Dyeing in South and South East Asia in "Madder and Turkey Red". Ciba Review 1941. 39, Basle. p. 1423.

100 Bühler, A., Ikats. Ciba Review 1941. 44, Basle. p. 1592.

101 Newman, T. R., Mordant Dyes. Contemporary South East Asian Arts and Crafts. Crown Publishers, New York 1977. p. 76.

102 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 66-72.

103 Bühler, A., Direct Dyes. Ikats. Ciba Review 1942. 44, Basle. p. 1597-1603.

104 Idem. p. 1597-1603.

105 Idem. p. 1602.

106 Newman, T. R., Contemporary South East Asian Arts and Crafts. Crown Publishers, New York 1977. p. 76.

107 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1602.

108 Houghton, T., Private Communication. Bali 1981. Photograph courtesy of Ted Houghton.

109 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 117.

110 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1593.

111 Bolland, R., Comparison between Looms in Bali and Lambok for Weaving Sacred Cloths. E.J.Brill, Leiden 1971. p. 171, 172.

112 "The Rijkmuseum voor Volkeujunde, Leyden, Holland, possesses one such loom. Catalogue No. 1586-47, which was acquired by Niewenkamp in Bubunan". From Bolland, R., Comparison Between Looms Used in Bali and Lambok for Weaving Sacred Cloths. E.J.Brill, Leiden 1971. p. 172.

113 Iklé, C. F., Ikat Techniques and Dutch East India Ikats. Bulletin of the Needle and Bobbin Club. XV, New York 1934. p. 51.

114 Idem. p. 52.

115 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 121.

116 Gittinger, M., Splendid Symbols. The Textile Museum. Washington DC 1979. p. 144.

117 Langewis, L. and Wagner, F. A., Decorative Art in

Indonesian Textiles. C.P.J. Van Der Peet, Amsterdam 1964. p. 13.

118 Thomassen à Thuessink Van Der Hoop, A.N.J., Indonesische Siermotieven. Koninklijk Bataviaasch Genootschap Van Kunsten En Wetenschappen, Bandung 1949. p. 13, 14.

119 Idem. p. 174.

120 Idem. p. 208.

121 Idem. p. 144, 146.

122 Idem. p. 24.

123 Idem. p. 34.

124 Idem. p. 54.

125 Idem. p. 64.

126 Idem. p. 68.

127 Idem. p. 92.

128 Gittinger, M., Splendid Symbols. The Textile Museum. Washington DC 1979. p. 144, plt. 107.

129 Nieuwenkamp the Painter and Explorer Discovered the Double Ikat Process in Tenganan in 1906. Real, D., Tissus des Indes Neerlandaises. Librarie des Arts Décoratifs, Paris 1927.

130 Purcell, V., The Revolution of South East Asia. Thames and Hudson, London 1962.

131 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 108.

132 Idem. p. 108.

133 Gittinger, M., Splendid Symbols. The Textile Museum. Washington DC 1979. p. 28.

134 Langewis, L. and Wagner, F. A., Decorative Art in Indonesian Textiles. C.P.J. Van Der Peet, Amsterdam 1964. p. 25.

135 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 108

136 Idem. p. 108.

137 Gittinger, M., Splendid Symbols. The Textile Museum. Washington DC 1979. p. 28, 148.

138 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1596.

139 Bolland, R., Comparison between Looms in Bali and Lambok for Weaving Sacred Cloths. E.J.Brill, Leiden 1971. p. 171.

140 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1596.

141 Idem. p. 1594.

142 Bühler, A., Turkey Red Dyeing in South and South East Asia in "Madder and Turkey Red". Ciba Review 1941. 39, Basle. p. 1423.

143 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 109.

144 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1594.

145 Idem. p. 1594.

146 Idem. p. 1594.

147 Idem. p. 1594.

148 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 110.

149 Idem. p. 110.

150 Idem. p. 110.

151 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1594.

152 Idem. p. 1595.

153 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 111.

154 Idem. p. 111.

155 Newman, T. R., Contemporary South East Asian Arts and Crafts. Crown Publications, New York 1977. p. 89.

156 Idem. p. 111.

157 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 112.

158 Bolland, R., Comparison between Looms in Bali and Lambok for Weaving Sacred Cloths. E.J.Brill, Leiden 1971. p. 178.

159 Langewis, L. and Wagner, F. A., Decorative Art in Indonesian Textiles. C.P.J. Van Der Peet, Amsterdam 1964. p. 24.

160 Gridley, C., Private Communication with, Tenganan 1979.

161 Bühler, A., Ramseyer, U. and Ramseyer-Gygi, N., Patola and Geriusing: Zeremonial Tücker und Indian und Indonesien. Museum für Volkerkunde und Schweizerisches Museum für Volkskunde. Basle 1975. p. 40, 68.

162 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications. London 1981. p. 113.

163 Iklé, C. F., Ikat Techniques and Dutch East Indian Ikats. Bulletin of the Needle and Bobbin Club. XV, New York 1934. p. 26.

164 Langewis, L. and Wagner, F. A., Decorative Art in Indonesian Textiles. C.P.J. Van Der Peet, Amsterdam 1964. p. 21.

165 Larsen, J. L., The Dyers Art: Ikat, Batik, Plangi. Van Nostrand Reinhold, New York 1976. p. 222.

166 Gridley, C., Private Communication with, Tenganan 1979.

167 Houghton, T., Private Communication with, Tenganan 1981.

168 Idem.

169 Sugimura, T. and Suzuki, H., Living Crafts of Okinawa. Weatherhill, New York and Tokyo 1973. p. 41.

170 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 76, 77.

171 Idem. p. 77.

172 The National Museum of Modern Art. Craft Treasures of Okinawa. Kyoto 1978. p. 263-265.

173 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 77.

174 Tonomura, K., Japanese Resist-Dyeing Techniques. Ciba Review 1967/4. Basle. p. 4.

175 Idem. p. 13.

176 Idem. p. 15.

177 Bühler, A., Shibori und Kasuri: Zwei Traditionelle Japanische Mueterungsuerfahren für Stoffe. Folk. Kobenhavn 1963. p. 60-64.

178 Idem. p. 60-64.

179 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 78.

180 Idem. p. 78.

181 Idem. p. 78.

182 Bühler, A., Shibori und Kasuri: Zwei Traditionelle Japanische Mueterungsuerfahren für Stoffe. Folk. Kobenhavn 1963. p. 60-64.

183 Tonomura, K., Japanese Resist-Dyeing Techniques. Ciba Review 1967/4. Basle. p. 19.

184 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 78.

185 Tomita, J. and N., Japanese Ikat Weaving. Routledge and Kegan Paul, London. p. 9.

186 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 80.

187 Idem. p. 79.

188 McCauley, B., Private Communication with, Kyushu April 1983.

189 Tonomura, K., Japanese Resist-Dyeing Techniques. Ciba Review 1967/4. Basle. p. 30.

190 Idem. p. 32.

191 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 79.

192 Idem. p. 79.

193 Broudy, E., the Book of Looms. Cassell, London 1979. p. 114, 115.

194 Tonomura, K., Japanese Resist-Dyeing Techniques. Ciba Review 1967/4. Basle. p. 10.

195 Idem. p. 10.

196 Idem. p. 10.

197 Idem. p. 33.

198 Idem. p. 33.

199 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 80.

200 Yuoshioka, U. (Editor), The Beauty of Dyeing and Weaving 1981. Japanese Kasuri Series, Kyoto 1981. p. 99-106.

201 Idem. p. 6-25.

202 Matsumoto, T. (Editor), Kasuri, Tsumugi and Shima Japan, Indonesia and other. Tokyo 1977. p. 29-32.

203 Hira, T., Banana Plant Fabric of Kikaiga. Human National Treasure Series 41. Kodansha, Tokyo 1977.

204 Haring, D., Tsumugi. 22(5) Craft Horizons 1962. p. 35.

205 Matsumoto, T. (Editor), Kasuri, Tsumugi and Shima Japan, Indonesia and other. Tokyo 1977. p. 43-47.

206 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 80.

207 Idem. p. 81.

208 Chiba, A., Kurume-Gasuri. Human National Treasure Series 20. Kodansha, Tokyo 1978.

209 Yuoshioka, U. (Editor), The Beauty of Dyeing and Weaving 1981. Japanese Kasuri Series, Kyoto 1981. p. 27-35.

210 Idem. p. 36-39.

211 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 81.

212 Yuoshioka, U. (Editor), The Beauty of Dyeing and Weaving 1981. Japanese Kasuri Series, Kyoto 1981. p. 58-60.

213 Idem. p. 61-65.

214 Matsumoto, T. (Editor), Kasuri, Tsumugi and Shima Japan, Indonesia and other. Tokyo 1977. p. 21-23.

215 Yuoshioka, U. (Editor), The Beauty of Dyeing and Weaving 1981. Japanese Kasuri Series, Kyoto 1981. p. 61.

216 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 81.

217 Idem. p. 81.

218 Yuoshioka, U. (Editor), The Beauty of Dyeing and Weaving 1981. Japanese Kasuri Series, Kyoto 1981. p. 50-57.

219 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 82.

220 Tourist Industry Bureau Ministry of Transportation. Japan. The Official Guide. Tokyo 1961. p. 590.

221 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 82.

222 Idem. p. 82.

223 Tourist Industry Bureau Ministry of Transportation. Japan. The Official Guide. Tokyo 1961. p. 543.

224 The Third Generation of Yuki Yuki. Human National Treasure Series 43. Kodansha, Tokyo 1979.

225 Langewis, J., Japanese Ikat Textiles. Etnografisch Museum, Delft 1963. p. 82.

226 Idem. p. 80.

227 Langewis, J., Kasuri Motif Symbolism in Japanese Resist-Dyeing Techniques. Ciba Review 1967/4. Basle. p. 34.

228 Mizoguchi, S., Design Motifs. Arts of Japan. New York and Tokyo 1968. p. 127.

229 Komuku, S. (Editor), Special Collection of Kasuri Pattern. Art and Craft Series 156. Kyoto 1969. p. 10-24.

230 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications, London 1981. p. 57, 58.

231 Bühler, A., Ikats. Ciba Review 1942. 44, Basle. p. 1622.

232 Idem. p. 1622.

233 Research carried out by the Author at Fashion Institute of Technology, New York 1979.

234 Milne, T. and Woodhouse, T., Jute and Linen Weaving. Part 1 Mechanism. Emmott and Co. Ltd., Manchester 1904. p. 108-111.

235 McKelvey, D., Private Communication, Middlesex Polytechnic, London 1980.

236 I.C.I Dyestuffs Division. An Introduction to Textile Printing. Butterworth, London 1967. p. 92.

237 Jenkins, B., Private Communication, Middlesex Polytechnic, London 1983.

238 McKelvey, D., Private Communication, Middlesex Polytechnic, London 1980.

239 I.C.I Dyestuffs Division. An Introduction to Textile Printing. Butterworth, London 1967. p. 55.

240 Grosicki, Z., Watson's Textile Design and Colour. Newnes-Butterworths, London 1975. p. 32.

241 Milne, T. and Woodhouse, T., Jute and Linen Weaving. Part 1 Mechanism. Emmott and Co. Ltd., Manchester 1904. p. 74.

242 Idem. p. 75.

243 Warming, W. and Gaworski, M., The World of Indonesian Textiles. Serindia Publications, London 1981. p. 108.

244 Larsen, J.L., The Dyers Art: Ikat, Batik, Plangi. Van Nostrand Reinhold, New York 1976. p. 135.

APPENDIX I - WOOL

Construction	Sample Number	Weft Count	Ends Per Centimetre	Picks Per Centimetre
Plain Weave	1	R40 Tex/2	20.4	13.6
	2	155 Tex	20	8.3
	3	389 Tex	20	5.9
	4	R722 Tex/4	20	3.9
	5	1525 Tex	21.2	3.1
	6	R1745 Tex/6	20	2.3
1/2 Repp	7	R40 Tex/2	20.4	11.0
	8	155 Tex	20	5.9
	9	389 Tex	20	4.3
	10	R722 Tex/4	20.5	3.1
	11	1525 Tex	20	1.9
	12	R1745 Tex/6	20.4	1.6
3 and 1 Twill	13	R40 Tex/2	21.2	20.4
	14	155 Tex	20.4	10.2
	15	389 Tex	20	7.9
	16	R722 Tex/4	20	5.1
	17	1525 Tex	20	3.1
	18	R1745 Tex/6	19	2.3
2/3 Repp	19	R40 Tex/2	31.4	9.4
	20	155 Tex	30	4.7
	21	389 Tex	31.4	3.5
	22	R722 Tex/4	28.3	2.4
	23	1525 Tex	29.9	1.9
	24	R1745 Tex/6	29.9	1.1
8 End Satin	25	R40 Tex/2	31.4	26.7
	26	155 Tex	31.4	15.7
	27	389 Tex	31.4	9.4
	28	R722 Tex/4	31.4	7.0
	29	1525 Tex	29.9	4.3
	30	R1745 Tex/6	29.9	3.1
Repeat Plain	31	R40 Tex/2	21.6	13.1
	32	155 Tex	20.3	7.6
	33	389 Tex	19.7	5.9
	34	R722 Tex/4	20	3.8
	35	1525 Tex	19.9	2.7
	36	R1745 Tex/6	19.9	2.0

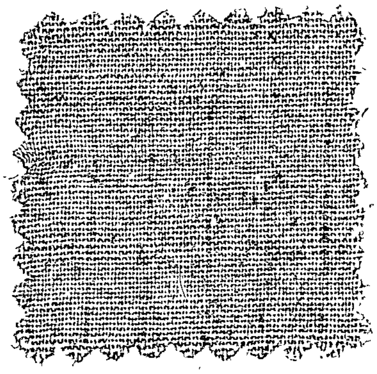
APPENDIX II - COTTON

Construction	Sample Number	Weft Count	Ends Per Centimetre	Picks Per Centimetre
Plain Weave	37	R11.75 Tex/2	21.3	12.9
	38	R37.5 Tex/2	20.5	9.0
	39	R98 Tex/2	19.4	8.4
	40	125 Tex	20.1	7.9
	41	R195 Tex/2	19.4	7.2
	42	R390 Tex/2	19	5.1
1/2 Repp	43	R11.75 Tex/2	20.7	12.5
	44	R37.5 Tex/2	20.1	7.9
	45	R98 Tex/2	19.5	7.3
	46	125 Tex	19.9	7.0
	47	R195 Tex/2	18.8	5.2
	48	R390 Tex/2	18.8	3.3
3 and 1 Twill	49	R11.75 Tex/2	21.1	21.3
	50	R37.5 Tex/2	20.8	13.4
	51	R98 Tex/2	20	12.5
	52	125 Tex	20.5	12.4
	53	R195 Tex/2	19.7	9.2
	54	R390 Tex/2	19.4	6.1
2/3 Repp	55	R11.75 Tex/2	15.3	10.5
	56	R37.5 Tex/2	14.9	6.7
	57	R98 Tex/2	14.2	6.1
	58	125 Tex	14.8	5.9
	59	R195 Tex/2	14.1	4.2
	60	R390 Tex/2	14.1	3.1
8 End Satin	61	R11.75 Tex/2	30.5	35.2
	62	R37.5 Tex/2		20.1
	63	R98 Tex/2	29.7	16.4
	64	125 Tex	30.4	18.2
	65	R195 Tex/2	33.9	11.2
	66	R390 Tex/2	29.5	8.4

APPENDIX III - SILK

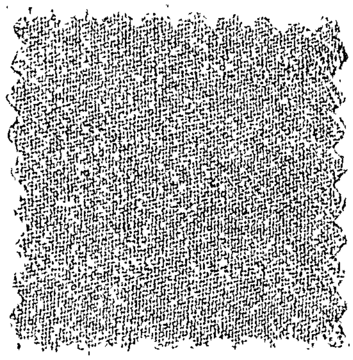
Construction	Sample Number	Weft Count	Ends Per Centimetre	Picks Per Centimetre
Plain Weave	67	R12.5 Tex/2	33.8	23.8
	68	R40 Tex/4	32.4	15.5
	69	R96 Tex/2	32.1	11.1
	70	118 Tex	23.1	10.5
	71	140 Tex	31.6	8.4
	72	R340 Tex/2	30.8	5.7
1/2 Repp	73	R12.5 Tex/2	32.6	19.1
	74	R40 Tex/4	31.5	14.1
	75	R96 Tex/2	30.7	8.7
	76	118 Tex	33.3	9.4
	77	140 Tex	31.7	6.4
	78	R340 Tex/2	31.7	4.3
3 and 1 Twill	79	R12.5 Tex/2	33.7	40.5
	80	R40 Tex/4	33.7	24.0
	81	R96 Tex/2	35.6	13.3
	82	118 Tex	34.6	13.9
	83	140 Tex	35.6	11.3
	84	R340 Tex/2	35.6	6.4
2/3 Repp	85	R12.5 Tex/2		17.4
	86	R40 Tex/4	43.5	10.3
	87	R96 Tex/2	43.4	7.2
	88	118 Tex	43.3	6.8
	89	140 Tex	43.3	5.0
	90	R340 Tex/2	43.1	3.5
8 End Satin	91	R12.5 Tex/2	49.6	43
	92	R40 Tex/4	45.8	28.9
	93	R96 Tex/2		18.3
	94	118 Tex		17.7
	95	140 Tex	42.1	13.0
	96	R340 Tex/2	41.9	8.9

APPENDIX IV - WOOL FABRICS

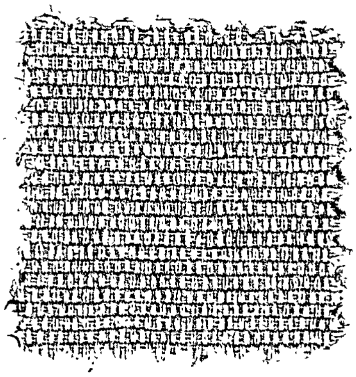


Plain Weave

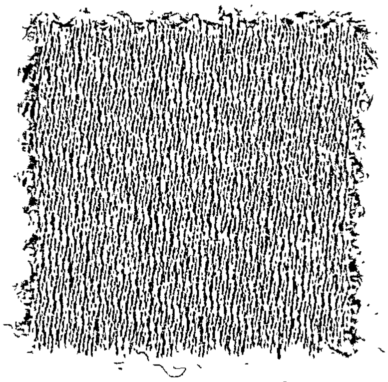
2/2 Repp



3 and 1 Twill

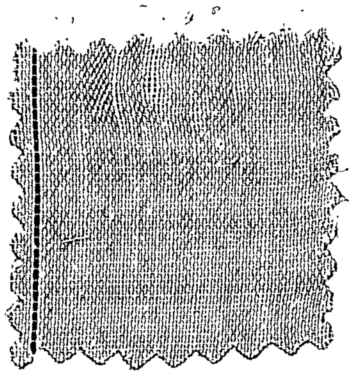


2/3 Hopsack

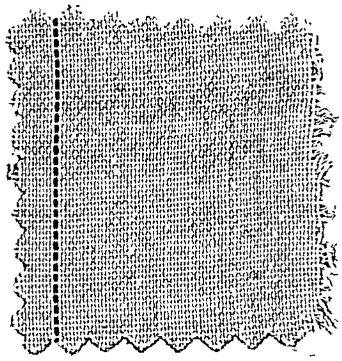


8 end Satin

APPENDIX V - COTTON FABRICS



Plain Weave



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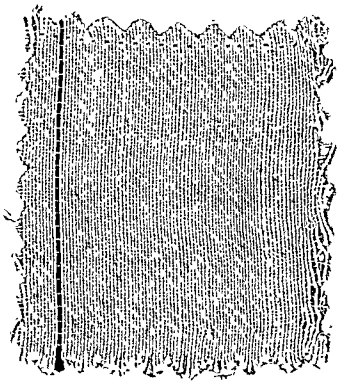

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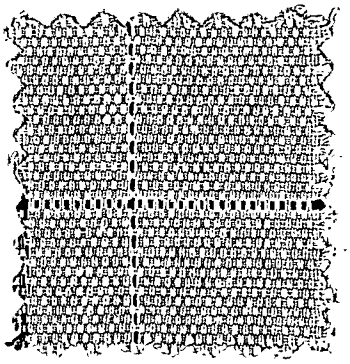
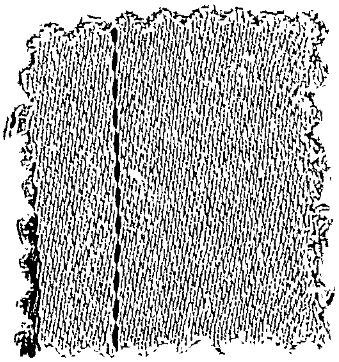
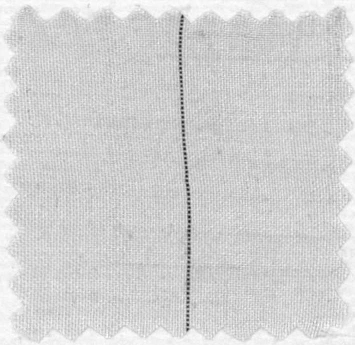


2/3 Hopsack

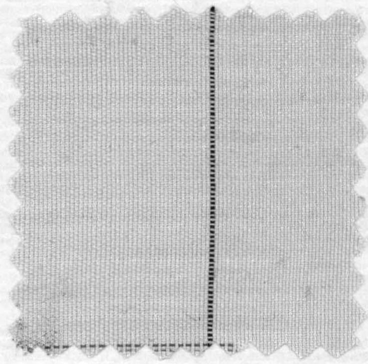


8 end Satin

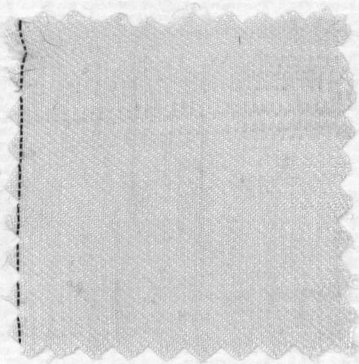
APPENDIX VI - SILK FABRICS



Plain Weave



2/2 Repp



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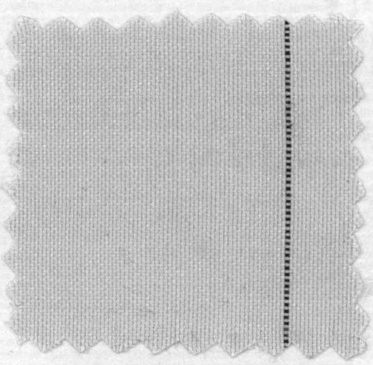
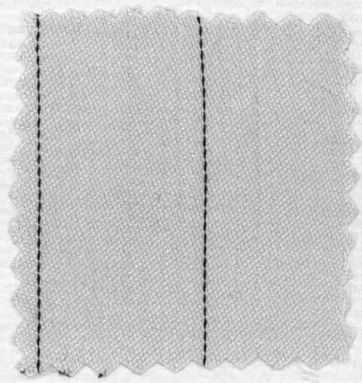


2/3 Hopsack



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