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TLX: 8954667 VBSTLX G quote 'REF IKI'

THE KNOW-HOW FOR THE PRODUCTION OF INDIGO-DYED COTTON YARN FOR KNITTING & KNITTING TECHNIQUE

Michael Quinnen
London, July 1984

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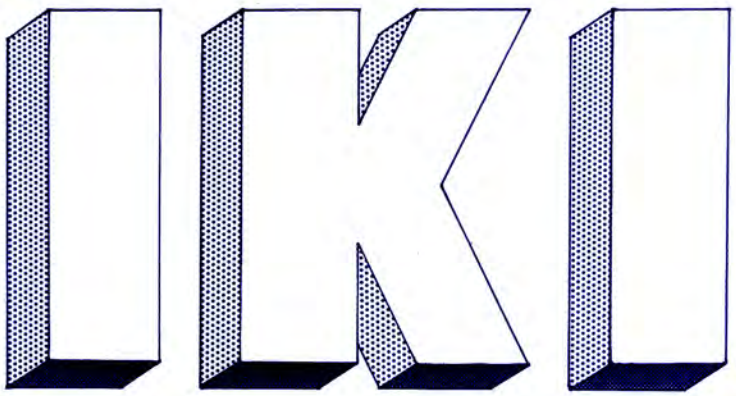
APPENDIX I Trademark in Use



I. THE PRODUCT

To obtain a good quality commercial indigo-dyed cotton yarn for knitting, the following have to be borne in mind:-

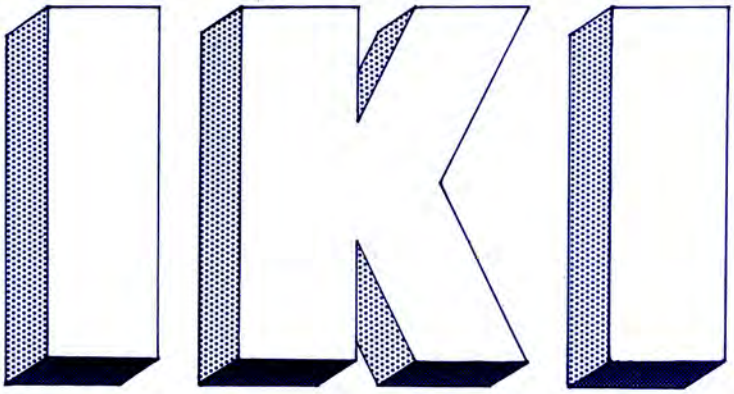
1. The yarn has to be suitable in appearance and handling qualities for its purpose.

2. The end product has to maintain its 'denim' characteristics.

3. The product must be consistent in colour and performance, and, therefore, the dye penetration should be appropriate for the type of knitted fabric required.

4. Its wash-down performance is critical and it must be neither too fast nor should it be too prone to sudden colour loss.

5. It must be obtained on package in single or ply form economically, be well lubricated, and have a minimum of knots.



II. CURRENT IKI PRODUCTION

We currently use a fairly high-grade rope-dyed 6.5 NE open-end spun yarn. The yarn is rope-dyed with higher penetration than would be normal for weaving denim. The colour is toward the red end of the spectrum.

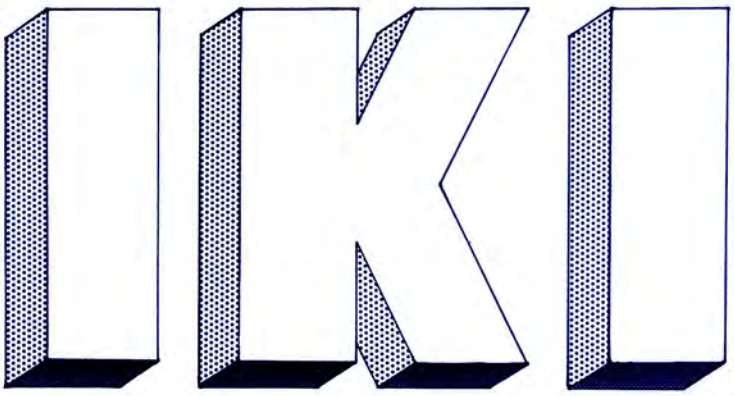
Each rope is 10,000 metres long, weighs approximately 250 kg and consists of 320 ends.

The ropes are then wound onto 8 spools set up in an adapted beaming machine (see Fig. 1). The spools containing 40 ends each are then loaded in an 'A' frame opposite a single-end winding machine (see Fig. 2) or on a ring-doubling frame (see Fig. 4). The bobbins from the doubling, and the packages from the Barmag winding heads (see Fig. 3) are sent for cone winding, waxing and oiling. This then provides the yarn on package suitable for knitting.

We use a limited amount of 2/16s NE ring-spun yarn. The dye is of low penetration and the colour is toward the green end of the spectrum. This yarn is not sold but used for mixing with the 6.5s on ribbing sold as trimming and for a backing yarn on fabric produced by a fabric knitter with whom we work closely.

Notes:-

1. Since it is difficult during indigo-dyeing to maintain absolute consistency of shade depth, we employ a strict batching regime, each rope being designated a batch number, as even on one dye run there can be some variation in shade from one side of the dye range to the other and, if yarn from one rope is mixed with that from another, it can lead to shadow-striping especially on circular knitting.

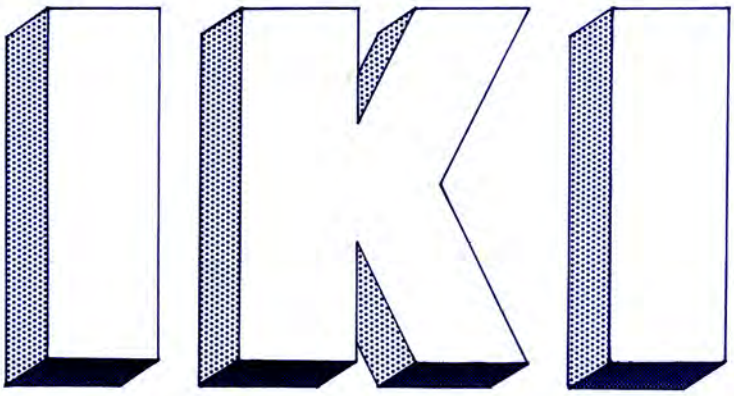


II. CURRENT IKI PRODUCTION (continued)

2. In the event of the dye range stopping during process causing stand marks, that part of the rope must be cut out and the ends tied in or, alternatively, the yarn must be used for other purposes, i.e. for weaving or trimmings.

3. Whenever there are breaks or ends have to be tied in during any of the winding processes, they must be tied in with tight weavers knots and the ends should be trimmed short. Poorly tied knots cause many problems during knitting, viz. damaged needles, castoffs, ladders and dropped stitches.

4. As the final product must be wet finished, there is no restriction on the type or quantity of lubrication applied. Maximum lubrication, both a hard wax and penetration oil , is recommended for trouble-free knitting.

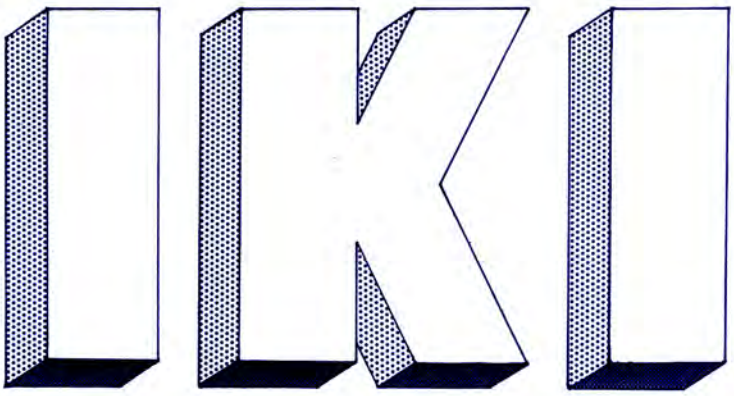


III. SINGLE-END WINDING

Initially, all yarn was wound onto package by the use of a Holts Quiller Pirn Winder. This machine is not dissimilar to using a warp mercerizer - it proved to be slow, expensive and, due to the small package, incurred a large number of knots in the yarn.

The next method employed was to use a combination of spools on adapted beaming machines. Firstly, a rope was split from 320 ends, so 160 ends were wound on to 8 spools of 20 ends each (see Fig. 1). Next the other half of the rope was tied in and winding continued. The spools containing 20 ends, 20,000 metres long, were wound onto 20 smaller spools under tension and with a traverse action (see Fig. 5). These spools were then unloaded and laid flat with one side removed and wound off onto cone. We discontinued this method when the single-end winding machine came on stream. Although the spool method required little capital investment and produced relatively knot-free yarn, it was labour intensive and slow.

The single-end winding machine was built from reconditioned Barmag winding heads taken from a machine used for the production of polyamide yarn. The heads had to be adjusted to wind with a gentler action so as not to snatch or jerk when starting up. Initially, a bank of 160 was fed by a power-driven sectioned beam; this worked reasonably well but the machine would be stopped too often when an end of yarn would break out; also, in spite of a sophisticated graduated drive control and braking system, the consistency of payout off the beam could not be controlled



III. SINGLE-END WINDING (continued)

absolutely because of the impetus created by the change of weight from 250 kg to zero while in process. This problem becomes minimal by sub-division. Using spools with 40 ends wound on set-up in an 'A' frame feeding a bank of 40 winding heads (see Fig. 2), automatically means that only 40 heads are stopped instead of 160 when an end breaks out. There are also less break-outs as the spool holds only approximately 30 kg of yarn obviating the weight impetus problem. Occasionally, one end of yarn breaks out and is entwined by another without tripping the breaker thereby causing a package to wind two ends; this calls for vigilance on the part of the operator and is one of the reasons we wind onto cone from these packages, the others being we prefer to lubricate separately and by selling yarn on the package of the Barmag winding head it would give an indication of our methods to others.

Currently, using 120 winding heads, three shifts produce five tons of yarn in a five-day working week.

The winding heads are supplied by:-

Barmag GmbH, P.O. Box 110240, D-5630 Remscheid 11, West Germany
Tlx: 8513611

The spools are made from Bakelite, a relatively cheap, tough and light-weight material (see Fig. 6).

N.B. The patent application features a non-existent winding head, so that when published it does not show exactly how we do things but serves to protect the principle. It is one thing to have a patent and it is quite another to be able to police it.

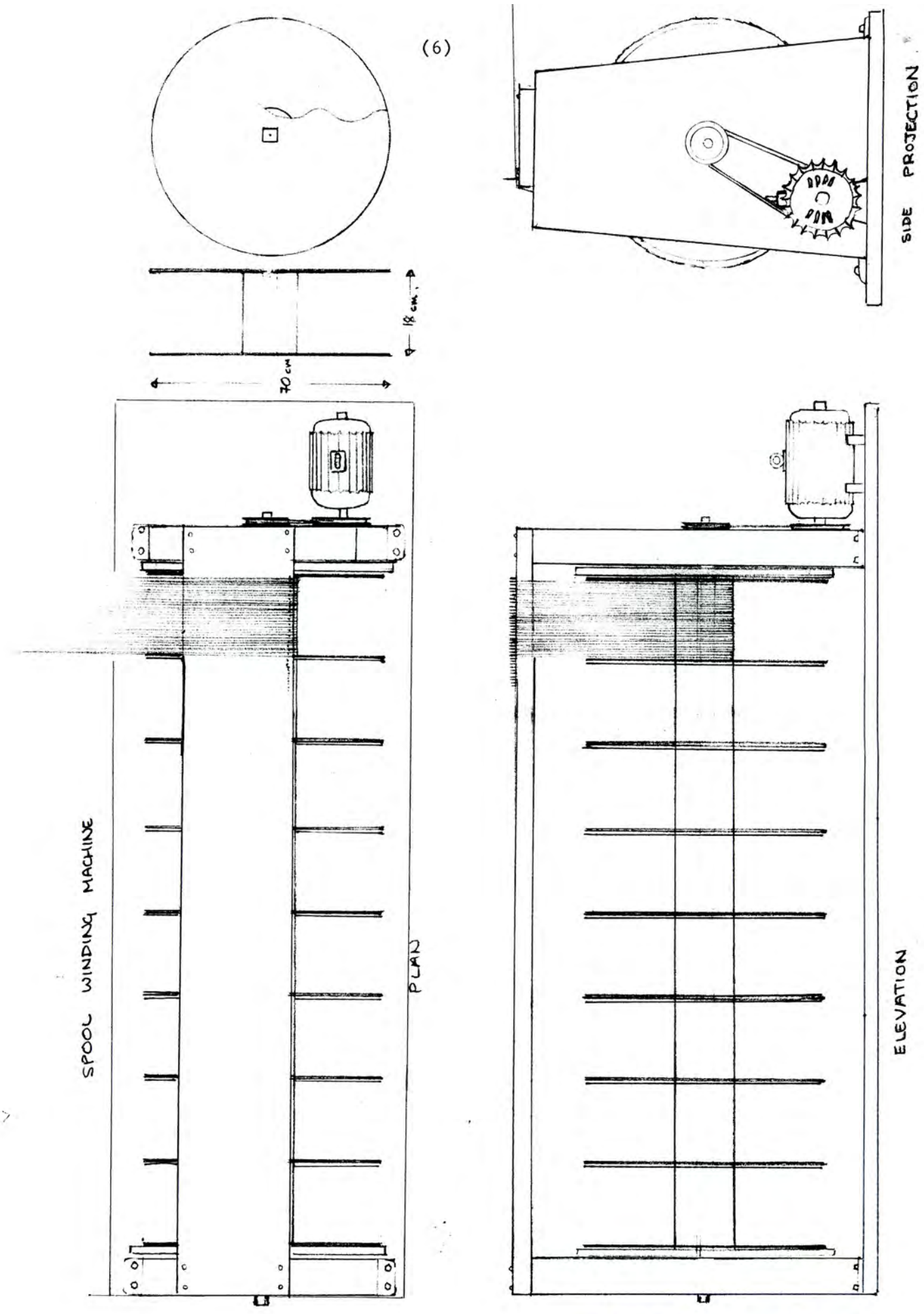
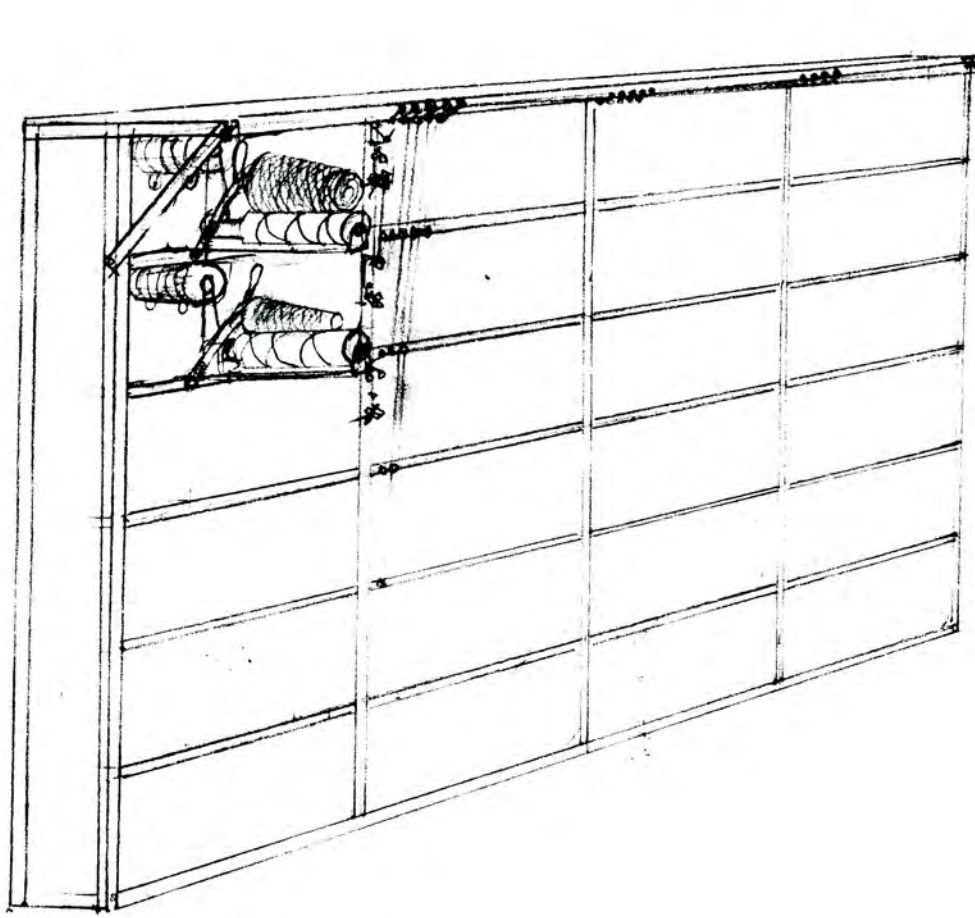
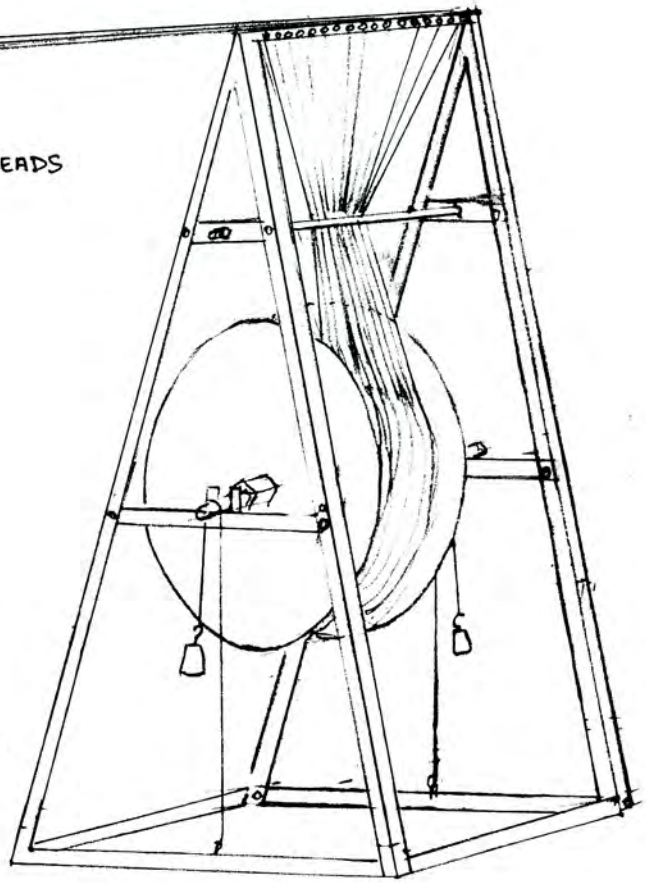

SIDE PROJECTION
18 cm.
70 cm
SPOOL WINDING MACHINE
PLAN
ELEVATION

FIG 1

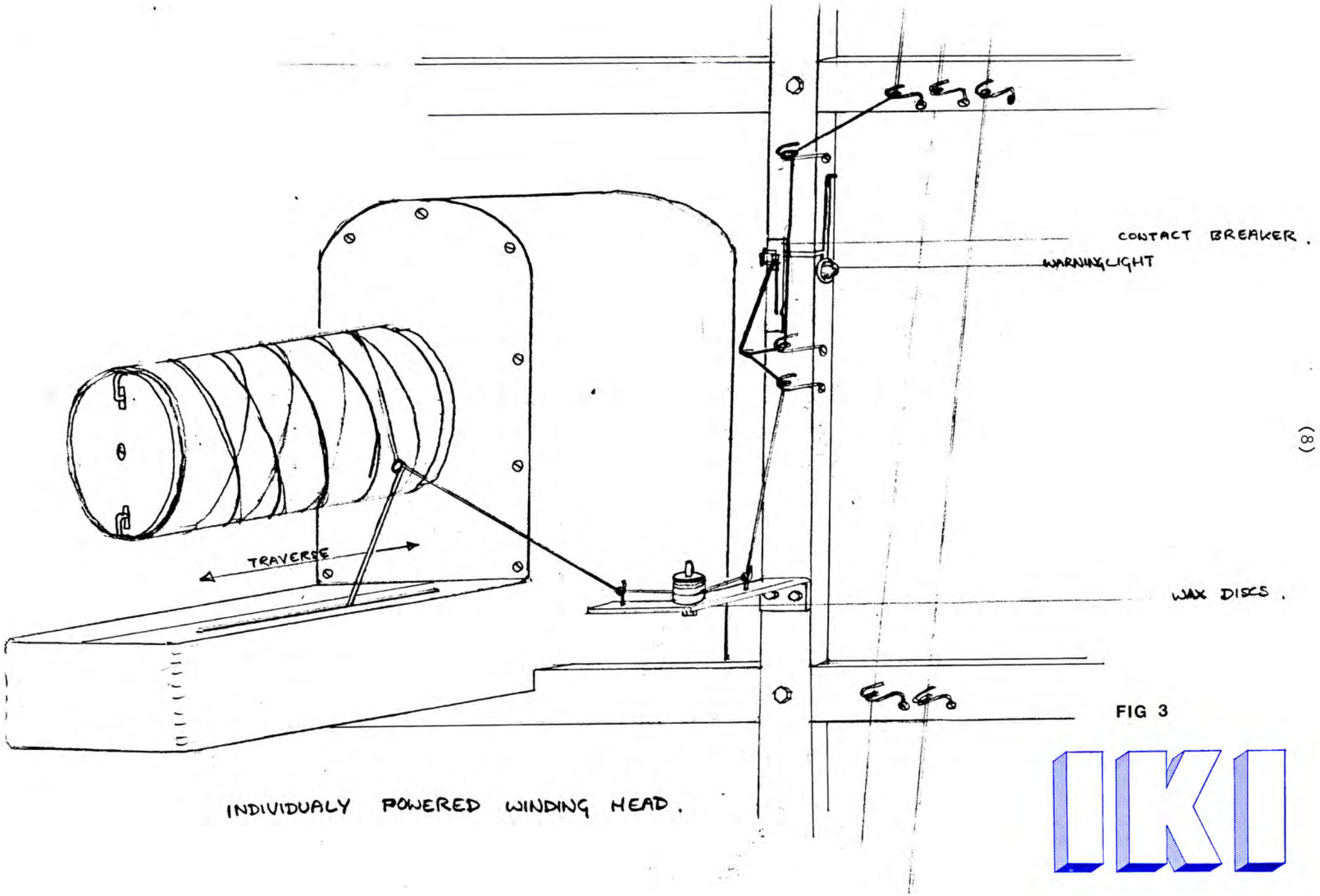


FRAME FOR 40
POWERED WINDING HEADS



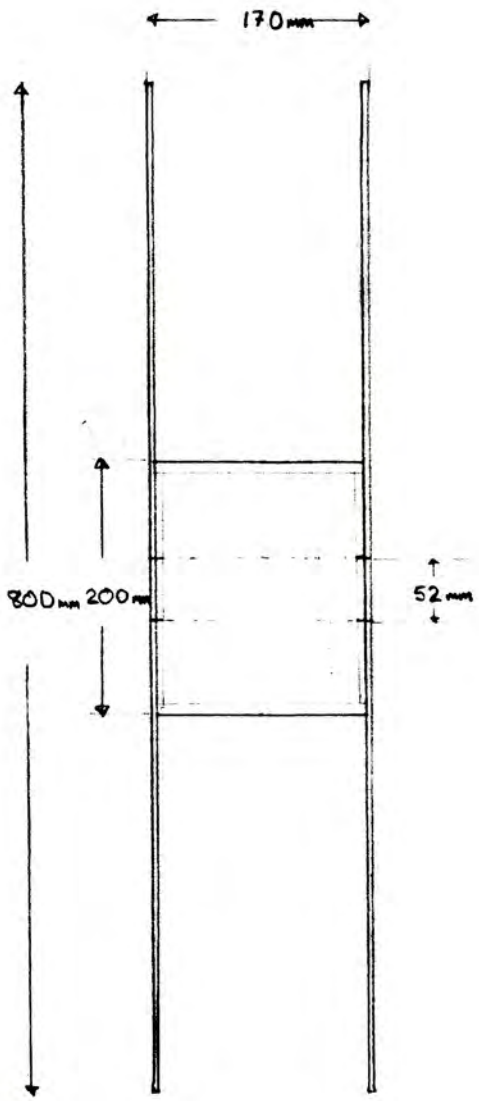
SINGLE END WINDING MACHINE.

FIG 2

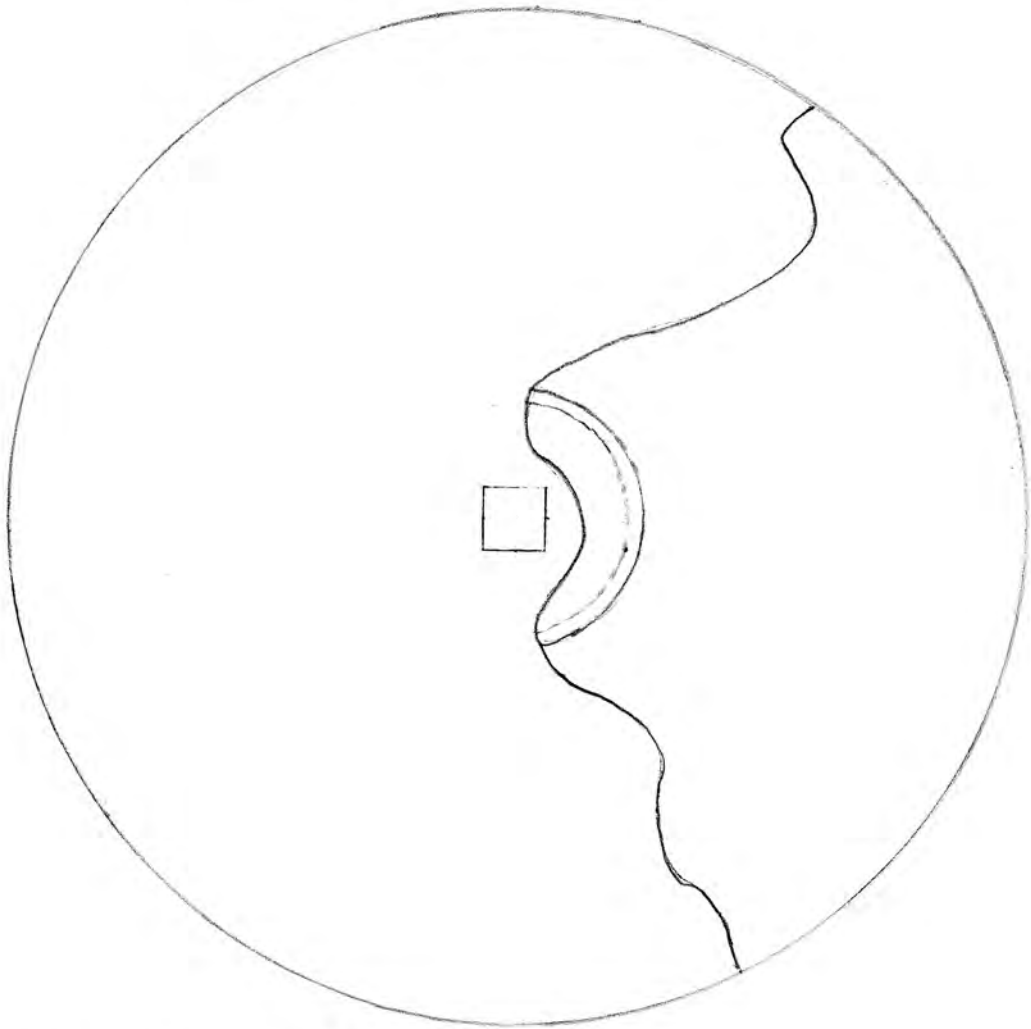


INDIVIDUALY POWERED WINDING HEAD.

FIG 3



WINDING SPOOL



SIDES 6 mm THICKNESS

EDGES TO BE MADE SMOOTH TO PREVENT YARN SNAGS

FIG 6

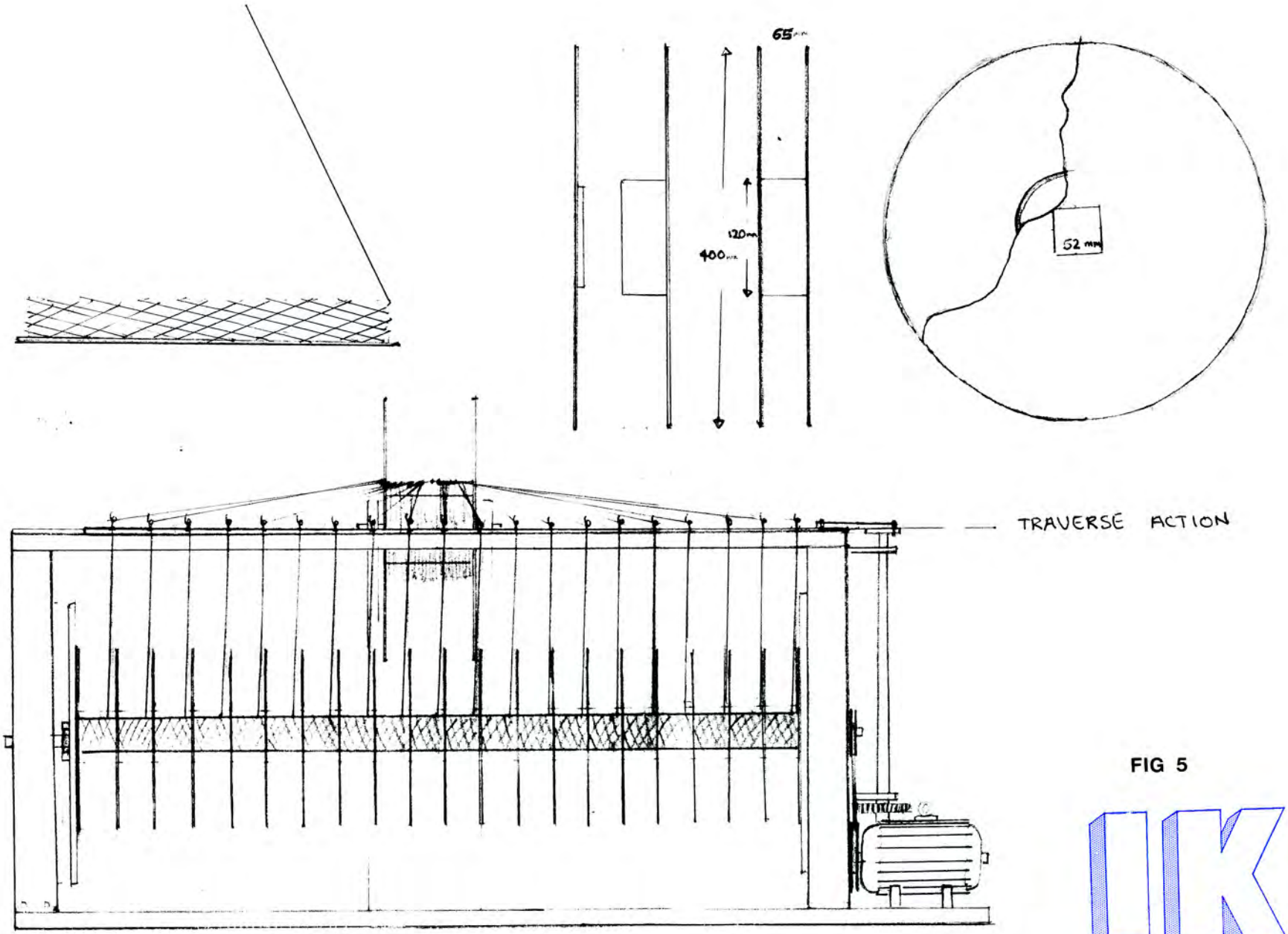
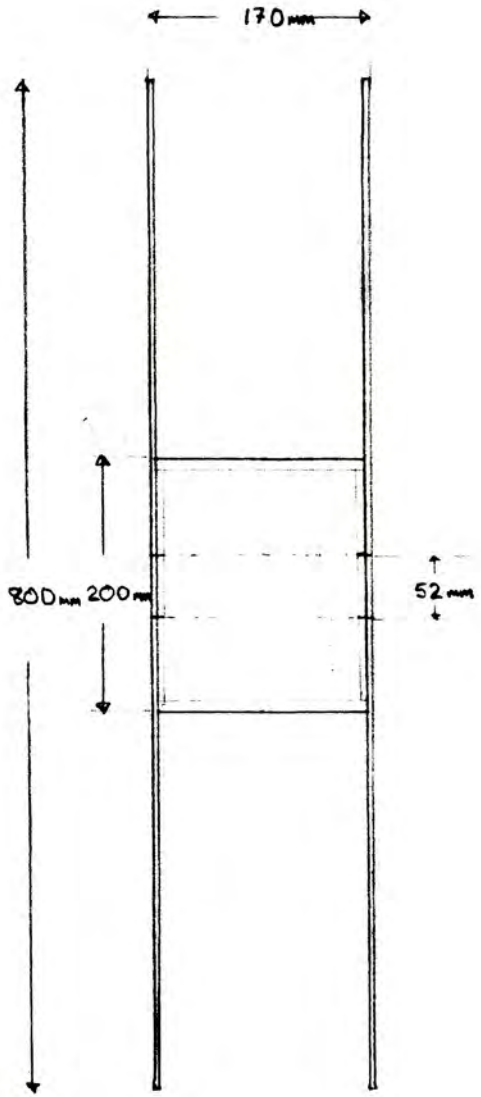
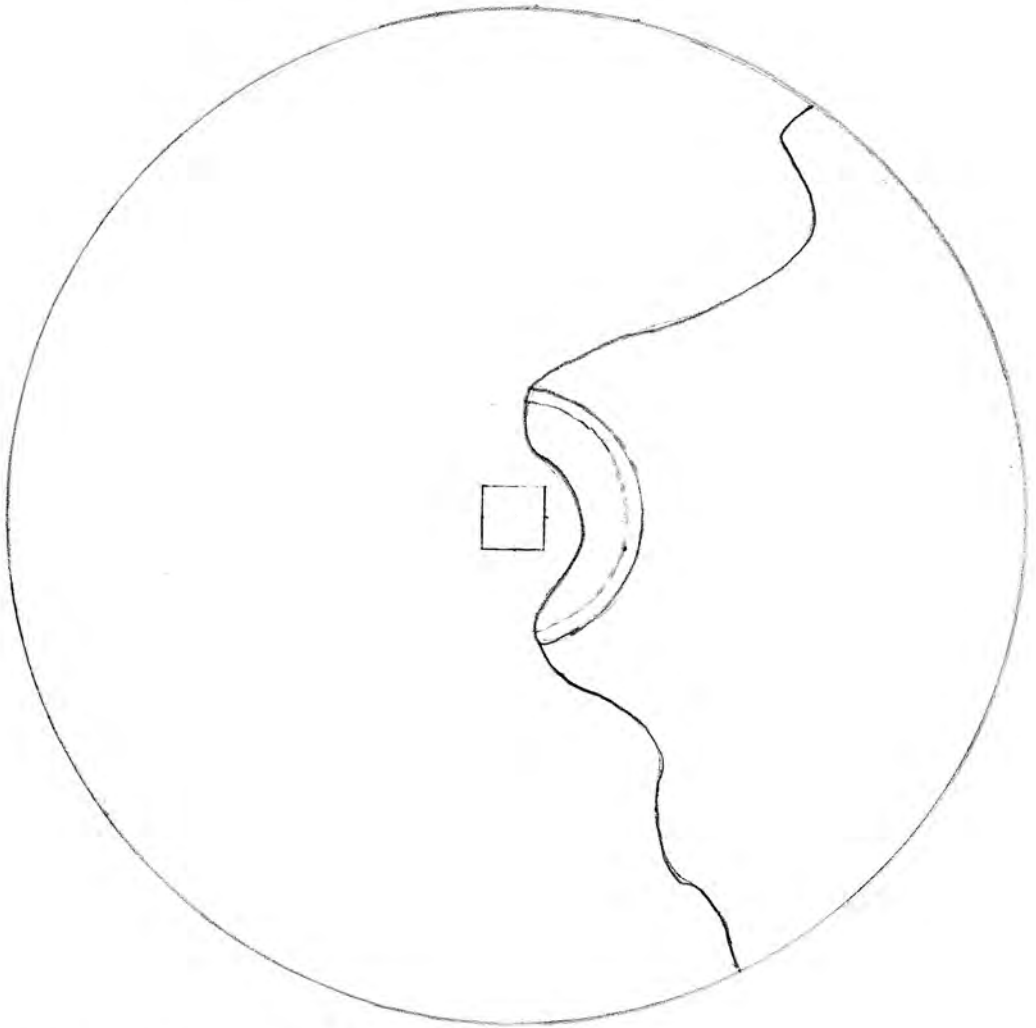


FIG 5



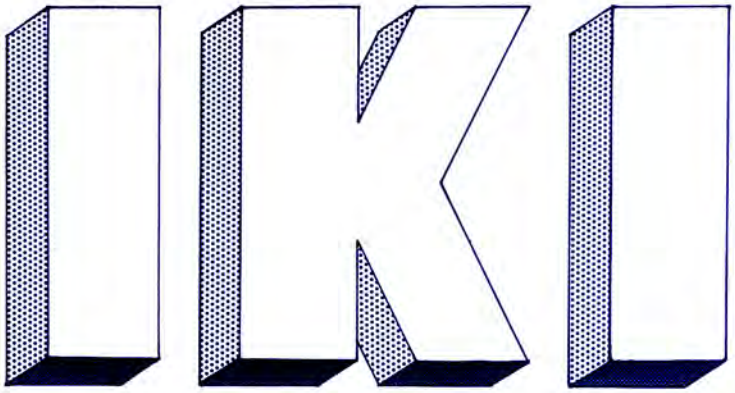
WINDING SPOOL



SIDES 6 mm THICKNESS

EDGES TO BE MADE SMOOTH TO PREVENT YARN SNAGS

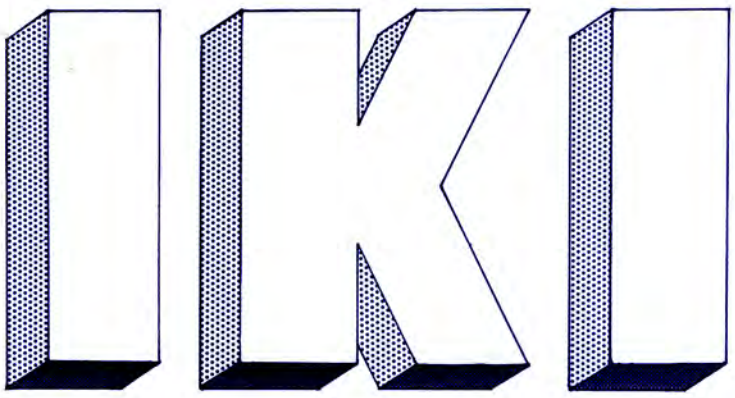
FIG 6



IV. DOUBLING

The first doubled yarn was obtained by taking the single-end yarn and doubling it by the normal method. This proved a rather expensive way of producing doubled yarn, so we attempted to double direct off the back beam. This was done by mounting a beam on top of an old, flat top ring-doubling frame with limited success. The problems we encountered were that we could only double a maximum of 120 ends at once and there was a high incidence of breakouts. There was also a degree of entanglement between the yarn being taken off and that remaining on the beam. We then made beams by splitting the ropes into three, reducing the beam to 107 ends and tying odd cones of single yarn in to balance up the number of ends. This method was more successful, obviating the problem of entanglement, but there was still a relatively high rate of breakouts of yarn. Bearing in mind that every breakout means a knot, and if not spotted quickly the loose end of yarn can become entangled with other ends causing a breakdown or become entwined with another end causing multi-ply yarn on one of the bobbins, we had to reduce this problem. Consequently, we mounted the spools containing 40 ends on the doubling frame and found this to be highly effecient as it minimized breakouts and much reduced the change-over time when reloading spools. The spools can also be set up to feed much faster modern ring doubling machines by mounting them in an 'A' frame similar to the single-end winding machine.

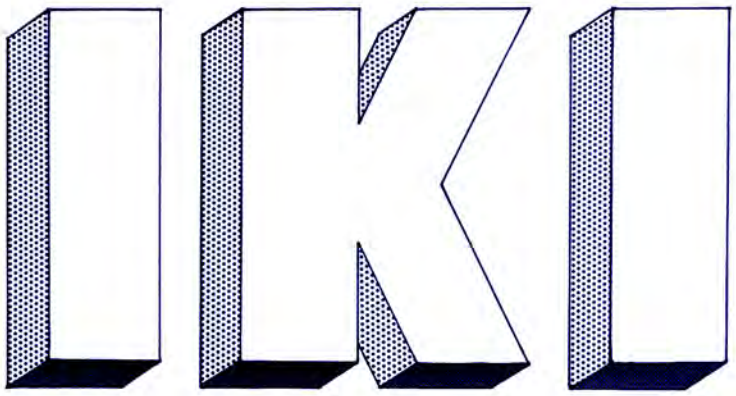
For knitwear it is important to produce a balanced twist when doubling so that when the fabric is washed and tumble-dried it does not skew off square. The best way to ascertain this is by trial and error; that is to take some yarn, double it, knit a trial square, wash and tumble-dry it. If it skews towards the bottom left there is not enough twist and the opposite means too much.



IV. DOUBLING (continued)

To give some indication in 2-ply 6.5s NE, we use 7 turns per inch, and in 3-ply 5 t.p.i.

N.B. The larger the bobbin on the doubling frame the better as it reduces the number of knots in the cone of yarn used for knitting.



V. DYEING AND CONTROL OF COLOUR

In considering what depth of colour and penetration is required, the following principles have to be taken into account:-

1. The thicker counts of yarn require proportionally higher dye penetration and finer counts less.

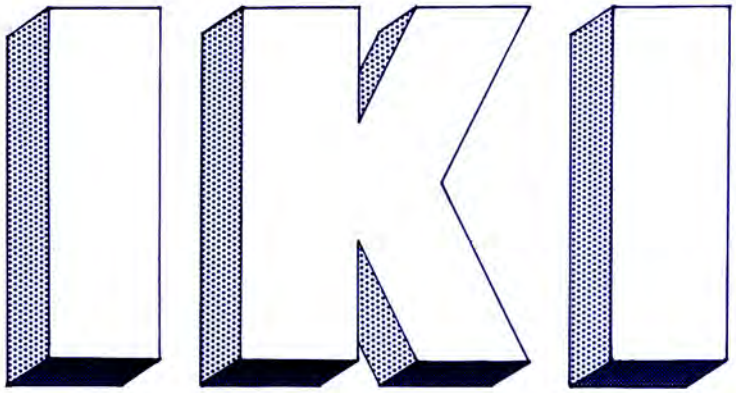
2. Doubled yarn is subject to friction and requires higher dye penetration than single yarn.

3. The tighter knit structures require lower dye penetration than slack or laid-in yarn (loopface construction). For example, sweatshirt ribs will remain darker than the body fabric after washing when both are knitted from the same yarn.

4. It becomes impractical to dye much finer than 16s NE and maintain sufficient white core for a denim effect.

The dyeing of 6.5s NE for doubling and for use as a laid-in yarn on loopface type fabrics requires higher penetration than normal denim warp dyeing. There are two ways of achieving this:-

1. Increase the effect of scouring and wetting out by raising the temperature and adding extra washing soda and wetting agent. Then increase the immersion time in the indigo by slowing the dye range throughput.



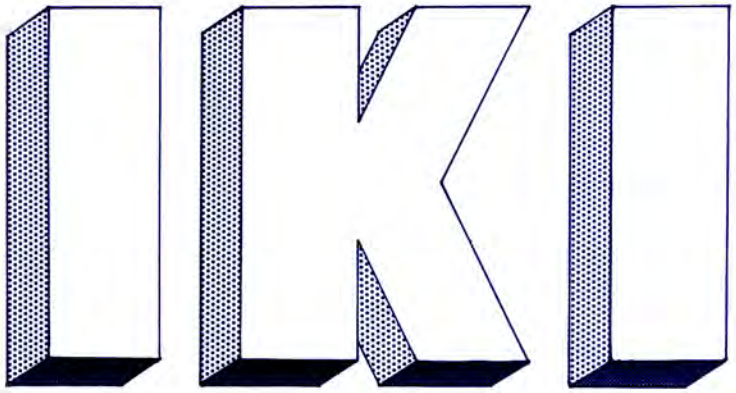
V. DYEING AND CONTROL OF COLOUR

2. Run the rope through 20% caustic soda solution, followed by a rinse bath containing dilute acid to neutralize, then into the dye range. The caustic will effectively mercerize the yarn giving a greater affinity with the dye thus producing a darker colour in addition to increasing the penetration.

It is worth noting that the extra conditioning of the yarn will reduce the possibility of streaky dyeing which must be avoided at all costs when producing yarn for knitting.

For the production of ribs for sweatshirts and, elasticated, for jacket trims, 10s NE would be ideal with a relatively low penetration. This yarn would be knitted on 12- or 14-gauge machinery.

For sweatshirting and single jersey fabrics (heavy quality T-shirts), a 16s NE with very low dye penetration is required while maintaining a dark colour; therefore, it should be dyed in a strong dye liquor with a short immersion period.



VI. WEAVING

A beneficial spin-off from obtaining indigo-dyed yarn for knitting is the design possibilities for weaving.

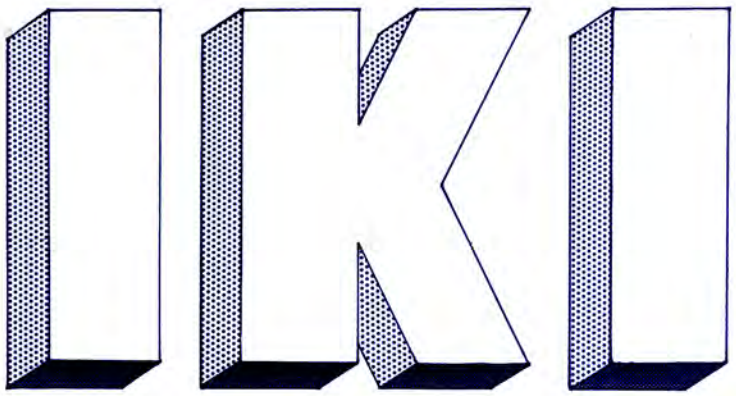
As weft yarn it can be used for checks (plaids) and jacquards, plus the doubled and multi-fold yarns can be woven into heavy textured fabrics. These fabrics cannot be achieved by piece dyeing because of their weight, and the effect would not be the same.

By putting on a PVC backing or bonding, they can be used for footwear and baggage and have a very attractive appearance which improves with ageing.

The best jacquards are woven on machines geared to the production of furnishing fabrics. These machines usually use a fine warp and a more dominant coarse weft. Using 6.5s indigo weft, very different looking fabrics can be obtained by using, for example:-

- 16s ecru warp (denim)
- 16s indigo warp (solid indigo)
- 16s dyed warp (recommend either pastels or black only).

Regarding checks (plaids) or other pattern weaving, where the warp is dominant - as in a twill or herringbone construction, it may be more economical to pressure-dye on cone with indigo. There is no fade-out effect from abrasion but the colour will be visually the same as the warp especially when subject to bleaching.



VI. WEAVING (continued)

To achieve package-dyed yarn, the following method may be employed:-

1. Load pressure dyeing vessel with appropriately wound packages of yarn.

2. Fill with between 10% and 20% caustic soda solution at 20°C and vacuum-extract after five minutes.

3. Rinse by flushing through with cold water and vacuum extraction.

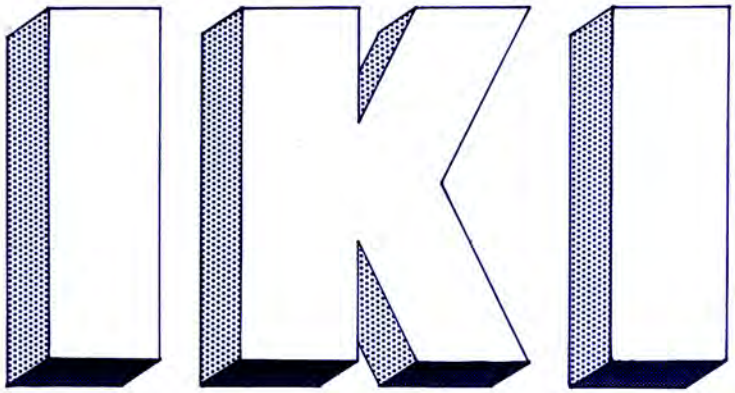
4. Fill with indigo dye solution for two minutes and vacuum-extract for five minutes to oxidize.

5. Repeat as necessary to build up shade.

6. Rinse off by flushing through with weak solution of perborate or percarbonate (to oxidize any remaining indigo in a reduced state) at 40°C and vacuum-extract.

The dye mixture should be made up from the following per 100 litres of water:-

. 100% indigo	8.0 kg
. Sodium Hydrosulphite	6.0 kg
. 100% caustic soda	6.2 kg



VI. WEAVING (continued)

N.B. It will be tempting to increase the amount of hydrosulphite to reduce the risk of fouling pumps, etc., but this would cause an unattractive green hue to the yarn colour. It is far better to flush the machine through with hydrosulphite after each dyeing.

The advantage of pre-treating the yarn with caustic soda is that it will increase its affinity with the indigo but if it is a 20% solution or more it will cause it to shrink as it is not under tension.

The indigo dye mixture can be retained and brought back up to strength by addition from a stock vat.

It is worth noting that yarn manufactured for knitwear but failing to meet the minimum quality standards for knitting will probably be perfectly acceptable for weaving purposes.

At present IKI makes use of all reject yarn by producing webbings for clothing trims, belt webbings or braided drawcords; all of which is a profitable addition to the business.

VII. KNITTING

In order to exploit the fade-down effect of the indigo dye, it is desirable that the garment should be capable of being machine-washed and tumble-dried just like a pair of jeans; therefore, due to the shrinkage inherent in any knitted cotton, this must be done before sale to the consumer. To best achieve this, whatever the type of knitting employed (with the exception of ribbing), the fabric must be knitted at a very slack tension so that when fully shrunk it retains a soft handle. If knitted tight it will, after it has been washed and tumble-dried, have the properties of cardboard.

To give an indication, on a 5-gauge sweater knitted with 3/6.5s NE yarn, the body piece would be knitted 50% longer than the finished garment. A 10-gauge fleecebacked fabric is knitted both 25% longer and 25% wider than the finished product.

To produce sweaters on flat bed machines, first a body blank is knitted at a slack tension, the rib being knitted tighter; also, two rows of strong elastomeric yarn are knitted single bed at the start of the rib to prevent its going slack with wash and wear. The body blanks are then washed at 60°C, hydro-extracted and tumble-dried. They are then cut and made up into sweaters in the normal way. Next the finished garment is washed at 70°C with washing soda and a dispersant, rinsed with a softener added, hydro-extracted, tumble-dried and pressed. The result is a garment presented with the fade-down process started, fully shrunk and ready to wear in much the same way as a pair of jeans is sold.

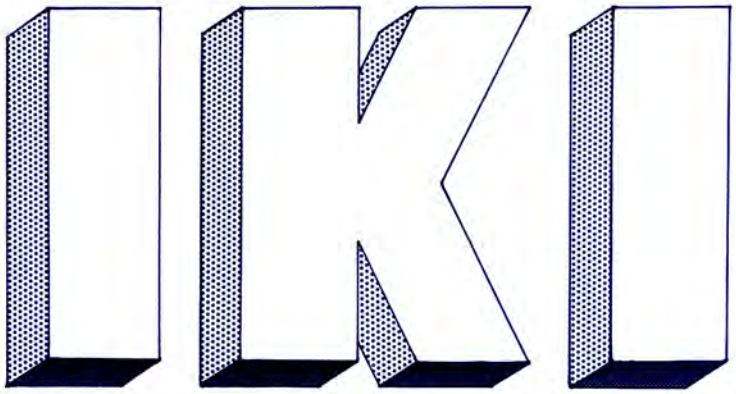
VII. KNITTING (continued)

A similar approach is the most appropriate for circular knitted fabrics when producing sweatshirt-type garments. It is best not to slit the fabric, but keep it in circular form and cut it into, at maximum, 10 metre lengths, wash and tumble-dry prior to laying up and cutting; this both stabilizes shrinkage and skewing due to its being single yarn and having a circular knitting twist. Then the cut garments are made up and wet finished as the aforementioned sweater, the only exception being the fleecebacked fabric which has to be scoured and brushed prior to shrinking.

It is virtually impossible to attain sufficient shrinkage and stability in knitted piece goods by calendering, peg-drying or any other finishing dryer.

An exception to this is a loopface (French terry) fabric knitted with a polycotton back. This is so because the knit structure is the 24s spun polycotton (50-50) knitted on an 18-gauge machine and the indigo is only laid in. This fabric can be knitted using dyed polycotton yarn, or undyed yarn which can have the polyester piece-dyed navy to produce a blue marl back. It is important for the fabric to be knitted so the back does not grin through the indigo face. Normal finishing will reduce the residual length shrinkage to 5% and width to zero.

The fleece currently made from IKI 6.5s yarn is a three-thread construction using 20s blue-dyed cotton for the tie-in yarn and 7s ecru condenser for the fleece. Although an excellent fabric it has two drawbacks. Firstly, it is very heavy making it expensive in cost per metre, and secondly, it skews dramatically. Ideally this fabric should be knitted on an 18-gauge machine using 16s yarn. If of a three-thread construction, it should be



VII. KNITTING (continued)

tied in with 40s matching dyed cotton and 10s ecru condenser. Alternatively, it could be of a two-thread construction in which case the condenser would have to be dyed a suitable shade of blue because with this construction it will grin through the face.

Another factor in knitting fleece and jersey type fabrics is the skewing especially as this is exacerbated by tumble-drying. Consequently, it is well worth looking at the possibility of using 'S' twist alternated with 'Z' twist yarn. The immediate objection is the necessity to mix batches, but it has been found that if two shades are mixed on alternate feeders the differing shades will blend into one. IKI is not currently producing 'S' or 'Z' twist yarn but it is planning to introduce it in the near future.

The use of high-twist single yarn for knitting can be problematic because it is lively and tends to snarl. This can be overcome by autoclaving which adds to the cost or by setting the knitting machine feeds up in such a way as to bring the yarn under tension when it leaves the cone.

There are more subtle factors to be taken into account when producing knitwear and these are best tackled as they arise.

VIII. MARKETING

Our experience to date has indicated some ground rules for this product: as it is a new concept it must be communicated in such a way as to capture the imagination of the consumer.

As a strategy it is necessary to keep the product up-market initially by only supplying well-designed brandnames. This type of manufacturer is more likely to promote the product, use it imaginatively, and not allow it to be sold in down-market outlets.

IKI has made it a condition of sale of yarn that the manufacturer identifies the garment in some way with the DEN-M-NIT logo in much the same way as they would use the wool mark on a woollen garment. This effectively identifies the product and distinguishes it from any imitations. IKI's customers have accepted the idea of using the DEN-M-NIT trademark as they feel it bestows exclusivity and shows it is a quality product.

Although IKI principally supplies yarn, it endeavours to provide good technical information along with design, styling and fabric ideas. The provision of trimmings is also appreciated by the manufacturers.

Advertising should be approached on two levels. The first is to put indigo in an exclusive context by using tasteful photographs and emphasising the myths, mysteries and ancient beginnings of indigo. The second is an educative process highlighting the innovative features of DEN-M-NIT. Because it has to be machine-washed and fully shrunk to

VIII. MARKETING (continued)

fade out, it becomes the first 'easy care' 100% cotton knitwear; prior to this cotton knitwear had to be handwashed and flat-dried or dry cleaned. It improves in appearance, gaining character with wash and wear. Only pure indigo-dyed yarn has this effect.

Presentation is very important in selling this yarn: it is necessary to have pictures or samples of well-designed garments and swatches of interesting fabrics.

The production of basic items on a cost conscious basis is not to be encouraged in the early stages of developing the market as they will either become just another piece of blue knitwear or will drag the market down, eventually killing any potential demand.

DEN-M-NIT is original, attractive and easy to wear. It should be able to carry indigo denim into a whole new sphere as it combines the comfort qualities of active sportswear with the long lasting characteristics of denim.

IKI

INDIGO DEN·M·NIT COTTON

REGISTERED TRADE MARK

THE WORLD'S FIRST
INDIGO DYED COTTON
KNITWEAR, MANUFACTURED
TO THE HIGHEST STANDARDS
FROM THE SAME YARN AS
DENIM JEANS.
IT CAN BE MACHINE WASHED AND
TUMBLEDRIED. GUARANTEED TO FADE
WITH WASH AND WEAR JUST LIKE
BLUE JEANS.
TOUGH YET COMFORTABLE.
ACCEPT NO IMITATIONS OF
THE ORIGINAL INDIGO

DEN·M·NIT

BRITISH PATENT APPLICATION No 8315210
U.S.A. PATENT APPLICATION No 507453

Made in the
UNITED KINGDOM
BY
INDIGO
KNITWEAR
INDUSTRIES

INDIGO DEN·M·NIT COTTON

REGISTERED TRADE MARK

INDIGO DYED COTTON
MACHINE WASH SEPARATELY
THIS GARMENT IS FULLY
SHRUNK AND TUMBLE-DRYING IS
RECOMMENDED TO MAINTAIN THIS