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D03695

Distr.
LIMITED

ID/WG.128/9
1[illegible] May 1972

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on New Techniques
of Yarn and Fabric Production

Manchester, United Kingdom, 19 - 22 June 1972

COTTON IN THE KNITTING INDUSTRY AND ITS FUTURE PROSPECTS

by

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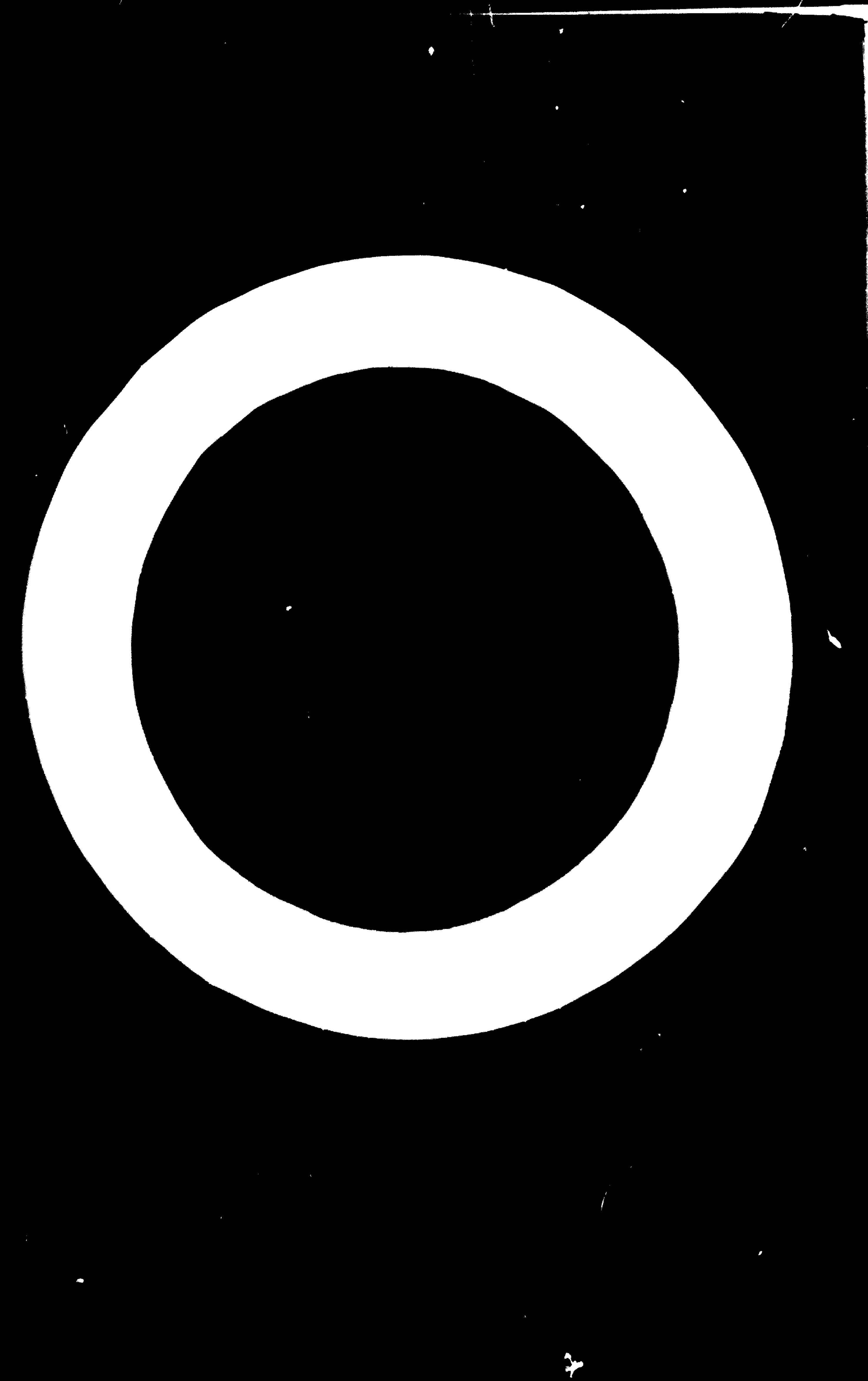

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UNIDO/I.I.C. EXPERT GROUP CONFERENCE - JUNE 1972

COTTON IN THE KNITTING INDUSTRY AND ITS FUTURE PROSPECTS

INTRODUCTION

Initially cotton and wool were the natural choice for raw materials in knitting. Cotton made its impact mainly in the underwear field; wool in the outerwear field. The end of the second world war saw an enormous demand for any sort of textiles and, seeing the potential, knitters started production of outerwear fabrics on existing machinery which up to that time had been turning out underwear fabrics exclusively. These machines had a high production rate but a very small scope for patterning. The fabrics were either plain interlock or small surface patterns. Terms like Milano rib, piqué etc. started to appear and are now becoming well known by the general public.

The underwear image of these knitted fabrics began to disappear and the public in general found that, far from being short-term substitutes for woven cloths, knitted materials gave added comfort in wear. As this trend continued both polyamides and polyesters were introduced and an extremely rapid expansion took place both in machine and yarn developments. This was to a great extent to the detriment of the wool industry. Cotton as it stood was a non-runner in the fashion field for weft knitted fabric, but its comfort factors could not easily be challenged by the synthetic yarns in the underwear field.

Warp knitters, seeing the boom taking place, were equally interested in a slice of the knitting cake. The synthetic yarns which were both very strong and uniform were ideally suited for warp knitting machines and in a short space of time warp knitting machines were constructed to knit at 1,000 courses per minute, and at such speeds cotton's last bastion in the warp knitting field had fallen. Sad as this was to the cotton producers initially it started a trend in the machine industry which was remarkable. It introduced new ideas in machine construction and strangely enough some of the innovation came from people who had no experience in the construction of knitting machines whatsoever.

The first really new development in the warp knitting machinery field, the F N F machine for instance, which achieved 1,000 courses per minute, was actually designed by aircraft constructors. They built their machines around a compound needle. Later, the conventional bearded needle machines were re-designed and similar or higher speeds were achieved also on this type of machine. None of these machines were really suitable for cotton unless extremely high quality yarns were used, and even then machine speeds had to be kept lower than those for which the machines had been built. With the passage of time the profitability of the warp knitting industry has dwindled. Today it is at a very low level. Consequently, the manufacturers are on the lookout for new products, and cotton is a fibre which has caught their imagination.

Problems are very much in evidence however, and machine builders are fully aware of these. One major factor is needle deflection caused by the rather uneven surface of the spun yarn. So it is not simply that there was a lack of enthusiasm on the part of the machine builders and spinners in finding a solution to the problem of knitting spun yarns satisfactorily. The machine builders tried to modify their approach by adding new features to existing machines. This resulted in unhappy compromises like the CO-We-nit machines. It also brought the development of weft insertion techniques. It does appear at this stage that weft insertion possibilities exist in specialised cloth constructions, but users should be warned against any over-enthusiasm for these machines until their potential can be evaluated more fully. Weft insertion will be discussed in greater detail later.

At this point it would be appropriate to say a few words about knitting as compared to weaving although this is discussed more fully later on. Weaving has long been a traditional method for producing fabrics. Knitting on the other hand is a much newer industry and new things always appear to catch our imagination. Besides, knitting as we know it is not a sort of 'father to son' industry with many closely guarded secrets and it is probably less difficult to establish a production unit as a knitter provided the essential technical know-how is available.
In addition the knitting industry offers fewer problems when changing from design to design than is the case for weaving; this again is a matter to be dealt with more fully later. Also, one can establish oneself without too much ancillary equipment and the starting capital will certainly be less. The fact that knitting has become an established means of production in the outerwear field has naturally encouraged more and more people to install knitting machines in their factories. This has resulted in further expansion and today even household textiles are prominently represented as an important end-use sector for the knitting industry.

It is clear that 100% spun fabrics can be produced on conventional warp looms using bearded needles or latch needles but this is not necessarily the most economic method. A new type of warp loom has been brought onto the market, which certainly has given the industry encouragement to think in terms of high-speed production of 100% cotton fabrics. This new machine is called the 'Copcentra'. It is a machine which is being built by Platt International in the United Kingdom and by Liba in Germany. In this machine the compound needle from the FNF warp loom has emerged in a new form and its unique shape has proved to be very resistant to needle deflection. Lint and fluff do not block the needles easily or interfere with their normal movement.

At I.I.C. this needle development has initiated knitting trials on a limited scale which have proved to be very encouraging indeed. In the main, consideration has been given to fabrics from the upper price ranges because it seemed likely that twofold yarns would be essential to meet strength and uniformity requirements.

To date, with weft insertion processes, one or two bars have been knitting synthetic yarns and the weft used has been cotton. However, we are negotiating with Continental machine builders to run trials of specially constructed 100% cotton weft insertion fabrics which incorporate Prograde yarns. We have great hopes for these trials.

The interest in natural fibres has been just as marked in the weft knitting field as in warp knitting. The enormous demand from knitters for polyester and polyamide yarns has not merely levelled out but the glamour of certain synthetic trade names has waned. Natural fibres are reappearing as knitting yarns and finding ever-increasing demand. This trend comes at just the right moment to correspond with other technical developments. The new Prograde (liquid ammonia) cotton yarns are providing all the properties for easy-care which have been sought, and recent modification of the process promises much cheaper installation costs for plants capable of treating this type of yarn.

Together with the existing capacity for producing conventionally mercerised yarn, prospects for treating a larger quantity of mercerised cotton yarns do exist even though the situation is far from satisfactory at present. The future will provide, we hope. On the other hand, this is only one side of the cotton knitting story.

Over the past few years several Continental firms have started mercerising knitted fabrics in fabric form.

These fabrics appear very stable to washing. They have a high degree of lustre, enhanced drape and increased affinity for dyestuffs, enabling brighter colours to be obtained in garments from such fabrics. Again, this is by no means the end but rather the beginning of a long-deserved comeback for cotton in the apparel field.

Although the knitted underwear market will remain a very strong one, cotton as such is unlikely ever again to be classified as fabric with an 'underwear image'. On the contrary, it seems likely that cotton will gain a real stronghold in the knitted outerwear field.

There are also new spinning systems coming into being, as for instance, twistless spinning, which promises great things for the future of the knitting industry.

Although it is very likely that an audience like this will be well acquainted with the different methods of textile production, it may be useful to give a short description of the three basic methods of production, namely weaving, warp knitting and weft knitting. Fig.1

Weaving employs a sheet of yarns to form the warp and a single end of yarn to form the weft. The warp yarns are wound on to a beam to form the lengthwise direction of the fabric. These warp yarns are separated by heald shafts so that a shuttle, rapier or some other method of weft insertion can take a weft yarn from one side of the divided warp sheet to the other in a to-and-fro motion. The up-and-down motion of the warp threads (shedding), weft insertion (picking) and firming-in of the weft (beat-up) allow the yarns to bind together to form a cloth.

Warp knitting is similar in a way to weaving; similar because warps are required by this method of production as well. Except that in the case of warp knitting each end of yarn from the warp beam is applied to the knitting needles. Needles can be of three types; i.e. bearded needles, latch needles and compound needles. The yarns are fed to the needles through yarn guides which move between the needles, swing around them and thus allow for yarn to be fed to the needles. This, again, allows these yarns to form into loops. Patterns can be obtained by moving the yarn guides sideways in pre-determined sequences and also by using several warps and guide bars.

Weft knitting also employs needles which could be of any of the three types already mentioned as used in warp knitting machinery. However, mainly latch needles are being used, although some machinery, especially in fine gauges, make use of bearded needles. In weft knitting, unlike warp knitting, each needle in sequence receives one and the same end of yarn, which again forms loops.

Methods of Fabric Production

These are the three basic methods of mechanical fabric production. Of course, different kinds of specialised machinery is made to deal with the many different types of fabric required in the textile industry, but to go into detail on this would require far more time than this paper permits. Major manufacturers of knitting machinery are listed in the Appendix. It is necessary, however,

to explain the more common terms. For instance, single jersey means a fabric made from one set of needles in a weft knitted construction. Double jersey is a weft-knitted construction produced on two sets of needles forming a double or twofaced fabric.

On the weft knitting side, jacquard patterns can be made by selecting needles to become active or remain inactive. Virtually any type of design can be made in conjunction with a choice of colours.

In the warp knitting field the method employed to obtain patterns has been explained already. What has not been explained so far is weft insertion in a knitting context. Weft insertion is a combination of knit ing and weaving. In addition to the conventional knitted loops a weft yarn is placed across the entire width of the machine and is locked in between the loops. This gives a resultant fabric with a fair degree of rigidity which is similar in many ways to woven cloth. However, whether it is a desired effect in knitted fabrics (apart from special end-uses) is a different matter. There seems to be a marked tendency for the weaver to attempt to imitate knitted fabrics and also for the knitters to imitate woven cloth. This can restrict the development of new ideas. A typical example would be the slow penetration of knitted fabrics into the menswear field. Here, not only do the knitters copy woven designs, they also copy the conventionally tailored suits for which weft knitted cloth is not the most suitable by any means.

Fig.2

What has to be considered is the feasibility of cotton's performance on modern knitting machines. Good quality cotton yarn, either single or double, creates no real problem in weft knitting. There is, of course, the problem of fluff and lint, but nearly all the modern machines have some device or other to deal with this. One thing in cotton's favour is prolonged wear life for the needle in the knitting machine as compared with machines running on synthetic yarns.

In warp knitting the case is entirely different. Polyester and polyamide yarns are ideal for warp knitting due to their smooth, even surface and their high breaking strength. Spun yarns invariably have thick and thin places and fluff protruding from the surface. At high speeds such flaws in the yarn invariably cause faults and to reduce speed is often a great drawback from an economic point of view. On the other hand it must be borne in mind that fashion (or indeed the customer's wishes) do not take production problems into consideration. This is something that warp knitters in most European countries are experiencing at present. The fantastic boom in the warp knitting of synthetic yarns has resulted in lower and lower profitability as more and more machines are put into production. At the same time fashion changes have occurred and there is a marked trend towards a spun look in warp knitted fabrics, too. For such fabrics the choices are wide but they also suffer from problems equal in magnitude to those experienced with conventional cotton yarns. The best results appear to be obtained from twofold yarns but the demand for high quality in such yarns is great. Very often it is common practice for knitters to make use of blends of synthetic and natural fibres presumably because they think such yarns will perform better than an all-natural fibre yarn. This may well be the case if the natural fibre yarns are of low quality, either because of the raw materials used or because of the actual spinning of the yarn. I do not claim to be an expert in yarn spinning, but as I work for I.I.C. my efforts so far have been concentrated on work with 100% cotton, and it is from this angle that we have considered the problem.

Our first thought was to look at the machine we considered most suitable for the initial knitting trials. Our choice fell on the Copcentra machine which is made by Platt International. The reason for choosing this particular machine was the sturdily constructed compound needles with which it is equipped. We believed this type of needle would not suffer from deflection providing yarn quality was of a reasonably good standard. Our yarn choice was liquid ammonia-treated combed American cotton of 2/60^s English cotton count. This yarn was knitted at Platts on a 21-gauge machine running at 780 courses per minute. At this speed the fault rate recorded was as low as only one per 100 yards of fabric. We feel confident that acceptable fault rates on this machine and with this yarn can be obtained at even higher speeds.

Knowing the limited availability of liquid ammonia-treated yarns it was felt that equally good results would be obtained using conventional first rate yarns. Naturally, as we were very encouraged by our results, our thoughts progressed to warp knitting of single end yarns. In this case we chose a conventional mercerised $1/60^s$ English cotton count combed American yarn which had been mercerised in a continuous operation by the American firm, Dixie Yarns Incorporated. Surprisingly, no real problems occurred in knitting on a 28-gauge Copcentra machine, although the fault rate was considerably higher than for the twofold yarns in the previous trials. But we were running these trials at no less than 1,000 courses per minute. At last we know cotton can perform quite satisfactorily in warp knitting. Whether we are limited to the Copcentra type of machine for high speed performance remains to be seen and we are investigating other machine types such as Mayer and Barfuss to establish their performance.

<u>Economic Aspects</u>

Now it is appropriate to look at the comparison between
Fig.3 warp and weft knitting, as well as weaving, from an economic viewpoint and also to see what growth area
Fig.4 has been estimated for the future. Direct cost comparison between weaving, weft- and warp knitting, is very difficult for many reasons. Prices of machinery vary considerably according to machine type. A weft knitting machine can cost anything from a few hundred pounds up to the teens of thousands.

Warp knitting machines fall into a price range between two and a half and ten thousand pounds, weaving machinery also varies according to type but is usually cheaper on a unit basis. The types of outlets differ, for instance for outerwear, underwear, furnishing and many others. Most of this section of the paper is based on information and figures collected by Dr. Ing. G. Bröckel of Sulzer Bros.

Weaving is by far the largest of the group with 83% by weight of the world wide market and the remaining 17% in knitted fabrics. However, if carpets and the industrial woven cloths are disregarded, it will be found that only 48% remains as standard woven cloth, and then the 17% comparison with the knitting industry becomes more significant, especially as this increase has been very rapid indeed. No doubt the reason for this rapid growth has to a great extent been due to the efforts by knitting machine manufacturers to gear their machines to such a high production rate and improve fabric qualities from these machines. Producers of weaving looms appear to have been less quick off the mark. However, new weaving techniques have been developed and machines with weft insertion rates close to 900 metres per minute have been developed.

A standard dresswear fabric weighs normally approximately

Fig.5 200 to 250 grammes per square metre. Sulzer compare the cost of the production of two similar cloths, one woven, the other knitted; both weighing 235 grammes per square metre. In the knitted fabric a spun yarn 1/40[s] (25 tex) was used, and in the woven cloth 1/19[s] (52 tex) was used. The exercise was based on a yearly production of 2,500,000 metres on a three-shift basis. To achieve this production the following machines would be required:

Weaving - 48 weaving looms, 85 in. wide with a production rate of approximately 9 metres per hour.

Knitting - 28 48-feeder circular machines would be required; these machines would have a production rate of approximately 15.7 metres per hour.

Fig.6 **CAPITAL INVESTMENT**

As the knitting machine purchase price is considerably higher than the price of weaving looms the smaller
Fig.7 number of knitting machines required virtually evens out in terms of machine cost. However, if beaming equipment and finishing equipment plus buildings are to be considered the investment cost for the weaving side would be 67% higher than for the knitting side of the exercise.

PRODUCTION COSTS

Actual production or manufacturing costs are dependent upon a whole series of factors. These will differ from country to country because of such items as depreciation time allowance for the machinery, labour costs, taxation on capital investment, ground rents and rates and a number of other factors. Again, basing the information on the figures given in the Sulzer Report (and this report is tied to Swiss conditions which would be fairly representative for a European country), depreciation accounts for 33.2% in the case of weaving; in knitting the depreciation cost is calculated at 38%, whereas wages account for 24.6% and 28.2% respectively. Floor space is considerably less for knitting than for weaving but still only accounts for 4.1% for weaving and 1.6% for knitting. Other important factors include mending costs; although knitting displayed a higher fault rate than for weaving, the knitting faults are much easier to mend and the mending costs are estimated to be less than half that of woven fabrics (29.2% against 11.6%). However, the mended woven fabrics give only 4.6% by way of second quality merchandise as opposed to 17.5% seconds in knitted fabrics. This is, of course, a very important factor.

Calculated production costs for knitted fabrics represent only a slight increase above woven cloth.

One would estimate that raw materials and wages in the two industries would tend to follow each other. It is, therefore, very likely that if less mending can result from improved weaving looms then production cost in the weaving sector would be greatly improved. However, to establish a true picture of production costs there are other factor influencing the cost of the final product. These include the different finishing procedures and the yarn counts used in the two processes of production.

Since finer yarn counts are used for knitting, yarn costs are approximately 10% higher than the weaving yarn costs. The finishing costs of the knitted fabrics are approximately 7% lower than woven cloth and, consequently, there is only 3% higher cost for the knitted fabric in total. From these figures it is
Fig.8 to be concluded that a changeover from weaving to knitted of standard or bulk production is not a very likely outcome. A quicker changeover, particularly in weft knitting, for smaller quantity orders is another matter. In such cases weft knitting has a definite advantage.

If we take manufacturing costs to be at 100% for woven cloth we find the following picture; production cost
Fig.9 is 10.3% for weaving; 10.5% for knitting. Finishing cost (including dyeing) amounts to 41.3% for weaving,

38.9% for knitted fabrics. The raw material cost for the knitted fabric amounts to 53.8% as opposed to 48.4% for woven fabrics. The manufacturing cost comes out at 3.2% to the advantage of the woven fabrics.

PRODUCTIVITY

The linear production of double jersey knitting machines is, as previously stated, approximately 75% higher
Fig.10 than that of weaving looms. This, however, does not mean an equal reduction in labour force. The 48 weaving looms mentioned require 8 operators per shift. In addition a further 4 people are required for additional labour on one shift only. To operate the 28 knitting machines mentioned, 10 persons are required per shift which means virtually equal labour force for the two types of production. There is a slightly higher requirement for menders, however, in the weaving section. This is normally done on a single-shift basis only. So looking at the two types of production there is very little difference from a production, productivity or investment savings point of view. The reason for the increased popularity of knitted fabrics must consequently be sought elsewhere.

The latter years have seen a growing demand for quick
Fig.11 changing fashion and a lessening demand for the previous conservative and quality type of fabric. The weaving industry demands a considerable amount of

preparatory work and consequently long runs are desirable. It is also essential that no mistakes in fashion shades are made since it is difficult to alter the final products after beaming of the coloured yarns has been carried out. But weaving has a real advantage in the wide range of yarn counts with which a weaving loom can cope; this is not the case on knitting machines where the count range is far more restricted and where the yarns used are normally far finer than those used in the weaving trade.

If we consider weft knitting the picture is different. Changeover, from one quality to another or to different designs, can be carried out in a very short span of time and virtually all preparatory work is eliminated apart from changing of cones. Pattern scope on modern weft knitting machines is large and the machine can operate with two, three or four colours at a time. The range of suitable yarn counts is very small however compared with weaving, consequently these knitting machines turn out fabrics which are very similar in weight and character. These drawbacks do not apply to weaving machines.

In circular knitting, fabric width is also limited to that of the circumference of the knitting machines, while weft knitting machines are also sensitive to such factors as yarn twist, as well as slubs and impurities in the yarn, to a greater degree than is the case for woven fabrics.

Factors in favour of weft knitted fabrics include such characteristics as elasticity, which adds to comfort in wear.

Modern weft knitting machines are becoming more and more complicated, however. The increased number of knitting elements, the sophisticated and elaborate stop motions and fault detectors, and the stresses imposed on yarn due to increased knitting speeds, are problems in themselves.

There is also a tendency to incorporate electronic devices for patterning in order to increase patterning potential on weft knitting machines. These problems impose a burden on the technicians and mechanics handling these modern machines; essentially such people must have acquired wide and varied knowledge of knitting machinery and must be highly skilled mechanically. Such highly qualified people are in great demand by the industry. This is stressed because wages for technical staff of this type are high and these payments must influence production costs to some extent.

So far only weaving and weft knitting have been considered. The warp knitting and Raschel knitting side of the industry is, however, a very important part of the total textile production as such. To compare costings for fabrics made on warp looms and Raschel machines with those produced on weft knitting machines and weaving looms is rather difficult since fabrics from these machines usually are entirely different in character.

For Raschel fabrics the bulk of production has been used for foundation garments and for lace fabrics, whereas
Fig.12 on conventional warp looms, nets and ladies' underwear fabrics have been the dominating outlets. Apart from the shirting fabric area which experienced its boom in the warp knitting field some five years ago, since when there has been a steady decline, an immediate breakthrough into outerwear on these machines cannot be expected. It will be a rather slow process but there is reason to think that the trend towards natural fibres will penetrate the outerwear market more rapidly than has previously been anticipated on warp machines.

No exact figures can be given for installation and production costs due to the very many types of machines and fabric constructions. However, installation outlay for warp knitting plant and machinery is lower than both weaving and weft knitting sectors for the same volume of production. Drawbacks include the cumbersome patterning devices which are required and the need for yarn preparation prior to knitting. These are minor drawbacks only, of course, and unlikely to hinder further expansion in this part of the textile industry.

Fig.13 In a survey carried out recently by the Shirley Institute a clear indication is given of the importance of warp knitting as an industry. Table 13 analyses the end-use categories of warp-knitted fabrics in millions of pounds for the year 1970.

Although the ladies' underwear and nightwear and men's shirtings are by far the main outlets for warp knitted fabrics, the outerwear field is already quite important at this stage and, understandably, it is in this field that growth potential is greatest for the future. At present, warp knitting accounts for approximately 10% of all textile produced. But there has been a decline, undeniably, in the figure for warp-knitted fabrics of the conventional type and manufacturerss are thus looking for new products.

As mentioned before, spun yarns have been the obvious choice. It is, however, no simple task to change completely from continuous man-made fibres to spun yarns. Modern warp-knitting machines were made to produce fabrics from continuous filament yarns and their fine gauge construction has caused no real problem with the smooth, even surface of these yarns.

The problems of fine gauge machinery and the use of spun yarns are formidable where bearded needle machines are concerned. A solution which has occurred to some manufacturers has been to rebuild their existing machine in coarse gauge. Using 18 needles to the inch permits the efficient use of spun yarns on those machines.

Weft Insertion

Other solutions as mentioned have been to modify machines by adding new features and I think that the most significant of these is the weft insertion technique. A weft insertion device can be fitted either to a Raschel or a warp knitting machine which additionally needs some apparatus for laying-in a weft thread across the entire width of the loom. This gives a rigid fabric construction, somewhat similar in behaviour to that of woven cloths.

Fig.15

There are several types of weft insertion, all of which seem to be performing satisfactorily. One of these systems has been chosen partly because this particular system offers a good solution technically and partly because to go into the fine detail of each type of weft insertion method would take far too long in a paper of this kind.

The weft insertion technique is the Weft-loc made by Liba and Platt International. This particular system uses 24 yarn ends taken from a creel at the rear of the machine. The 24 yarn ends are threaded through tension devices, and fed to a weft carrier which moves from side to side over the entire width of the machine. When the needle reaches its lowest position the yarn is laid-in, one end at each course if required, although patterning can be achieved over a 24 course repeat. Knitting speed is not affected in any way; a special vacuum device removes loose ends and trims off each selvedge. The weft insertion facility does allow a variety of yarn types and yarn counts to be used and as the laid-in yarn does not take part in the actual loop formation, thick and thin places in the yarn are of minor significance. Lack of uniformity can actually be turned to advantage inasmuch as fancy yarns can be used for special effects. It must be emphasised that this is just an addition to the existing vast range of warp-type knitting machines. It can hardly be expected to occupy more than a small share of the market, and then most likely as a replacement for some woven cloths rather than warp-knitted fabrics.

OPPORTUNITIES FOR COTTON

Finally, it would be appropriate to consider briefly those aspects of production which seem to offer the greatest opportunity for cotton as a fibre in the knitting field. (Fig.16) There are so many factors governing the choice of fabric types and production methods that no really decisive advice can be given. We know that cotton creates no real production problem in weft knitting and weaving. We know that certain types of warp knitting machines also are quite acceptable to cotton and we feel confident that when Prograde yarns become readily available most of the existing types of warp knitting machines will be able to cope with natural spun yarns even at high speeds.

There are, however, special considerations to be taken into account when establishing a textile manufacturing unit. For instance, it must not be forgotton that weaving and warp knitting require a great deal of preparation such as beaming and winding and often sizing of yarns. Other factors of importance are proper finishing equipment for the given type of production. Easy-care performance is so desirable and one must ensure that the finished garment will reach the desired wear standards. Another factor is that ambient atmospheric conditions in the factory will determine whether air conditioning or humidifiers are required. Naturally controlled humidity and temperature are desirable in every case, but there are many situations where existing conditions will suffice.

The choice then is rather one of market analysis, capital availability and, possibly of equal or greater importance, technical skill in operating machines. The most efficient production planning, market expertise and salesmanship all rely upon efficient handling of the machinery if optimum production is to be extracted from the existing knitting plant.

TRAINING:

Knitting machines are extremely complicated pieces of engineering and it is vital that those responsible for their operation and maintenance receive adequate training. Courses for technicians and mechanics are provided by some of the machinery manufacturers and by colleges and universities in the developed countries. The IIC Technical Research Division is prepared to give advice on these matters.

NEW MACHINERY DEVELOPMENTS

The number of machine builders are many and very few are specialised in one particular type of machine. To go into detail of each type of machine and its merits would be extremely difficult. However, it may be worthwhile mentioning a few. Moratronic, which was developed by Morat (now part of the Sulzer organisation) was the first real breakthrough utilising electronic patterning devices. This machine has a pattern area which is limited in width only to the circumference of the machine; in depth, the pattern area can exceed 62". Other interesting new types of machines have been introduced with mechanical patterning devices and I would like to mention the Mayer & Cie rib jacquard machine (model OBJA-36-H) which in addition to conventional jacquard patterning also can produce plush jacquard. In the warp knitting field the firm Karl Mayer has introduced a new machine (model KC 4) which operates with a swinging needle bar which reduces the time needed for the guide bars to pass through and clear the needles. Barfuss of West Germany has introduced the Turbotex weft insertion machine. On this machine the weft yarn is laid across the machine between a pair of rotating star wheels, one at each end of the guide bars, and a propeller-type device delivers the weft to these star wheels. The star wheels hold enough yarn for seven complete traverses and consequently the danger of weft breakage is reduced.

There are other, equally important new machine developments, but mention must be made of some of the new developments carried out at the technical research division of the International Institute for Cotton. A major effort has been made to introduce Prograde or liquid ammonia-treated yarns into the knitting industry. We have successfully established correct knitting and finishing methods for these yarns in the whole field of weft knitting and also twofold yarns in warp knitting. New trials are being carried out with single-end Prograde yarns both for the warp and weft knitting sections. In another area, the use of conventional ring spun yarns for knitted ladies' dresswear and men's shirts is being stimulated and exploited. Other activities include fabric mercerising and the use of twistless yarn in knitting. Methods of bulking cotton yarns for knitting processes are on the development programme together with simplified and better finishing methods, both for these new fabrics and for more conventional products.

Finally, it should be noted that in the typical textile areas such as Leicester for knitting, and Lancashire for weaving, technical staff are available - at a price. The problem in recruiting qualified technical staff, and in particular qualified and competent mechanics outside these areas, is acute. When a decision has been made as to the type of fabrics to be produced, then one should choose the simplest kind of machine available which is capable of doing the job. This will enable the operators to get acquainted with the equipment and, given time, they will progress towards the more sophisticated types of machinery which will follow.

Modern textile machinery can be very expensive and one should beware the temptation of choosing a Rolls-Royce when a Volkswagen will perform equally well.

STOFFPRODUKTION DURCH

CLOTHPRODUCTION BY

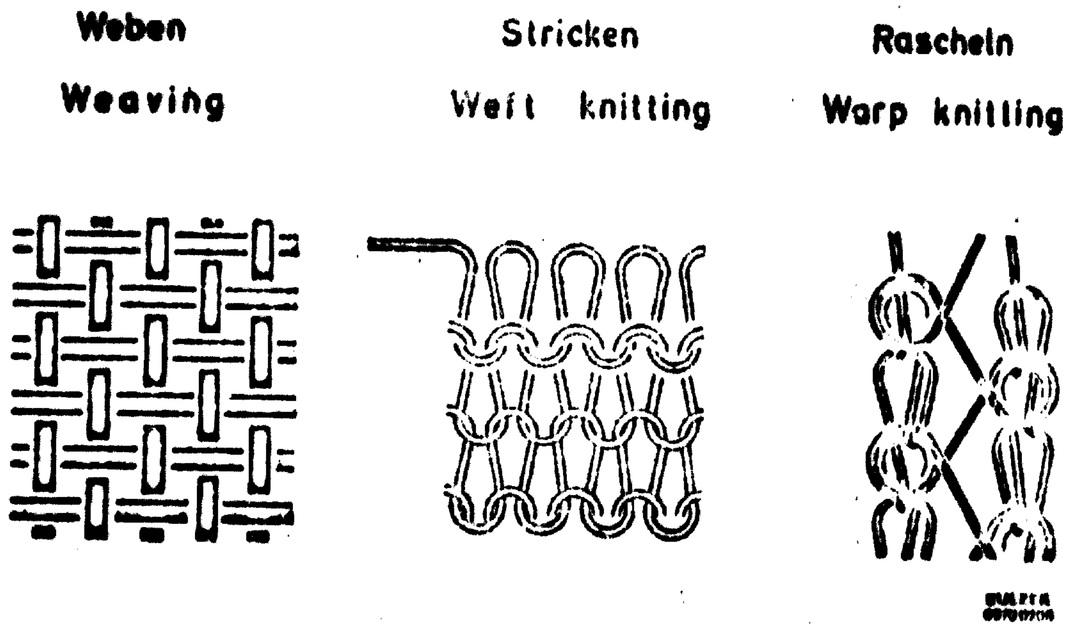
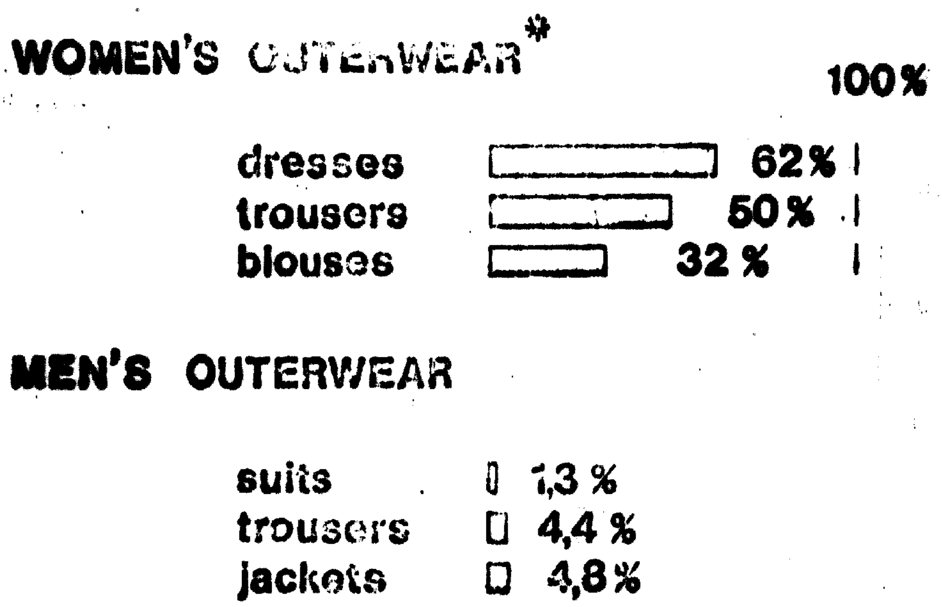


FIGURE 1

SHARE OF KNITTED GOODS

(1970 IN WEST GERMANY)



* Source: GfK panel

FIGURE 2

PRODUCTION OF (STANDARD-) WOVEN AND KNITTED GOODS IN THE EEC + EFTA (WITHOUT FINLAND)

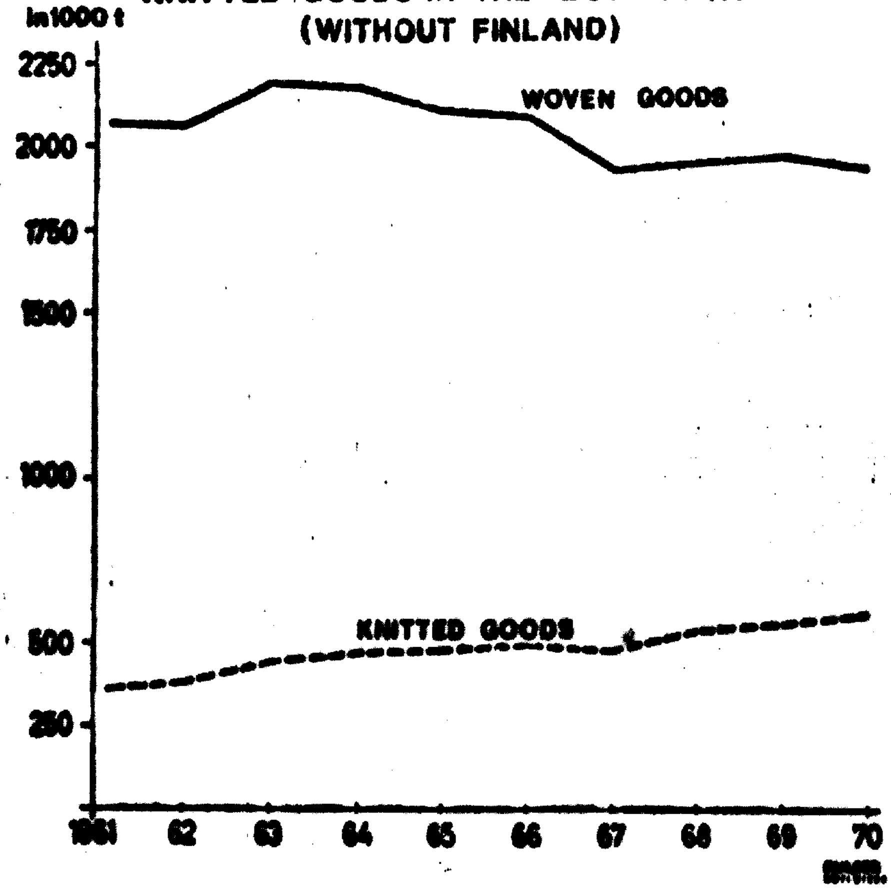


FIGURE 3

PRODUCTION OF (STANDARD) WOVEN AND KNITTED GOODS AND FORECASTS UNTIL 1975 IN THE EEC + EFTA

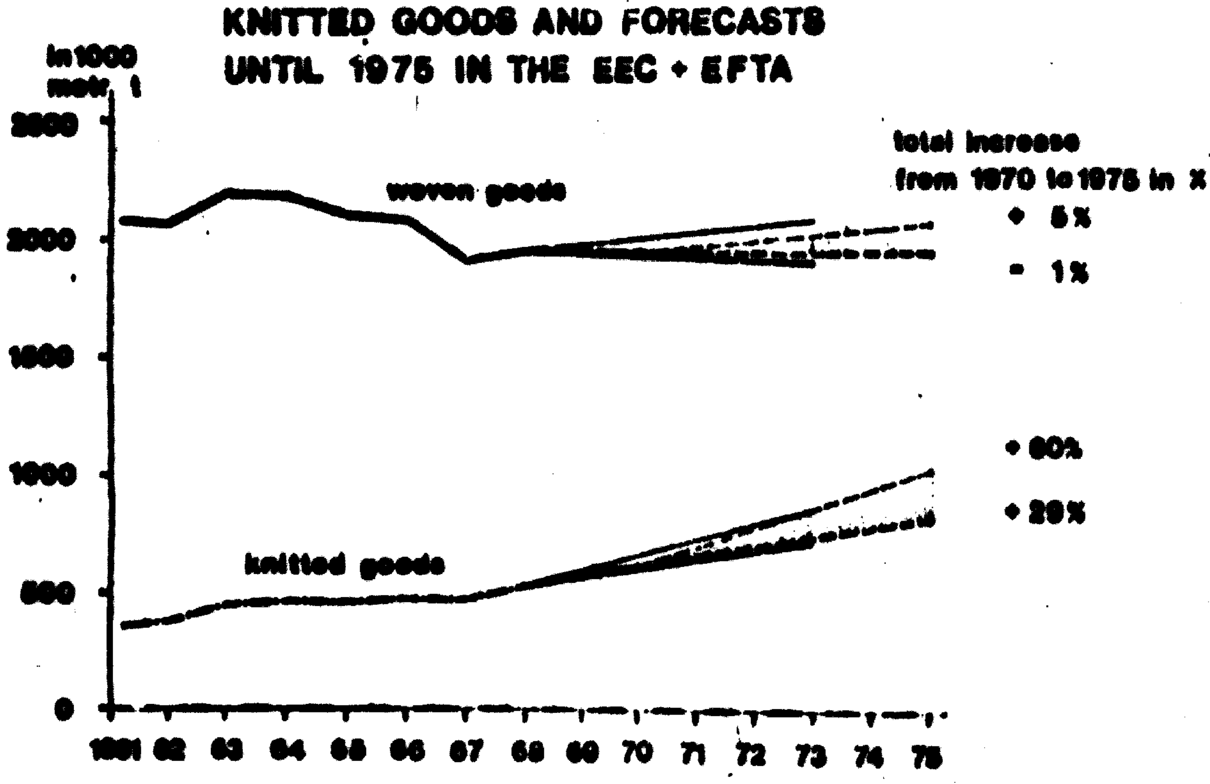


FIGURE 4

A. ARTICLE SPECIFICATION

TYPE OF FABRIC	WOVEN	KNITTED
ARTICLE DESIGNATION:	light women's outerwear	
DENSITY: warp threads or wales	20	13.5 (2 systems)
picks or stitches/cm	18	14
FINENESS in Nm: warp/stitch	19/1	40/1
weft/stitch	16/1	
MATERIAL:	wool/synthetic (unbleached white)	wool/synthetic (unbleached white)
RAW WIDTH: cm	158	163
WEIGHT in g/m2: raw	220	215
finished	235	235

FIGURE 5

CAPITAL INVESTMENT COMPARISON BETWEEN WEAVING AND KNITTING MILL

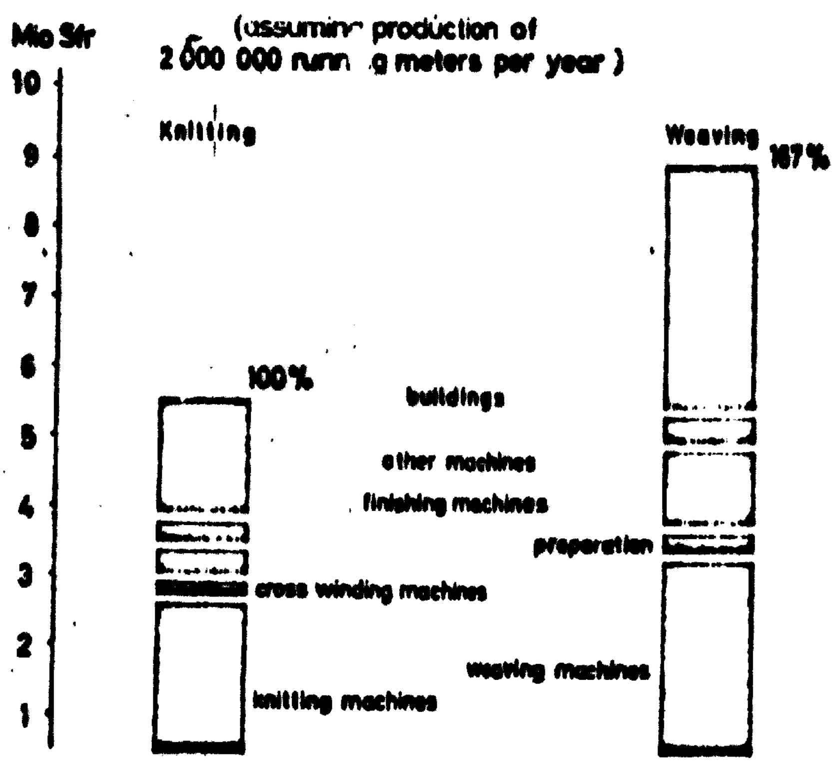


FIGURE 6

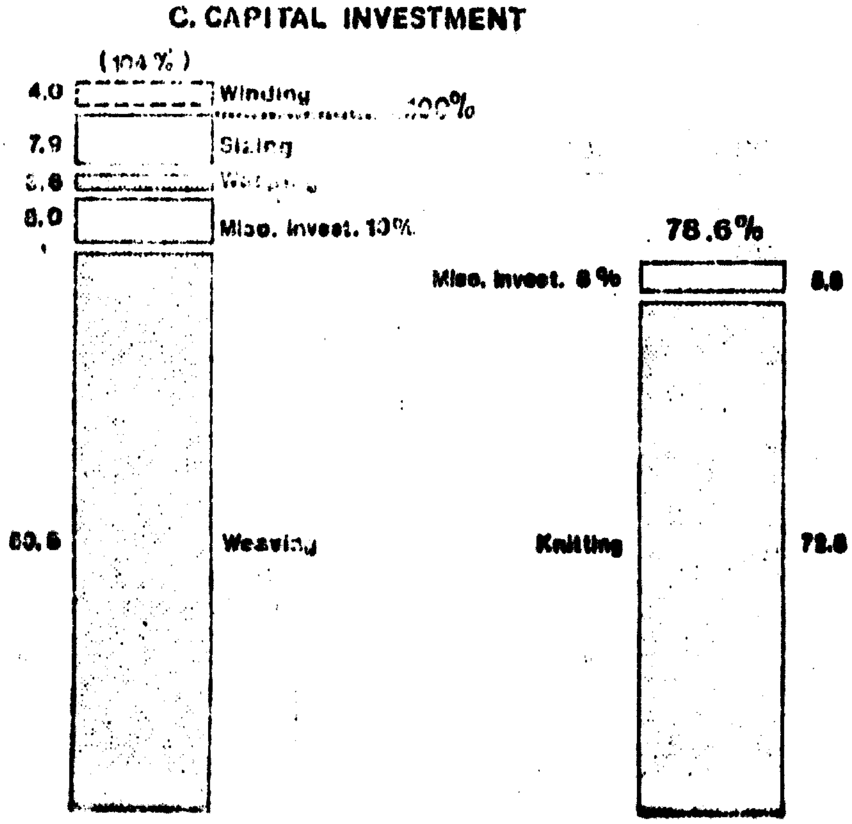


FIGURE 7

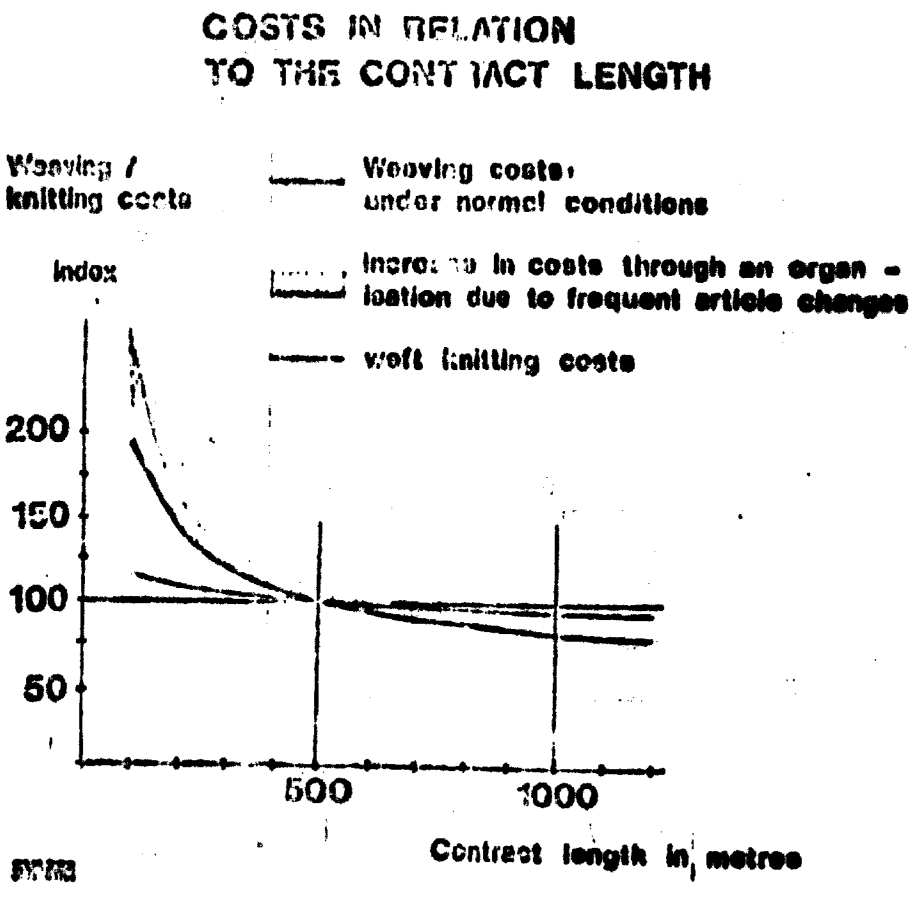


FIGURE 8

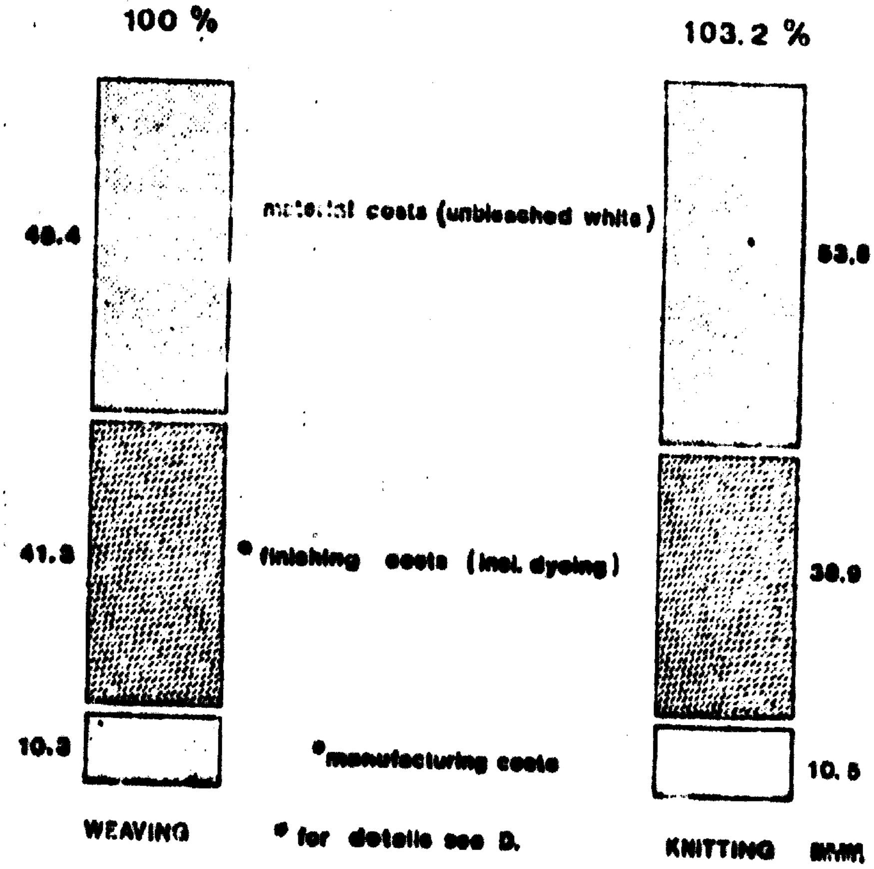
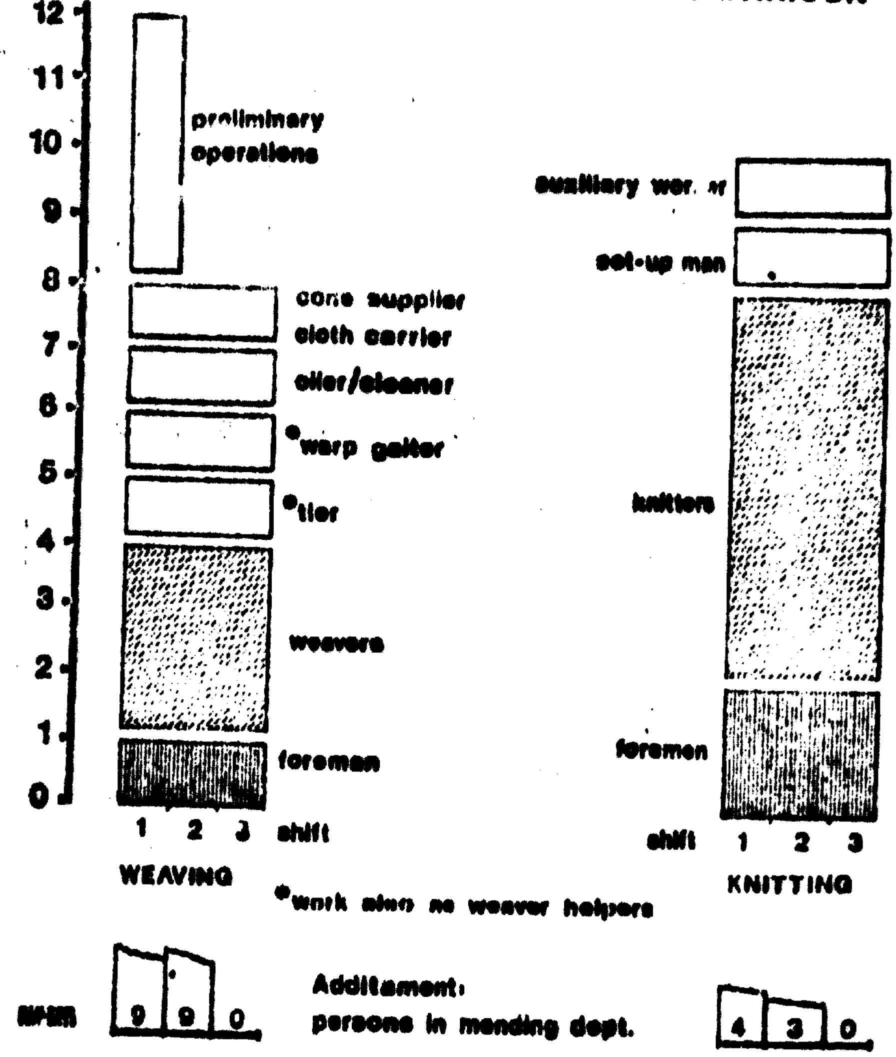


FIGURE 9

F. PERSONNEL COMPARISON



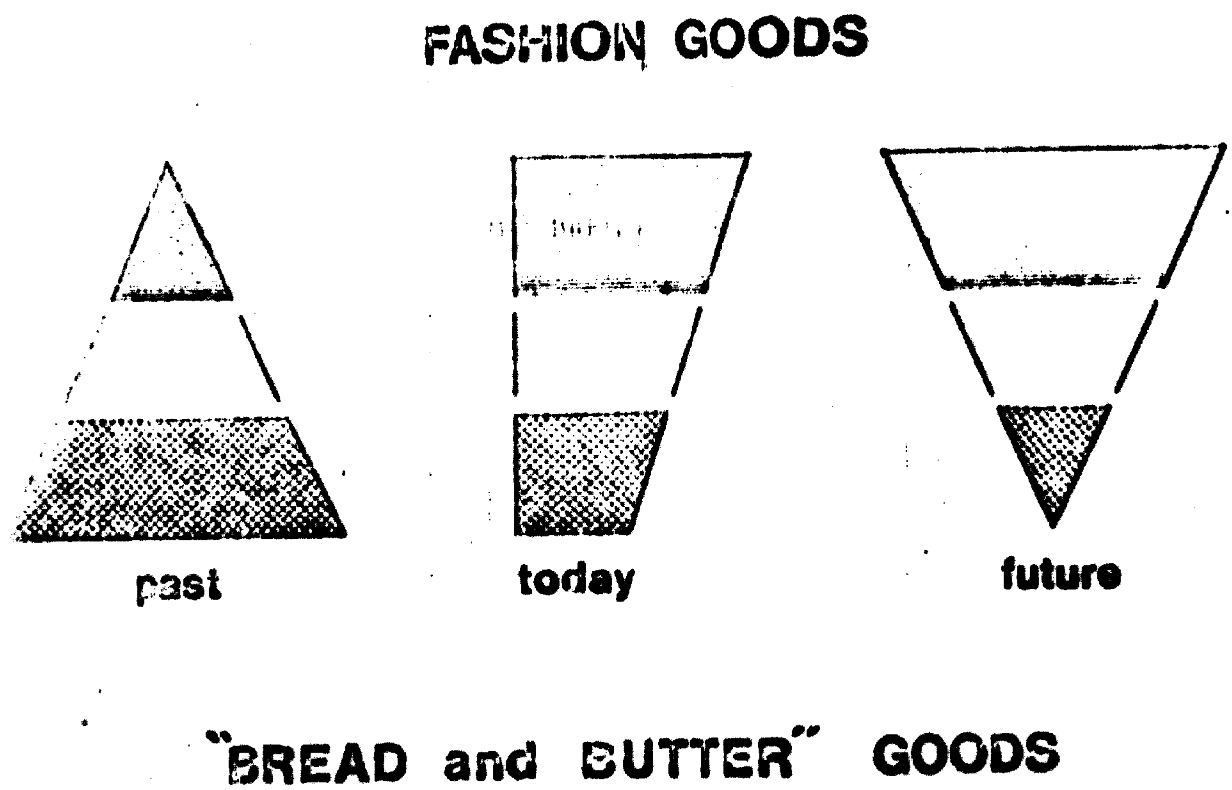


FIGURE 11

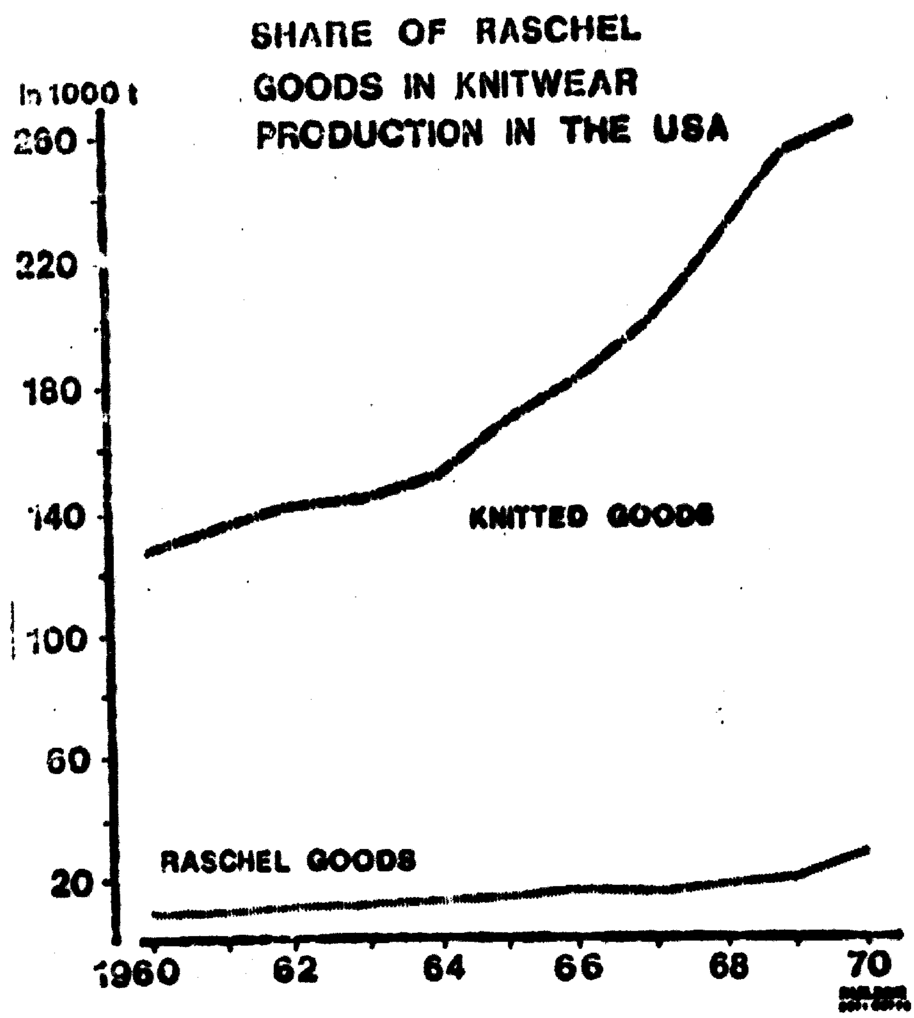


FIGURE 12

END-USES OF WARP-KNITTED FABRIC

1970 - (m.lb)

Suits, skirts etc.	2.8
W & G lingerie & nightwear	21.5
M & B shirts & nightwear	18.2
Dresses, blouses etc.	9.6
Overalls	1.7
Linings & interlinings	9.6
Gloves & other apparel	9.9
Sheets	5.6
Curtains	8.8
Other household	5.2
Industrial	0.7
TOTAL	93.6

A more detailed breakdown can be found in Table 14.

FIGURE 13

	1965	1966	1967	1968	1969	1970	1970 I	II(c)	III(c)	IV(c)	1971 I(d)	
	(b)					Million lb						
CLOTH PRODUCTION(a)												
Total	37.54	35.46	46.70	66.63	77.30	71.76	16.62	17.38	16.25	21.50	20.61	19.
Apparel												
Total	..	33.33	40.53	53.57	63.14	59.90	14.27	14.77	13.62	17.25	..	..
Women's & girls' lingerie etc.	..	17.47	17.32	23.88	26.87	21.88	4.98	5.30	5.13	6.45	..	.
Men's & boys' shirts etc.	..	9.02	12.44	14.65	15.36	12.25	3.09	3.30	2.92	3.04	..	.
Dresses, blouses, etc.	..	3.06	4.94	5.63	7.42	12.05	2.89	2.65	2.72	3.60	..	.
Suits, skirts, etc.	..	1.16	.90	1.12	1.62	1.48	.32	.38	.35	.43	..	.
Linings & interlinings	..	.80	2.29	5.70	9.22	9.31	2.37	2.46	1.96	2.53	..	.
Gloves	..	.53	.31	.56)	2.66	(.30	(.07	.07	.08	.10	..	.
Other	..	1.29	2.33	2.01)		(2.61	(.56	.61	.56	.89	..	.
Household & Furnishing												
Total	..	1.93	5.17	13.06	13.77	11.29	2.19	2.48	2.64	4.09	..	.
Sheets	..	.67	4.22	9.00	7.49	5.70	1.12	1.37	1.37	1.84	..	.
Curtain nets	..	) 1.26	(1.04	.72	.91	.67	.19	.17	.12	.20	..	.
Other	..	)	(.91	3.34	5.37	4.93	.88	.95	1.04	2.06	..	.
Industrial	..	..	..	..	.39	.57	.17	.14	.11	.15	..	.
YARN INTAKE (a) (b)												
Total	..	38.54	49.47	72.39	80.55	78.52	19.43	18.67	18.38	22.04	21.24	19.
Yarn of UK manufacture												
Continuous filament synthetic	..	27.90	38.64	58.62	62.34	58.94	14.59	14.30	13.58	16.47	..	.
Continuous filament other		8.05	8.86	10.37)	13.97	14.71	3.95	(3.15)	3.31	4.07	..	.
Spun man-made fibre		.28	.17	.20)				(.23)				
Cotton	)	.44	.20	.20	.15	.08	.03	.02	.01	.02	..	.
Wool & wool mixtures	)											
Imported yarn	..	1.87	1.61	3.01	4.18	4.79	.86	.96	1.49	1.47	..	.

(a) Larger establishments only. Figures before 1967 are incomplete.
(b) Before 1967 years are twelve months beginning 1st February of year stated.
(c) The figures from the second quarter of 1970 are not comparable with previous periods owing to greater coverage.
(d) Figures incomplete

U.K.

TABLE: Warp knitting - Fabric production and yarn consumption (Data sources Departments of Trade and Industry and the Textile Council)

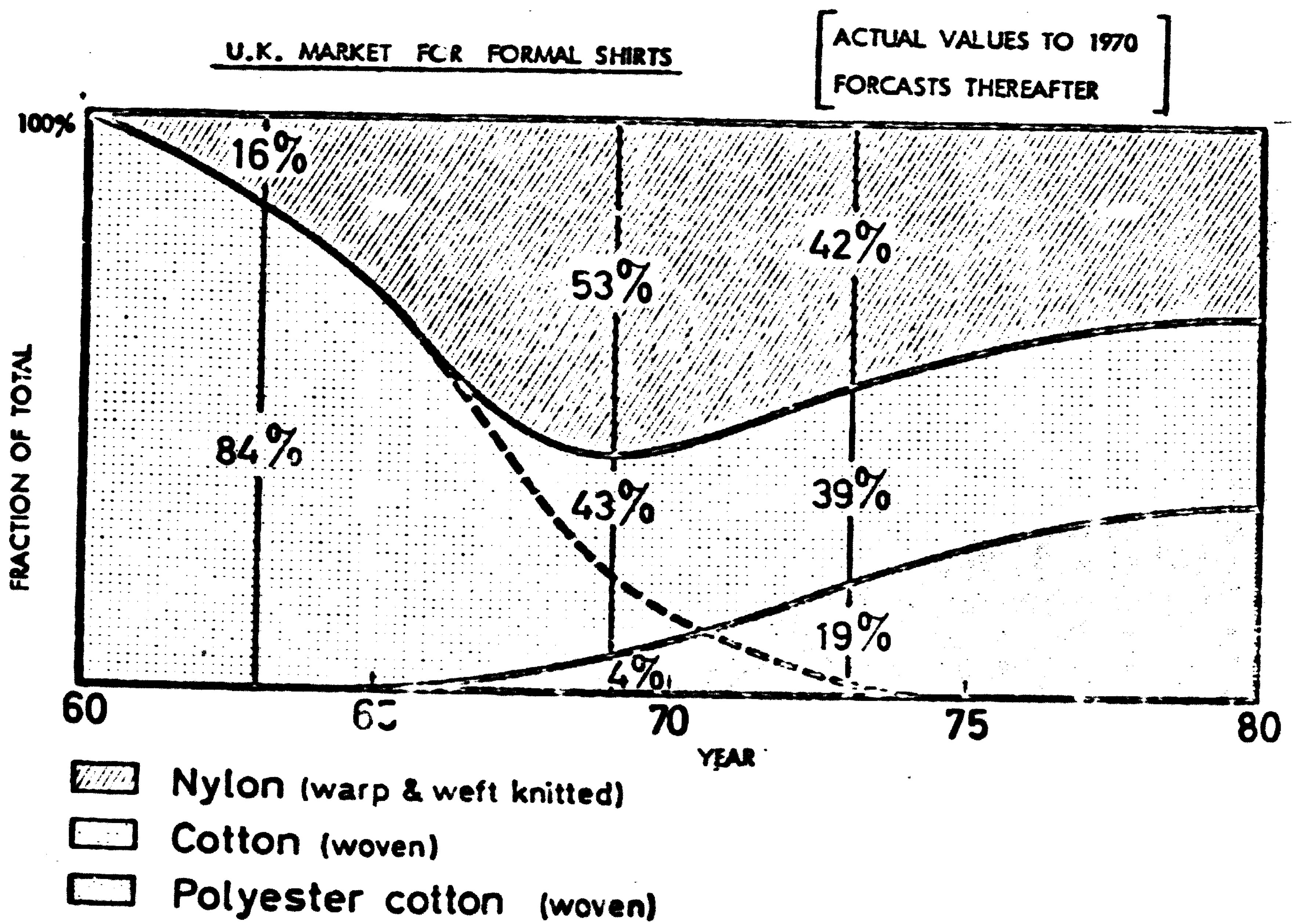

U.K. MARKET FOR FORMAL SHIRTS
ACTUAL VALUES TO 1970
FORCASTS THEREAFTER
100%
FRACTION OF TOTAL
16%
84%
53%
43%
4%
42%
39%
19%
60
65
70
75
80
YEAR
Nylon (warp & weft knitted)
Cotton (woven)
Polyester cotton (woven)

FIG. 15

PRODUCTION OF STANDARD WOVEN GOODS AND KNITTED GOODS IN THE EEC AND EFTA, 1963=100

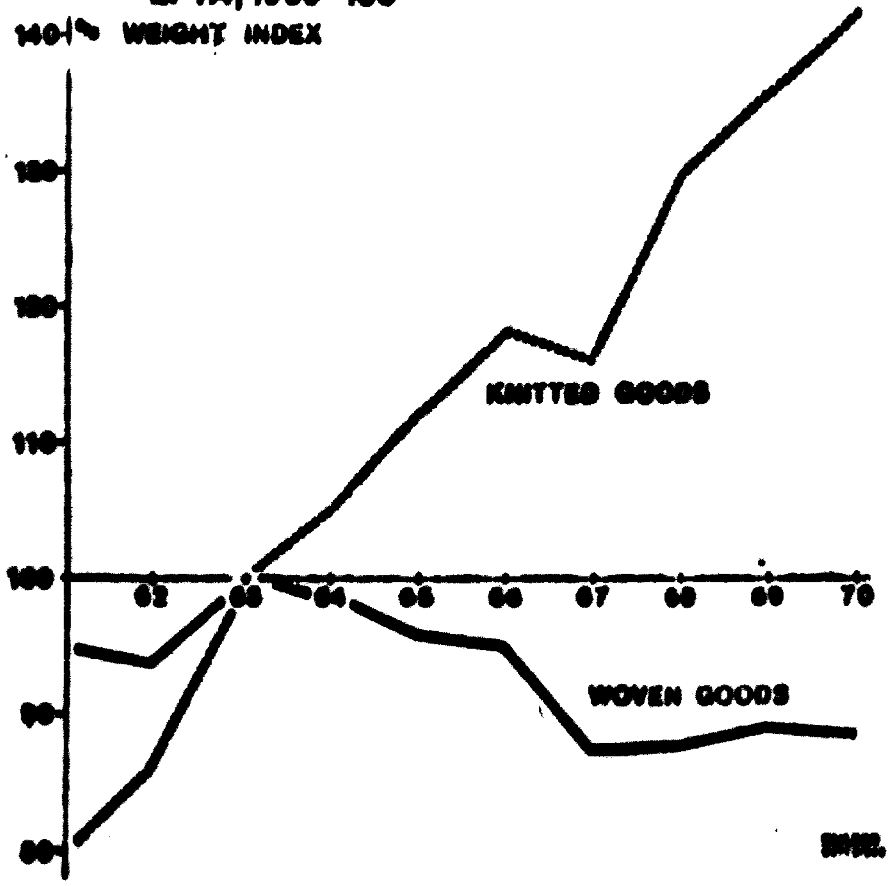


FIG. 16

PRODUCTION: (STANDARD) WOVEN FABRIC VERSUS KNITGOODS
FORECAST UP TO 1973 IN THE COMMON MARKET PLUS EFTA

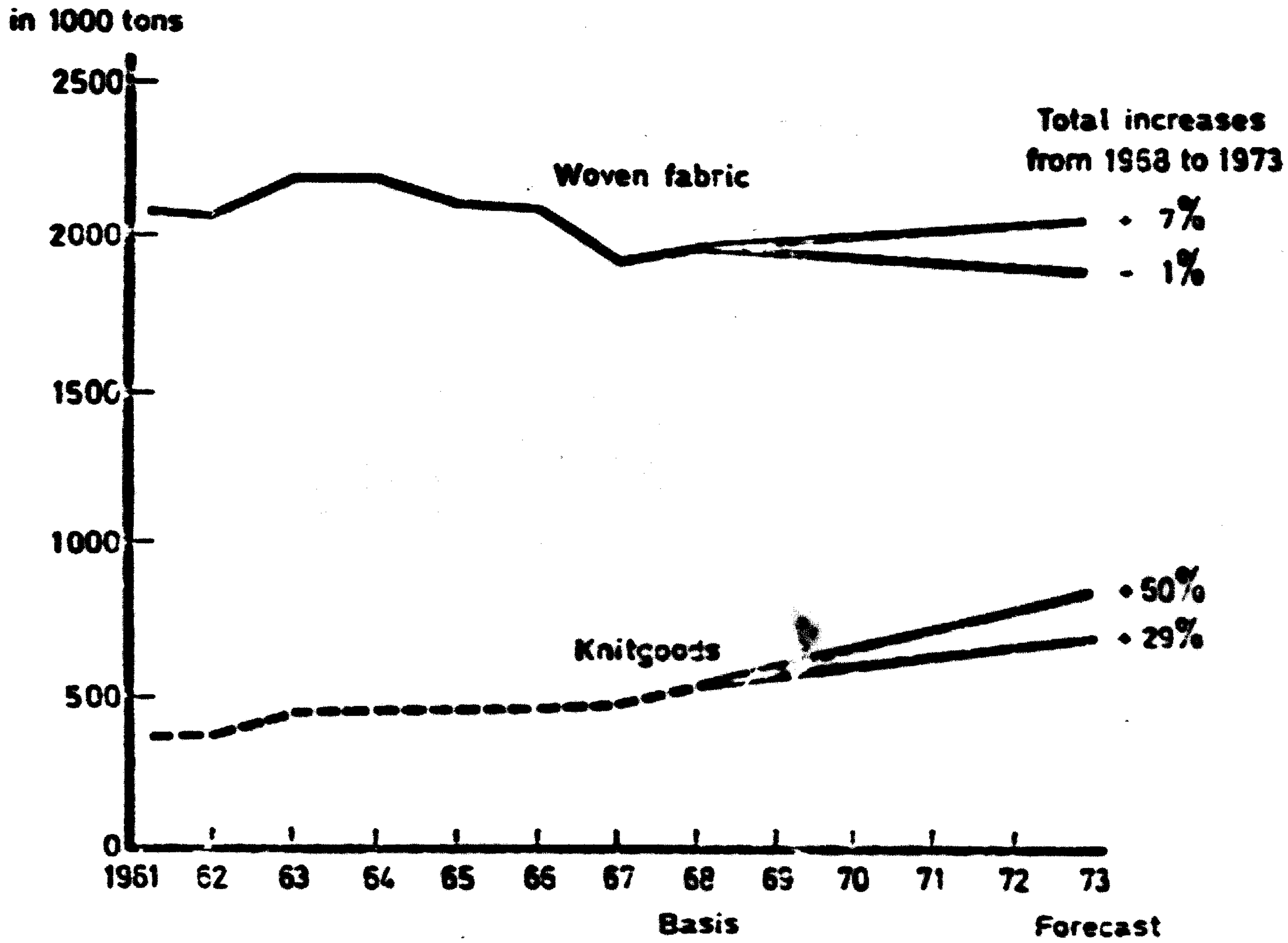


FIGURE 17

PRODUCTION OF TEXTILE FABRICS IN THE EEC IN 1968/69

(incl. durable fibres) (calculated by weight)

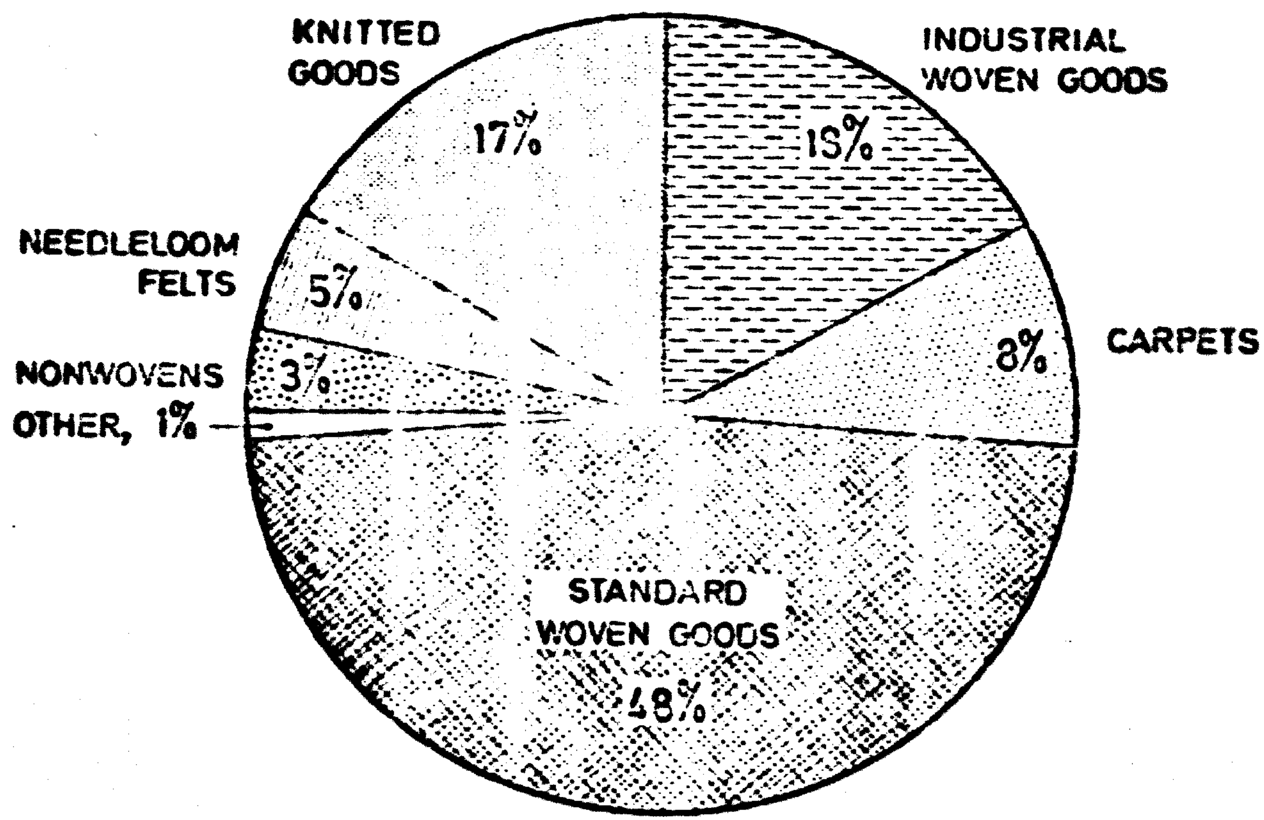


FIGURE 19

FLAT KNITTING MACHINES

FDOUARD DUBIED ET CIE S.A.
2001 NEUCHATEL, SWITZERLAND.

FABRIQUE NATIONALE D'ARMES DE GUERRE
'KNITTING MACHINES'DIVISION
12 ZONDERNAAMSTRAST
GENTBRUGGE
BELGIUM

INDUSTRIAS KOOP
JUAN BRUGADA MIQUEL
QUINTANA ALTA
17/19 BADALONA
SPAIN

KUNO FLAT KNITTING MACHINERY CO.LTD.
NO.2 CHOME KODAMACHO NISHKU
NAGOYA
JAPAN

LAMB KNITTING MACHINE CORP.
CHICOPEE FALLS
MASS.,
U.S.A.

AQUILA SANTAGOSTINO
VIA PALANZONE 16
MILAN
ITALY

SCHAFFHOUSE KNITTING MACHINE WORKS LTD.
SCHAFFHAUSEN
SWITZERLAND

SINGER-ALEMANNIA MASCHINENFABRIK GMBH
8581 CREUSSEN/OBFR
WESTERN GERMANY

H. STOLL & CO.
POSTFACH 73
741 REUTLINGEN/WURTTEMBERG
WEST GERMANY

TAKAHASHI KNITTING MACHINE CO.LTD.
32 2-CHOME
NISHI-IMAZATOCHO
HIGASHINARI-KU
OSAKA
JAPAN

UNIVERSAL MASCHINENFABRIK
DR.RUDOLF SCHIEBER GMBH
7081 WESTHAUSEN
KREIS AALEN (WUERTT)
WEST GERMANY

FIGURE 19

CIRCULAR PIECEGOODS MACHINES (CONTINUED)

G. STIBBE & CO.LTD.
MAXIM BUILDINGS
GREAT CENTRAL STREET
LEICESTER
ENGLAND

C. TERROT SOHNE MASCHINENFABRIK
7 STUTTGART-BAD CANNSTATT
DURRHEIMER STR.12
GERMANY

TOMPKINS BROS.CO.INC.
623 ONEIDA STREET
SYRACUSE 4
N.Y.
U.S.A.

TRADEL S.A.
CARRETERA BARCELONA
S/N APARTADO CORREOS
24 MATARO (BARCELONA)
SPAIN

WILDMAN JACQUARD CO.
1210 STANBRIDGE STREET
NORRISTOWN
PENNSYLVANIA
U.S.A.

WILDT MELLOR BROMLEY LTD.
ADELAIDE WORKS
AYLESTONE ROAD
LEICESTER
ENGLAND

FIGURE 20

CIRCULAR PIECEGOODS MACHINES

ALBER & BITZER K.G.
7477 TAILFINGEN/WUERTT
SCHILLERSTRASSE 10
POSTFACH 81
GERMANY

CAMBER INTERNATIONAL LTD.
39/45 SPARKENHOE STREET
LEICESTER
ENGLAND

EDOUARD DUBIED ET CIE S.A.
2001 NEUCHATEL
SWITZERLAND

FOUQUET-WERK FRAUZ UND PLANCK
ROTTENBURG-AM-NECKAR
WEST GERMANY

A. KIRKLAND & CO.LTD.
APEX WORKS
MELTON ROAD
SYSTON
NR.LEICESTER
ENGLAND

GEORGES LEBOCEY & CO.
23/35 AVENUE PASTEUR
10-TROYES
FRANCE

MAYER & CIE
TAILFINGEN
WURTTEMBERG, WEST GERMANY

MIYAKE KNITTING MACHINE WORKS LTD.
MINAMI 1-CHOME
SHINMORISHOJI
ASAHI-KU
OSAKA
JAPAN

MONARCH INTERNATIONAL LTD.
175 STOCKHOLM STREET
BROOKLYN 11237
N.Y.
U.S.A.

FRANZ MORAT GMBH
7 STUTTGART-VAIHINGEN
HESSBRUEHISTRASSE 51
GERMANY

SCHAFFHOUSE KNITTING MACHINE WORKS LTD.
SCHAFFHAUSEN
SWITZERLAND

SCOTT & WILLIAMS INC.
LACONIA
NEW HAMPSHIRE
U.S.A.

THE SINGER CO.
SUPREME MACHINE DIVISION
94-02 104 STREET
OZONE PARK 16
NEW YORK
U.S.A.

FIGURE 20 (continued)

CIRCULAR GARMENT-MAKING MACHINES

ALBER & BITZER K.G.
7477 TAILFINGEN/WUERTT
POSTFACH 81
SCHILLERSTRASSE 10
GERMANY

FOUQUET-WERK FRAUZ UND PLANCK
ROTTENBERG-AM-NECKAR
GERMANY

JUMBERCA S.A.
JACINTO BENAVENTE
S/N BADALONA
(BARCELONA)
SPAIN

GEORGES LEBOCEY & CO.
23/35 AVENUE PASTEUR
10-TROYES
FRANCE

MAYER & CIE
TAILFINGEN/WUERTT
GERMANY

THE SINGER CO.
SUPREME MACHINERY DIVISION
94-02 104 STREET
OZONE PARK 16
NEW YORK
U.S.A.

G. STIBBE & CO.LTD.
MAXIM BUILDINGS
GREAT CENTRAL STREET
LEICESTER
ENGLAND

C. TERROT SOHNE & CO.
MASCHINENFABRIK
7 STUTTGART-BAD CANNSTATT
DURRHEIMER STR.12
GERMANY

TRABEL S.A.
CARRETERA BARCELONA
S/N APARTADO CORREOS
94 MATARO
(BARCELONA)
SPAIN

WILDMAN JACQUARD CO.
1210 STANBRIDGE STREET
NORRISTOWN
PENNSYLVANIA
U.S.A.

WILDT MELLOR BROMLEY LTD.
ADELAIDE WORKS
AYLESTONE ROAD
LEICESTER
ENGLAND

HALF-HOSE AND SOCK MACHINES

BENTLEY ENGINEERING CO.LTD.
NEW BRIDGE STREET
LEICESTER
ENGLAND

CAROLINA KNITTING MACHINE CORP.
508 WEST FIFTH STREET
CHARLOTTE
NORTH CAROLINA
U.S.A.

GOTTLEIB EPPINGER KG MASCHINENFABRIK
7306 DENKENDORF/BEI STUTTGART
GERMANY

FABRIQUE NATIONALE D'ARMES DE GUERRE
'KNITTING MACHINE' DIVISION
12 ZONDERNAAMSTRAAT
GENTBRUGGE
BELGIUM

FOSTER KNITTING MACHINE CO.LTD.
88/96 MARKET STREET
PRESTON
LANCASHIRE
ENGLAND

LAWSON-HEMPHILL INC.
CENTRAL FALLS
RHODE ISLAND
U.S.A.

OFFICINE MONCENISIO S.P.A.
VIA TORINO 19
CONDOVE
TURIN
ITALY

NAGATA SEIKI CO.LTD.
TOKYO
JAPAN

SCOTT & WILLIAMS INC.
LACONIA
NEW HAMPSHIRE
U.S.A.

TEXTILE MACHINE WORKS
READING
PENNSYLVANIA
U.S.A.

FIGURE 22

STRAIGHT BAR F/F OUTERWEAR MACHINES

WILLIAM COTTON LTD.
BENTLEY-COTTON
PO BOX 2
BELTON ROAD
LOUGHBOROUGH
LEICESTERSHIRE
ENGLAND

FABRIQUE NATIONALE D'ARMES DE GUERRE
'KNITTING MACHINES' DIVISION
12 ZONDERNAAMSTRAAT
GENTBRUGGE
BELGIUM

S.A. MONK (SUTTON IN ASHFIELD) LTD.
MANSFIELD ROAD
SUTTIN-IN-ASHFIELD
NOTTS.
ENGLAND
(MEMBER OF STIBBE GROUP)

SCHUBERT & SALZER MASCHINENFABRIK A.G.
INGOLSTADT/DONAU
GERMANY

TEXTILE MACHINE WORKS
READING
PENNSYLVANIA
U.S.A.

FIGURE 23

WARP KNITTING MACHINES

WIRKMASCHINEN-FABRIK WILHELM BARFUSS GMBH
2940 WILHELMSHAVEN
FREILIGRATHSTR. 282-88
GERMANY

FRATELLI COLLI
VIA G. CAMPANA
CILAVEGUA
PAVIA
ITALY

KOHLER & CO.A.G.
TEXTILMASCHINEN-FABRIK
WYNAU
SWITZERLAND

LIBA MASCHINENFABRIK GMBH
8674 NAILA/BAYERN
WEST GERMANY

KARL MAYER GMBH
6053 OBERTSHAUSEN UBER OFFENBACH
MAIN/4
WEST GERMANY

S.P.A. VIRGINIO RIMOLDI & C.
VIA VESPRI SICILIANI 9
MILAN
ITALY

TEXTILE MACHINE WORKS
READING
PENNSYLVANIA
U.S.A.

TSUGAMI MANUFACTURING CO. LTD.
TOKYO
JAPAN

EMIL WIRTH
WIRKMASCHINEN-FABRIK
HARTMANNSDORF
NR. KARL-MARX-STADT
EAST GERMANY

YAMAMOTO MACHINERY WORKS CO.LTD.
MORITA
FUKUI
PREF.,
JAPAN

FIGURE 24

17.6.74