Technical Information on Processing

CHEMSTRAND spandex

S1

Published by Chemstrand • A Division of Monsanto Company • Decatur, Alabama

# SPANDEX TECHNOLOGY

January 1965

spandex
CHEMSTRAND

## KNITTING CORE-SPUN YARNS

Yarns for knitting, spun with a core of *Chemstrand Blue "C"* spandex, can be used either on an "as-is" basis, or plied with 100 per cent textile fiber yarns such as those spun from *Acrilan* acrylic fiber, wool, etc. The reasons core-spun and regular textile yarns are sometimes plied are as follows:

- To reduce stretch to a level more practicable for the specific fabric being knit.
- To add texture. In this respect a wide variety of new and different textured effects in the fabric can be obtained by, for example: plying a cotton system core-spun yarn with a worsted spun textile fiber yarn; or plying a core-spun yarn in a light count with a textile fiber yarn in a heavy count.

As an alternative to using the core-spun yarn "as-is" or plying with another yarn, the core-spun yarn can be knit in conjunction with companion textile yarns from alternate feeders. Probably the most dramatic development in this area—and one that offers tremendous prospects with excellent possibilities for dynamic growth—is the manufacture of sweaters made with *Blue "C"* spandex—*Turbo* processed *Acrilan* core-spun yarns in conjunction with companion yarns of 100 per cent *Turbo* processed *Acrilan.*

Half-hose made with core-spun yarns present another area of great potential growth. In this regard, a spokesman for a major hosiery manufacturer recently predicted that the amount of core-spun spandex used in hosiery alone may reach 3 million pounds by 1970 and that within five years, two-thirds of all cotton socks will be made with core-spun spandex yarns.

### TENSION IN KNITTING

Tension on the core-spun yarn in any type of knitting operation should be light—just sufficient to straighten out the kinks. To accomplish this in the most effective manner, the tension should be applied to the core-spun yarn on the side of the cone rather than by passing the yarn through a disc or disc compensator tension device. Just two of the several cone-side tensioning devices suitable for core-spun yarns are the Mellor Bromley *Neversnarl** (British Patent No. 548,667) shown in Figure 24, and the *Yarn Monitor†* (U.S. Patent No. 3,099,418) made by Stop-Motion Devices Corporation shown in Figure 25.

### KNITTING

Yarns spun with a core of *Blue "C"* spandex or core-spun yarns plied with textile yarns can be knit on multi-feed circular knitting machines either: 1) from all feeders, *or* 2) in conjunction with companion textile yarns from alternate feeders, 1 feeder in 3, 1 in 4, 1 in 6 or in any other ratio.


*Fig. 24—The Mellor Bromley* Neversnarl—*just one of the several devices used for tensioning yarn spun with a core of* Blue "C" *spandex on the side of the cone.*

*Mellor Bromley & Co., (Members of the Bentley Group), St. Saviour's Road, Leicester, England.
†Stop-Motion Devices Corporation, 155 Ames Court, Plainview, Long Island, New York.

*Fig. 25—The "Yarn Monitor" made by Stop-Motion Devices Corporation—another type unit that can be used successfully for tensioning yarn spun with a core of* Blue "C" *spandex on the side of the cone.*

In interlock and double-knit constructions the core-spun yarn can, if desired, be knit on dial needles only. This technique facilitates the production of brushed surface interlock constructions because it permits the core-spun yarn to be knitted on the inside of the fabric and the textile yarn on the outside which, in finishing, can be brushed up for effect and hand.

In jersey inlay or jersey fleece fabrics, the core-spun yarn can be either: 1) knit at every feed—in which case a fabric with a highly elastic backing results, or 2) if less stretch is desired, knit at alternate feeds in conjunction with textile fiber yarns.

Variety in both rib and jersey constructions is made possible by feeding in the core-spun yarn so that the other parts of the structure are raised to give a bouclé or puckered effect. The technique consists of floating the core-spun yarn across more than one wale, an action which, because of the elastic properties of the yarn, has the effect of pulling the wales together to create novel effects.

The knitting of core-spun yarns in welt stitch structures on jersey sinker top pattern wheel machines induces stretch characteristics into what would otherwise be fairly rigid twill fabrics.

Yarns spun with a core of *Blue "C"* spandex can also be used *most effectively* in men's, women's and children's half-hose and socks either in the stretch tops only, or, for maximum stretch, throughout the hose. When knitting core-spun yarn throughout the hose, use minimum tensions and knit extra-long legs and feet to take care of subsequent relaxation shrinkage.

When knitting sweater bodies, allowance must likewise be made for relaxation shrinkage. For this reason, bodies should be made longer and wider. The total shrinkage depends on the amount and denier of the *Blue "C"* spandex core present in a given construction, and on whether or not the core-spun yarn has been heat-set. Machine adjustments for yield and construction should be made by checking steam or tumble relaxed fabric samples.

Listed below are the yarn counts suggested for use on various types of knitting machines:

| | Multifeed Yarns | |
|---|---|---|
| | Non-Elastic Yarn | Core-Spun Yarn |
| **Single Jersey** | | |
| 16 cut | 1/28 to 1/36 w.c. | 1/32 to 1/40 w.c. |
| 18 cut | 1/30 to 1/36 w.c. | 1/36 to 1/45 w.c. |
| 20 cut | 1/32 to 1/36 w.c. | 1/36 to 1/45 w.c. |
| **Double-Knits** | | |
| 14 cut | 1/30 to 1/36 w.c. | 1/36 to 1/45 w.c. |
| 16 cut | 1/32 to 1/36 w.c. | 1/36 to 1/45 w.c. |
| 18 cut | 1/36 to 1/40 w.c. | 1/36 to 1/45 w.c. |
| **Rib Machines** | | |
| 4 cut | 2/8 to 2/16 w.c. | 1/16 to 1/20 w.c. |
| 6 cut | 2/16 to 2/20 w.c. | 1/20 to 1/26 w.c. |
| 8 cut | 2/20 to 2/26 w.c. | 1/20 to 1/26 w.c. |
| 10 cut | 2/26 to 2/32 w.c. | 1/26 to 1/32 w.c. |
| 12 cut | 2/32 to 2/36 w.c. | 1/32 to 1/36 w.c. |
| **Full Fashion** | **Combination Ply Yarns** | |
| 21 GG | 1/36 to 1/40 w.c. | 1/36 to 1/45 w.c. |

## ELASTICIZED FABRICS FOR SWIMWEAR

The amount of natural elasticity in interlock and other type fabrics for swimwear is comparatively small and must, therefore, be supplemented by either: 1) knitting the fabric from yarns possessing high stretch characteristics such as stretch nylon, and/or 2) incorporating spandex into the fabric structure during knitting. In this latter connection, the excellent stretch and return characteristics, high strength, exceptional flex life, and resistance to oils and sun-tan lotions of *Chemstrand Blue "C"* spandex are being exploited to the full in the introduction of new concepts to the swimwear market. The light-weight, form-fitting garments with excellent figure control being made from fabrics powered with the yarn have proved a boon to the trade and a delight to the consumer. Their comfort and ease of care in washing and drying add to consumer appeal. In most cases, less than 10 per cent of *Blue "C"* spandex is sufficient to produce fabrics with stretch recovery and general performance comparable, if not superior, to conventional fabrics produced using textured or rubber yarns.

## KNITTING BARE CHEMSTRAND BLUE "C" SPANDEX

In knitting elasticized fabrics for swimwear, the *Blue "C"* spandex component can be used either covered or bare. Of the two, however, knitting the *Blue "C"* spandex bare is generally the most efficient and economical way to combine, in any knit construction, the unique properties of fine denier with high strength and recovery force, good resistance to abrasion, long flex life, dyeability and resistance to oils and lotions. Properly designed and balanced fabrics in single jersey, interlock, and jacquard constructions (discussed in detail later) powered with bare *Blue "C"* spandex, offer superior performance and economic advantages over conventional stretch fabrics. Additionally they can be made aesthetically more attractive because of the versatility of effects possible in constructions ranging from the feather weight and sheer, to form-fitting foundation-type garments. In most constructions it is advisable to keep the bare *Blue "C"* spandex component on the back of the fabric or buried in the construction. The simplest and most commonly recommended methods of accomplishing this include:

1. Either plating the *Blue "C"* spandex component (suggested primarily for single jersey constructions) or
2. Modifying standard or interlock constructions so that the *Blue "C"* spandex is introduced to the back or dial position only, at pre-determined intervals.

Laying-in of the spandex by the conventional tuck-miss selection of needles is seldom satisfactory as a method of incorporating bare *Blue "C"* spandex into the knitted structure of elasticized swimwear fabrics, and should usually be avoided.

Here are several suggestions that will assist materially in the knitting of elasticized swimwear fabrics powered with bare *Blue "C"* spandex:

- Metering Yarn. Success in using bare *Blue "C"* spandex in elasticized swimwear fabrics is contingent upon precise metering of the yarn to the needles. Three devices that reportedly perform this function well are: 1) the Scott and Williams* Elastic

*Scott and Williams, Inc., Laconia, N.H.

the knitting is done on a jersey, plain rib, interlock or double knit basis. Probably the major advantage of knitting-in over laying-in is that the resultant structure possesses two-way stretch. Spandex yarns that are laid-in on a jersey, plain rib, interlock or double knit ground impart only one-way stretch to the resultant fabric.

Wrapping has much to recommend it as a procedure for incorporating spandex in a swimwear fabric. Spandex is introduced weft-wise on a jersey basis, and wrapping yarns are introduced in a warp-wise direction. If the wrapping yarn is a moderately elastic one such as textured nylon, a resilient fabric will result possessing lengthwise stretch. If in addition, the highly elastic spandex is fed on a knit-in basis in a weft-wise direction, a two-way stretch fabric will be produced. Spandex yarns also may be wrapped at predetermined feeds to produce panels of stretch, for example, in the sides of swimsuits to assure a form-fit.

Plating (recommended primarily for single jersey constructions) is the technique in knitting involving the simultaneous feeding of two yarns, one to appear on the face of the fabric and the other on the reverse. In plating, the *Blue "C"* spandex component is fed almost simultaneously with a textile or non-elastic yarn so that the former appears on the reverse side of the fabric.

The best and most generally used means for incorporating *Blue "C"* spandex in specific type knit fabric structures—single jersey, interlock, jacquard, blister, and ripple—are shown in Figure 47 and discussed below.

## SINGLE JERSEY FABRICS

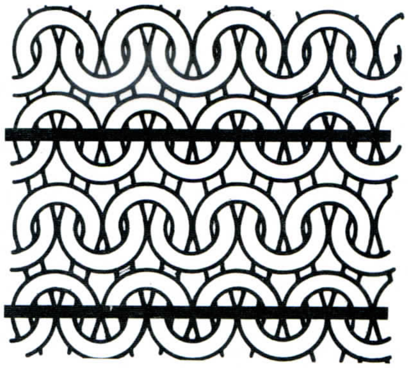
For single jersey construction, the *Chemstrand Blue "C"* spandex component can be introduced into the fabric by either:

1. Plating.
2. Laying-In. Extra lateral stretch can be developed in single jersey fabrics by laying-in the *Blue "C"* spandex component which, for best results, must be covered. Laying-in is best accomplished by introducing the covered *Blue "C"* spandex in alternate feeds, tying-in in odd wales at Feeds 2, 6, 10, etc., and in even wales at Feeds 4, 8, 12, etc. The repeat cycle of movements extends over four feeds. After a row of cleared loops has been made from textile yarn at the first feed, the *Blue "C"* spandex component is supplied to odd needles at the second feed, and after another row of cleared loops has been made from textile yarn at the third feed, the *Blue "C"* spandex is supplied to even needles at the fourth feed. Needles are raised to tucking height to receive the *Blue "C"* spandex component.
3. Introducing the Spandex at Every Third Course. A plain jersey fabric can be adapted for swimwear by having every third course knit using *Blue "C"* spandex, the yarn being fed under very light tension so that the loops formed from it are not too tight. The introduction of *Blue "C"* spandex in this way produces two-way or dual stretch.

## INTERLOCK FABRICS

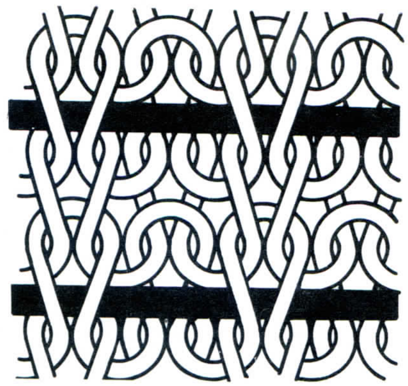
Almost all double knit machines of the modern interlock type can be readily adapted to make elasticized fabric for swimwear. Interlock fabric made from textured nylon yarn elasticized with *Chemstrand Blue "C"* spandex lends itself admirably to screen printing for the production of figure designs in color, and in this respect serves as a convenient substitute for the more expensive jacquard designs. In unpatterned interlock fabric, the introduction of *Blue "C"*

## FIG. 47—METHODS OF INCORPORATING BLUE "C" SPANDEX IN KNITTED SWIMWEAR FABRICS



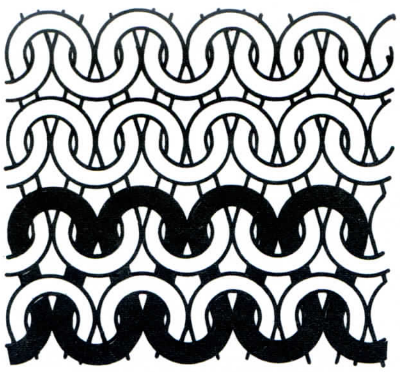
A.

Spandex laid in on reverse side of jersey (single cylinder) fabric. The spandex is introduced on a tuck and knit basis; in other words, alternate tucks and floats.



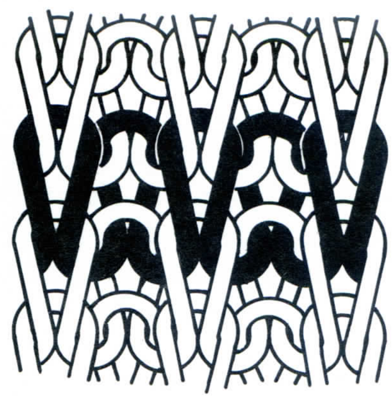
B.

Spandex laid in on a plain 1 x 1 rib fabric. The spandex here is introduced in the form of straight weft threads between the rib and plain wales.



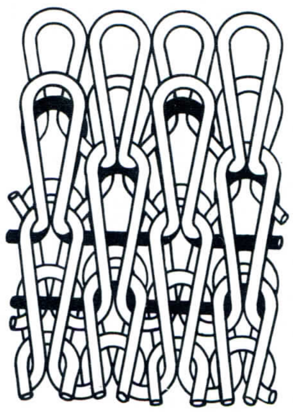
C.

Spandex knitted in on every third course of conventional jersey (single cylinder) fabric.



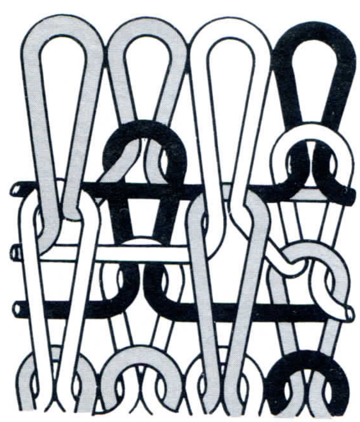
D.

Spandex knitted in on a 1 x 1 rib fabric at predetermined course intervals.



E.

Spandex incorporated in interlock-type double knit fabric. The body yarn is supplied to long cylinder and long dial needles at feeds 1 and 5, and to short cylinder and short dial needles at feeds 2 and 6. The spandex is supplied to long dial needles at feed 3 and to short dial needles at feed 4.



F.

Spandex knitted into rib jacquard fabric. The white and gray loops represent the body jacquard yarns and the black loops the spandex. The latter is introduced to odd needles at the third feed and even needles at the sixth feed. Structure is based on six feed repeat cycle in dial knitting.

# SCOURING, BLEACHING, DYEING AND FINISHING

The development of procedures for scouring, bleaching, dyeing and finishing fabrics powered with *Chemstrand Blue "C"* spandex is advancing at a very rapid pace, and many innovations continue to be made—even as this bulletin goes to press. In the subsequent discussions, therefore, we have presented merely an outline of the methods of handling these fabrics. The recommendations given, nevertheless, will be of invaluable assistance in helping mills establish commercial procedures on their own equipment. For more complete information in regard to the dyeing and finishing of fabrics elasticized with *Blue "C"* spandex, contact: Applications Research and Service Department, Chemstrand Company, Decatur, Alabama. The Dyeing and Finishing Service Facility of this Department matches shades submitted by the customer, works out complete details of formula, application conditions and performance, and sends a report to the customer, usually in the form of a specially prepared booklet. When required, Chemstrand's Dyeing and Finishing Service specialists carry out service calls and thereby make their highly specialized knowledge and skills *directly* available to the customer.

## BASIC PRINCIPLES

Conditions used in the dyeing and finishing of fabrics powered with *Blue "C"* spandex must be such as to conserve the highly elastic nature of the spandex component. With this foremost in mind, the basic principles of dyeing and finishing fabrics elasticized with *Blue "C"* spandex, as now known, include the following:

1. Where maximum stretch in a fabric is desired* or when the stretch must be conserved,† it is essential at every step in dyeing and finishing that: a) tension on the fabric be kept as low as possible, especially in those operations carried out at elevated temperatures, b) that *temperatures* used should be as low as possible consistent with the necessity for good penetration of dyes and fixing agents, and effective heat setting (where heat setting is required), and c) that the *duration* of treatment be as short as possible consistent with the attainment of good results. High temperatures and excessive tensions do not degrade *Blue "C"* spandex easily, but they do induce loss of final elasticity because of non-elastic stretching and a permanent set in the stretched form. Unfortunately, once the elastic properties of *Blue "C"* spandex have been diminished due to the use of excessive tension, temperature and time, they cannot be restored satisfactorily. We recognize that it is easy to say "use minimum times, temperatures and tensions where maximum stretch in a fabric is desired" but that this is not practical for many fabrics. The message we are trying to convey to the dyer or finisher is to use discretion in making decisions in regard to the processing of these fabrics. If the dyeing temperature for a certain fabric is somewhat high, then try to reduce tension and time to the minimum. Likewise, if a fabric must be processed under tension, reduce the temperature and time factors to the minimum.

2. High concentrations of chemicals and extremes of *p*H, particularly at elevated temperatures, should be avoided since these may damage the spandex. Fabrics powered or elasticized

*As in most power net fabrics and most woven foundation garment fabrics.

†As in some warp and filling stretch woven fabrics elasticized with heat-set *Blue "C"* spandex core-spun yarns.

with *Blue "C"* spandex core-spun yarns *can* be carbonized but should be neutralized immediately after baking. Likewise, fabrics containing *Blue "C"* spandex can be mercerized—but cold (60°F). An area where much care must be taken is in the stripping of core-spun fabrics. Strong oxidizing agents containing chlorine must be avoided since they seriously impair the strength of the spandex. For stripping, in general, reducing agents are employed since they are milder and do not appreciably affect the properties of the spandex.

3. All fabric should be processed on a first-in-first-out basis.
4. To prevent "snagging" on minor nicks or rough spots it is most important that all equipment used in dyeing and finishing elastic fabrics be perfectly smooth and clean.
5. In many cases, but particularly in filling stretch fabrics, tacking the fabric "face-in" before dyeing will help prevent rolling of selvages and minimize the formation of creases and crack marks.
6. Both greige and finished fabrics should be wrapped during storage.
7. To avoid complaints, the fabric, when shipped to the cutter, should ideally have a residual shrinkage potential of from 1 to 2 per cent. Growth potential rather than a small amount of residual shrinkage potential in a fabric is extremely undesirable and all precautions should be taken to insure against same.
8. Effective quality control programs should be established from the time that the goods enter to the time that they leave the dyeing and finishing plant.

## TECHNIQUE

As might be expected, different types of elastic fabrics powered with *Blue "C"* spandex require totally different dyeing and finishing techniques, and in different dyehouses techniques must be further varied to suit installed equipment. Typical dyeing and finishing routines for various type fabrics elasticized with *Blue "C"* spandex are outlined in Table 19.

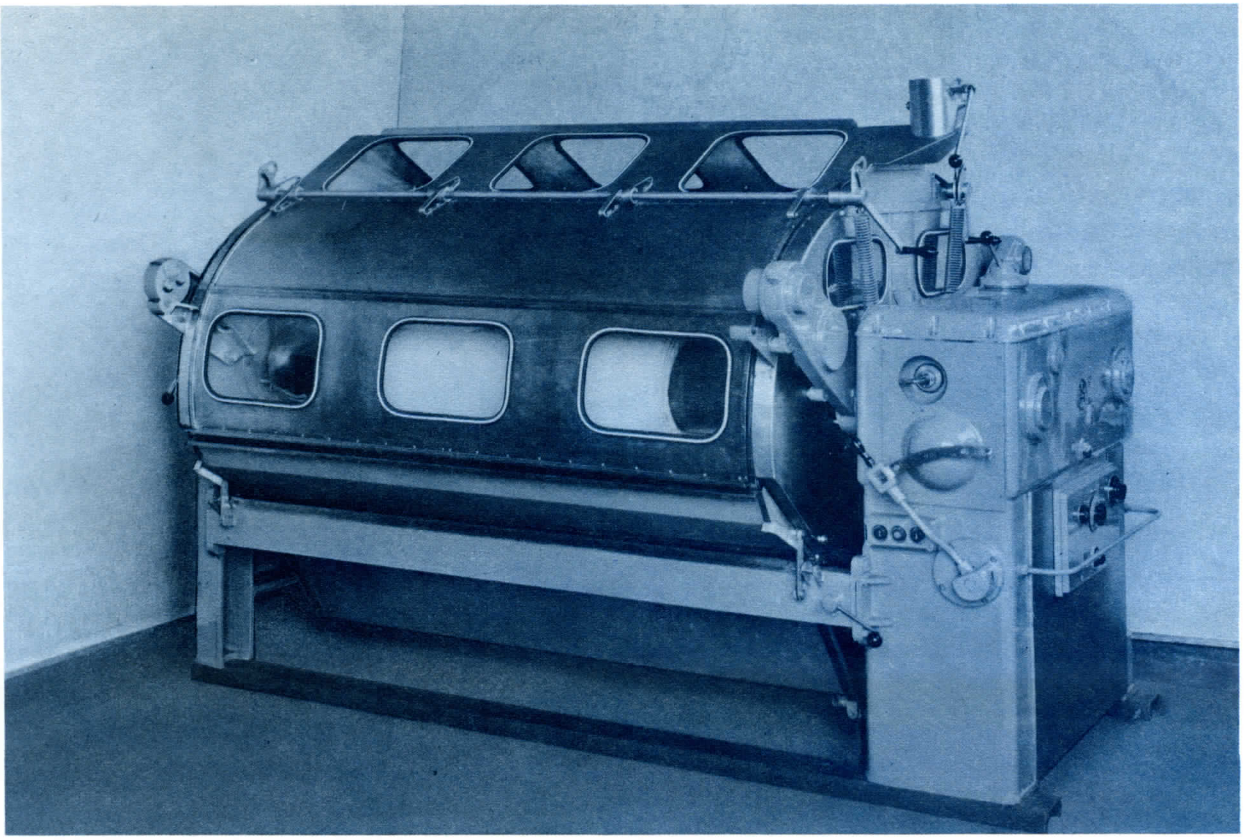
## EQUIPMENT

### Scouring, Bleaching and Dyeing Equipment

For Foundation Garment Fabrics—For best results, most open-width power net and warp stretch woven foundation fabrics powered with *Blue "C"* spandex should be scoured, bleached and dyed in tensionless jigs such as the Vald. Henriksen machine shown in Figure 83. In contrast, filling stretch fabrics, which do not require the same degree of warp tension control may be processed in jigs that do not have special tension controls providing that the spreader bar is adjusted or modified to minimize filling tensions. In some instances an open jig can be used satisfactorily for dyeing fabrics powered with *Blue "C"* spandex to light shades—blue, pink, salmon and yellow, but a closed jig is almost always preferred. The reasons: 1) with a closed jig, processing conditions are more uniform, and 2) elevated temperatures, which not only enable dyeing to proceed more rapidly but additionally are essential for the successful dyeing of many of the companion yarns used in conjunction with the *Blue "C"* spandex, are more easily achieved and maintained in a closed jig.

For Woven Fabrics Made with Core-Spun Yarns—Fabrics in this category of the filling stretch variety can, after being heat-set in the greige, be scoured, bleached and dyed satisfactorily in open or closed dye becks.

For Circular Knit Fabrics—Circular knit fabrics may be scoured, bleached and dyed



Courtesy: Vald. Henriksen i/S.

*Fig. 83—The Vald. Henriksen Universal Precision Jig Type VH-Super.*

satisfactorily in dye becks. Shallow becks equipped with reels close to the dye liquor are preferred to reduce the tension created by pulling wet fabric from the hot bath.

For certain specialty type fabrics which require complete relaxation during dyeing (lace elasticized with *Blue "C"* spandex, for example), paddle dyeing machines must be used.

#### Drying Equipment

The drying of open width fabrics powered with *Blue "C"* spandex should be carried out, wherever possible, using an overfeed tenter frame such as the ones shown in Figures 84 and 85. Circular knit fabrics powered with *Blue "C"* spandex are usually loop dried or processed on one of the several different types of tubular drying equipment available.

#### Other Equipment

Other items of equipment that may be required in the finishing of elastic fabrics powered with *Blue "C"* spandex include machinery for: pad application of resins; palmering; decating; calendering; rotary pressing; shearing, napping and sueding.

### PREPARATION

#### Foundation Garment Fabrics

To prevent cockling, puckering, and distortion of the fabric due to non-uniform processing tensions during weaving or knitting, foundation garment fabrics should be relaxed before wet processing.

Specifically, the objects of the relaxation steps are:

1. To release latent tensions that originated during knitting or weaving.
2. To induce fabric shrinkage.

3. To obtain better finished fabric dimensional stability.

Open width fabrics such as filling and warp stretch lenos and power nets can be relaxed by either: 1) a hot water treatment, or 2) by passing over a steam box. Of the two, however, the steam box method is preferred. The reason: the fabric is processed in a more relaxed state, whereas with a hot water treatment full relaxation of fabrics with a high shrinkage potential is seldom realized. In most cases, the steam box consists of a trough through which several steam pipes (perforated for steam ejection) run. For best results, the steam box should be fitted with a top hood to prevent the moisture of condensation from dripping onto the fabric.

A positive overfeed device should be used to permit fabrics to pass over the steam box fully relaxed. The duration of the relaxation period will depend on fabric construction, rate of steam generation, and speed of cloth over the steamer. The use of a scray pan for collecting fabric from steaming equipment is beneficial because it permits additional lengthwise shrinkage and provides better over-all dimensional stability.

### Filling Stretch Woven Fabrics Made With Core-Spun Yarn

Most filling stretch woven fabrics made with *Blue "C"* spandex core-spun yarns must be heat-set* in the greige. The reason:

*A note on the meaning of the term "heat setting" referred to here and throughout this book in connection with *Blue "C"* spandex. The effect of heat setting on *Blue "C"* spandex is completely different from that on nylon and polyester. Nylon and polyester become more crystalline when heat-set which imparts fabric stability. In the case of *Blue "C"* spandex however, the heat setting of the yarn in an extended state produces a new yarn having a finer denier but with essentially unchanged properties when measured on a grams per denier basis. Due to this change in denier there is a measurable difference in the total contractive power of the yarn, so that naturally the heat-set fabric will require less force to stretch it and will exert a lower recovery force. The net effects of heat setting fabrics elasticized with *Blue "C"* spandex are these: 1) reduction of the forces exerted by the spandex, 2) reduction of the spandex content per unit area of finished fabric, and 3) reduction of the total elongation of the spandex.

Summing up, the heat setting of *Blue "C"* spandex is essentially a hot drawing process which reduces the denier of the spandex, and hence gives the fabric characteristics desired.

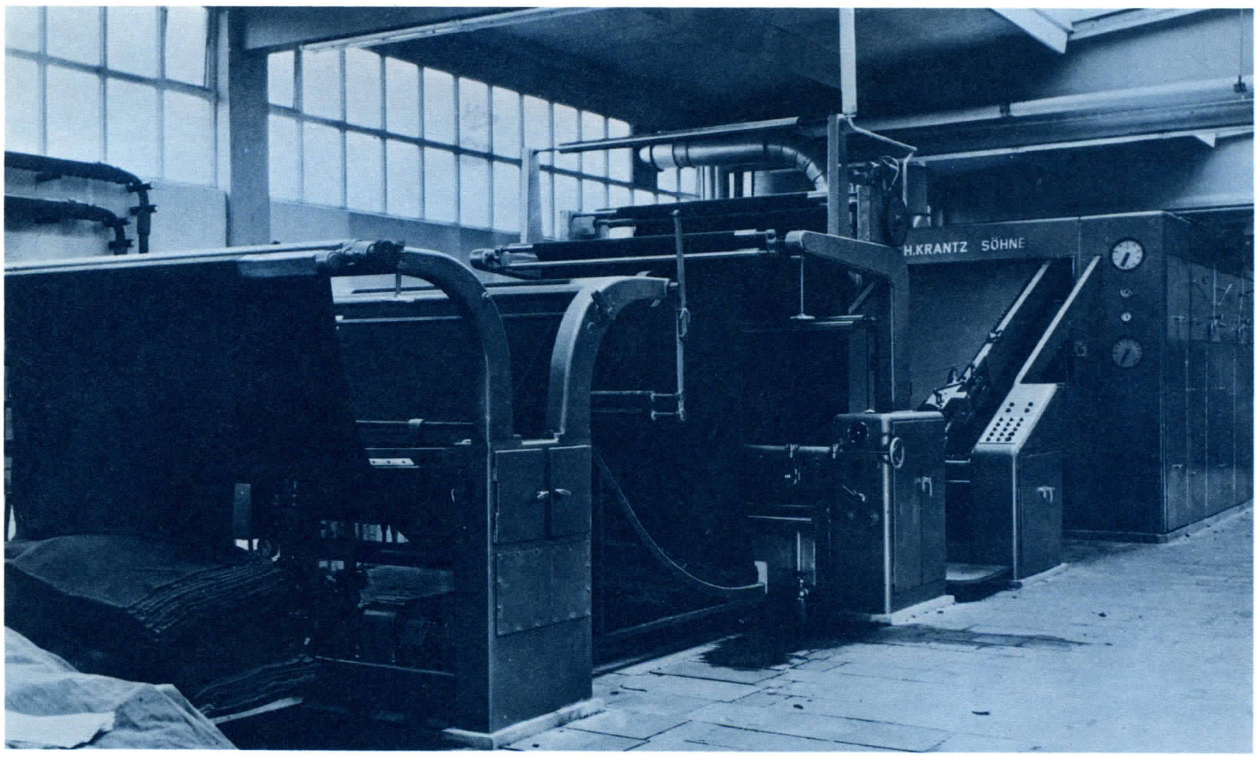
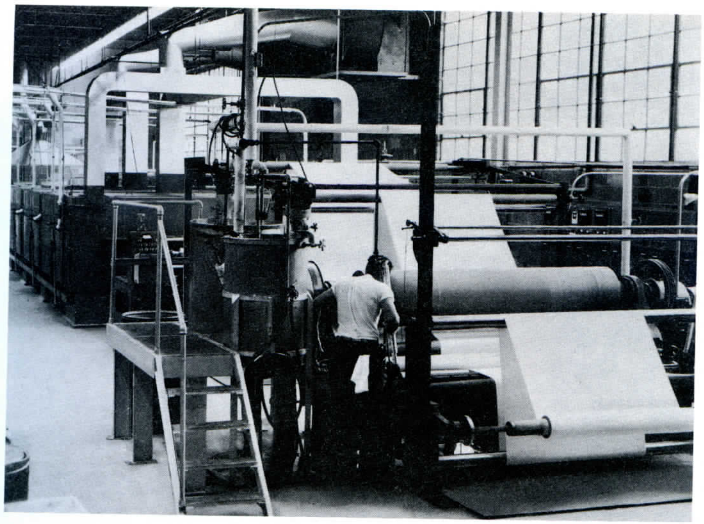
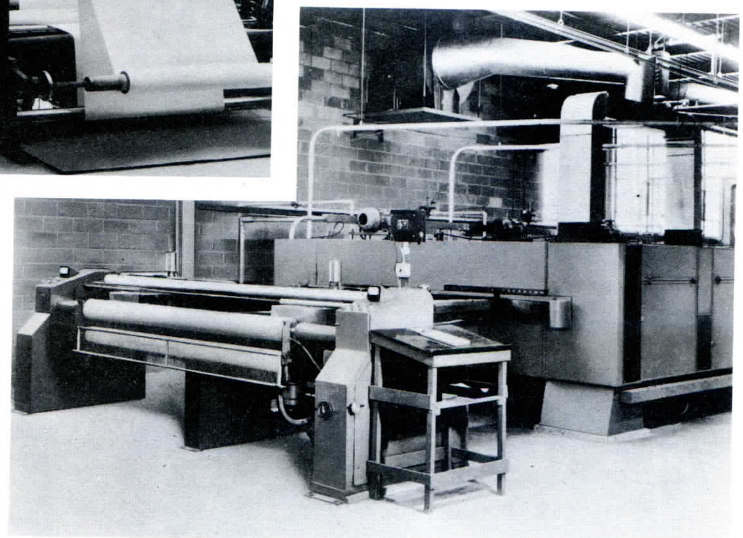


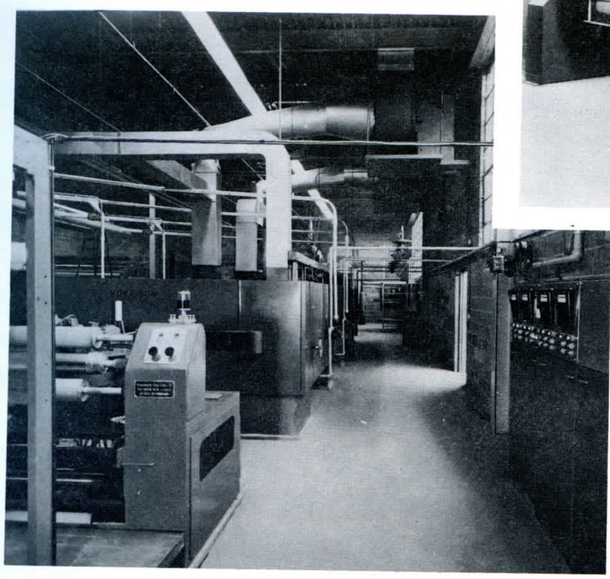

*Fig. 84—Krantz finishing range consisting of vacuum extractor, two-bowl padder and multi-tier jet tenter.*



◀ Cloth travels directly from this padder to the tenter.

Windup end of pin frame tenter with overfeed mechanism. ▶





◀ Pin frame tenter, overfeed mechanism and control panel. Chain drive for the unit was designed to go under the concrete floor, out of sight, yet readily available for service. Average running speed is reportedly 25 yds/min.; average drying temperature: 375°F.

Courtesy: Fablok Mills, Inc.

*Fig. 85—This drying unit, made by Morrison Machine Company, Paterson, N. J., is reportedly being used with great success for the drying of foundation garment fabrics powered with spandex. Features of the unit are these:*

1) It utilizes a heavy duty, standard type tentering frame, and incorporates engineering and manufacturing features designed to assure uninterrupted performance with a minimum of maintenance.

2) It is capable of a wide range of speeds and is engineered so that all changes, whether in speed, overfeed or width, can be controlled from a centrally located control panel.

3) An overfeed mechanism allows the operator either to overfeed the fabric in a relaxed state or to stretch the fabric as desired. The unit is mechanically capable of over or underfeeding the fabric from 40 per cent plus to 15 per cent minus. It is also equipped with entering end scroll rolls and motor driven finger selvedge openers.

4) Heat transfer, described as efficient and uniform, is accomplished by using specially designed gas-fired burners with high air velocities. Each drying chamber is equipped with independently adjustable dampers for regulating the circulating volume of air. The drying portion of the unit is designed to accomplish in a 40 ft. housing the drying effect that would normally require a longer unit.

The heating chamber temperature can be raised from 100° to 200°F in about ten minutes.

5) The unit has a low profile housing with small heating area and rapid recirculation of air to give accurate temperature controls and efficient, economical operation.

6) The unit is equipped with a water-cooled drum over which fabric can be run before windup. This is especially valuable with delicate elastic fabrics.

the actual stretch potential of these fabrics is often 100 per cent or more—in other words, far in excess of 25 to 65 per cent stretch generally required by most cutters. For this reason, the width of the fabric must be adjusted and set to give the desired stretch in the finished fabric. This is best accomplished by *heat setting in the greige.*

In addition to fulfilling its primary objective, i.e., that of reducing stretch, there is an added advantage of heat setting in the greige: it greatly improves the appearance and hand of the finished fabrics. Quite often fabrics that show a very high shrinkage or stretch in a boil-off sample will turn out cracked and puckered when they are boiled-off in the full piece. This condition is very hard to correct, and the appearance of the finished pieces of such a fabric cannot compare in smoothness with that of heat-set pieces. Heat setting in the greige also conserves the strength of the filling yarns in filling stretch fabrics, the reason being that it puts considerably less strain on yarn and fabric to pull it from 46 or 48 in. to 57 in. than to force it from 36 to 57 in.

### Determining Width At Which To Heat-Set In The Greige

Step 1—The first step in determining the width at which to heat-set filling stretch fabrics in the greige is to determine the maximum stretch potential of the greige goods.

A simple, inexpensive and effective method for doing this is as follows:

1. Cut a one-yard head end of greige fabric and protect edges from raveling.
2. Prepare a bath with 0.5 to 1.0 per cent o.w.f. of a non-ionic detergent and a small amount of TSPP (tetrasodium pyrophosphate).
3. Raise the temperature from 100° to 208°F and wash sample at 208°F for 10 minutes.
4. Rinse in cold water.
5. Extract sample in a centrifugal extractor.
6. Flat dry at 160° to 180°F for 10 minutes.
7. Mark the relaxed fabric with 10-inch bench marks in the stretch direction.
8. Stretch the sample by hand to its maximum elongation and record the distance between the original 10-inch marks. (This technique for measuring stretch is sometimes designated the "New York Hand Stretch Test.")
9. Maximum stretch potential is then calculated using the following formula:

$$\text{Maximum per cent stretch potential} = \frac{B - A}{A} \times 100$$

Where: A = Original relaxed length
B = Extended length

*NOTE:* Once the maximum stretch potential has been determined, it can readily be ascertained whether the desired stretch and desired width in the fabric are feasible. If, for example, the boiled-off sample shrinks from 66 to 36 inches and contains 100 per cent stretch and the desired finished stretch is 100 per cent at 45 inches, then clearly nothing can be done in finishing to achieve the desired end result.

Step 2—As the second step in determining the width at which to heat-set in the greige to obtain the desired stretch, apply the following formula:

$$\text{Width at which fabric must finish to give desired stretch} = \frac{A\ (100 + B)}{100 + C}$$

Where: A = Boiled off width of 1 yd. sample
B = Maximum per cent stretch potential
C = Desired per cent stretch in finished fabric

*NOTE:* The above formula is not infallible because of fabric construction and other variables. It nevertheless helps eliminate a great deal of experimentation and reprocessing and has proven of great value to dyers and finishers processing stretch fabrics elasticized with core-spun yarns.

Step 3—To the width at which fabric must finish to give desired stretch obtained in Step 2, add several inches (generally from 2 to 3) to take care of the from 5 to 20 per cent relaxation shrinkage that will occur in the fabric after heat setting in the greige. This will then give the approximate width at which the fabric must be heat-set to obtain the desired stretch. Heat-set a one yard end at this width using a suitable heat setting temperature and duration of treatment (see discussion on heat setting technique below). Then boil-off the heat-set sample to determine the relaxation shrinkage. Having obtained this, one can then make suitable allowances and specify the exact width at which the fabric should be heat-set to obtain the desired per cent stretch.

### Heat Setting Technique

The greige fabric should be heat-set on a frame—preferably equipped with a steamer at the entering end to start shrinkage and make it easier for the pins to grip the fabric. Heat-setting conditions across the fabric from selvage to selvage must be consistent to prevent the possibility of side-to-center shading caused by uneven heating.

Tints and sizes should be checked out thoroughly before heat setting to insure that they can be completely and easily removed after heat treating.

Optimum heat-setting conditions for the particular fabric being processed will depend naturally, on such factors as spandex denier, spandex content, yarn count, type sheath or hard fiber employed, and fabric construction, but in most cases a heat-setting temperature in the range 360° to 380°F for from 20 to 40 seconds will give excellent dimensional stability. The effects of varying the heat-setting temperature (range 360° to 400°F) and time (20 to 40 seconds) on dimensional stability width, stretch and other properties of just one of the many fabrics made with core-spun *Blue "C"* spandex in Chemstrand's Applications Research and Service Department, are outlined in Table 16 (page 153). In conjunction with the information presented in Tables 17 and 18 these data provide a useful insight into the finishing of fabrics elasticized with *Blue "C"* spandex core-spun yarns and are worthy of careful study.

As mentioned earlier, the full piece is usually heat-set 2 or 3 inches wider than the estimate obtained in Step 2, page 166 to compensate for the tensions which will be subsequently exerted in beck or jig dyeing. But here a word of caution is necessary. Once the fabric has been set at too wide a width, nothing can be done to compensate for the error. For this reason, it is always preferable to come up light rather than heavy on the width. The fabric can always be re-heat-set, but once the heat-set relaxed width is exceeded, then nothing can be done to bring the fabric "in" if the final width and stretch have been definitely specified. A further word of caution. If, in the final frame drying after dyeing, it is found necessary to pull the fabric out five or six inches more, don't do it since this could only result in the fabric having poor dimensional stability. Rather, re-heat-set the fabric at a wider width, relax it, and then review the stretch data. Remember that it is always possible to increase the width of the finished fabric by re-heat-setting fabric, but that once heat-set, the fabric cannot be narrowed. After experience is gained, one heat treatment in the greige should be entirely sufficient to give the desired per cent stretch at the specified width providing yarn and fabric have been properly constructed.

### Warp Stretch Woven Fabrics Made With Core-Spun Yarns

To determine how best to handle a particular warp stretch fabric, first boil-off a one yard head end and determine maximum per cent stretch potential. Having obtained this, the following general rules can be applied: 1) In the case of fabrics having a high to very high stretch potential (75 to 150 per cent), heat-set* in the greige with warp tension. The amount of tension applied will depend on the actual per cent

*Suggested heat setting conditions: 360° to 380°F for from 20 to 40 seconds.

stretch potential, and on the per cent stretch desired. Suitable allowance should be made for the approximately 10 to 20 per cent loss in warp stretch that will occur due to the tension applied in dyeing and finishing. After dyeing, steam overfeed and/or relax dry to remove residual shrinkage. 2) In the case of fabrics having medium stretch potential (50 to 75 per cent), heat-set* in the greige either without tension or with overfeed. After dyeing, steam overfeed and/or relax dry to remove residual shrinkage. 3) In the case of fabrics having low stretch potential, do not heat-set in the greige at all. After dyeing, steam overfeed and/or relax dry to remove residual shrinkage.

### Two-Way Stretch Woven Fabrics Made With Core-Spun Yarns

In two-way stretch fabrics, most fabrics must be heat-set in the greige to give the desired amount of filling stretch. To insure good warp stretch the fabric must therefore be constructed to allow for the loss in stretch that will occur during heat setting as well as for the 10 to 20 per cent loss in warp stretch that will occur due to the tensions applied in dyeing and finishing.

### Circular Knit Fabrics

In the case of circular knit fabrics made with *Blue "C"* spandex core-spun yarns that shrink excessively, the goods must be steam-calendered (using *Tube-Tex* or similar type equipment) in the greige before scouring and dyeing—otherwise a quite bulky fabric with a very firm hand (that cannot be softened by the usual softeners applied after dyeing) will result. As an alternative to steam calendering in the greige, the greige goods can, if desired, be split and heat-set on a tenter frame.

To dramatize the need for heat setting in the greige, a circular knit fabric made with core-spun *Blue "C"* spandex having a greige width of 28 inches was recently processed in Chemstrand's Applications Research and Service Department Dyehouse. First, the piece was put on the dyebeck and scoured and dyed. Then it was given a relaxed drying on a loop dryer. The finished fabric was 20½ in. wide, had a very firm hand, and offered little resistance to wrinkling.

Another piece of the same style fabric was pre-steamed on the steam calender at 35 in. It came off the calender at 31 in. (three inches over the greige width). It was then dyed and given the relaxed drying in the loop dryer and resulted in a finished width of 23 in. This piece had a very nice, soft hand.

Another piece of a similar fabric had a greige width of 45 in. open width. It was heat-set in the greige in open width at 47 in. at 360°F for 20 seconds on the tenter frame. After heat-setting, it was dyed and given a final finish at 40 in. This fabric also had a soft, drapey hand.

*Suggested heat setting conditions: 360° to 380°F for from 20 to 40 seconds.

## SCOURING

*Chemstrand Blue "C"* spandex, as supplied, contains a small amount of finish to facilitate processing. In order to obtain a clean fabric for subsequent bleaching, dyeing and finishing, however, the finish must be removed. This, in most instances, can be accomplished by using a mild detergent scour. In the final analysis, however, the particular scour used will be governed by the companion yarns of fibers used in conjunction with the *Blue "C"* spandex.

A typical detergent scour suitable for most fabrics powered with *Blue "C"* spandex is as follows:

1. Set bath at 100°F with:
   - 1.00% *Igepal* CO-710 (G) (or equivalent non-ionic detergent)
   - 0.5% TSP.

2. Enter goods.
3. Raise temperature to 160°F at the rate of 2°F per minute.
4. Run 30 minutes.
5. Rinse until clear.

In the case of fabrics constructed from cotton—*Blue "C"* spandex core-spun yarns, a boil-off using 2 per cent caustic o.w.g. is usually required and gives excellent results without impairing either color, elastic properties or strength of the spandex component.

### SUGGESTIONS FOR SCOURING

Here are some helpful rules for scouring elastic fabrics powered with *Blue "C"* spandex that will assist in achieving the best results:

- Keep the wet-out and scour just slightly on the alkaline side except in the case of *Blue "C"* spandex—cotton blends which require a caustic scour.
- Minimize tensions at all times during feeding, processing and take-off.
- Standardize yardage on batch rolls.
- Control temperature and steam pressure so that variations are held to a minimum.
- Establish standard time cycles for scouring and washing the goods.
- Except in the case of fabrics heavily contaminated with oil and grease, do not use a solvent emulsion scour.

## BLEACHING

*Chemstrand Blue "C"* spandex, as shipped, has a high level of whiteness that equals the best of man-made fibers or bleached cotton. For this reason, the bleaching of fabrics powered with *Blue "C"* spandex is carried out primarily to whiten the companion yarns or fibers (cotton, nylon, rayon, acetate, etc.) used in conjunction with the spandex.

Bleaches used for this purpose should not contain chlorine. The reason: chlorine-containing bleaches such as sodium chlorite or sodium hypochlorite do not improve the color of *Blue "C"* spandex and will cause yellowing.

Increased whiteness or a particular cast or hue in the *Blue "C"* spandex component, when required, can readily be obtained through the application of selected optical whitening agents—either alone or in combination with tints. Optical whitening agents can also be used for whitening the other fibers in fabrics powered with *Blue "C"* spandex. Under suitable conditions, selected optical whitening agents for the spandex and other yarn component respectively can be applied together in the same bath. Unfortunately, some optical whitening agents that show affinity for *Blue "C"* spandex tend to turn yellow on exposure to light. For this reason, careful selection of optical whiteners is obviously required.

Specific recommendations for the best bleaching or whitening of various *Blue "C"* spandex with other fiber combinations are given below:

### BLUE "C" SPANDEX—ACRILAN TYPE 16

Chemical bleaches cannot be used for this particular fiber combination, the principal reason being that the only really effective bleach for *Acrilan* Type 16, a sodium chlorite bleach, yellows the spandex considerably. For whitening the *Acrilan* Type 16 component therefore, an optical whitening agent must be used. One of the most effective of these is *Phorwite* DCB (VPC) which can be applied as follows:

1. Scour as described on page 168.

2. Set bath at 120°F with:

   0.50% non-ionic surfactant adjusting $p$H to 4 to 5 using acetic acid (glacial).

3. Circulate 10 minutes and add previously dissolved (or diluted) optical whitening agent (*Phorwite* DCB) in the amount of 0.80 per cent o.w.g.

   *NOTE:* *Phorwite* DCB, being a *non-ionic type* product, will exhaust not only onto the *Acrilan* Type 16 component but also onto the *Blue "C"* spandex core. Its lightfastness on the spandex will not be as good as on the *Acrilan* Type 16. This, however, presents no problem since the spandex core is usually well-concealed under the sheath fibers. Insofar as cationic type optical brightening agents are concerned, almost all of these have good affinity for *Acrilan* Type 16 but virtually no affinity for *Blue "C"* spandex. Among the optical brightening agents which have good affinity for *Acrilan* Type 16 but virtually no affinity for *Blue "C"* spandex are these:

| Product | Suggested per cent o.w.g. for optimum whiteness | Mfr. |
|---|---|---|
| Calcofluor White ART | 0.40% | ACY |
| Calcofluor White ABT | 0.40% | ACY |
| *Tinopal* ACA | 0.80% | GGY |
| *Uvitex* ALN Conc. | 0.15% | CBA |

4. Circulate 10 minutes and heat to 210°F over a 30-minute period.

5. Run 30 to 60 minutes at 210°F.

6. Cool to 160°F by radiation and rinse until clear.

   *NOTE:* To increase the percentage of optical whitening agent above the level suggested will not produce a significantly better white. But the amount can, of course, be decreased to meet specific shade requirements.

## BLUE "C" SPANDEX—ACRILAN TYPE 16—WOOL

The best white on this blend is obtained by applying an optical whitening agent to the *Acrilan* Type 16 and/or wool component followed by a peroxide bleach for the wool. A typical procedure is as follows:

1. Scour as described on page 168.

2. Apply a suitable whitening agent to the *Acrilan* Type 16 component from a bath containing 2 per cent acetic acid at 200°F. If desired, a suitable optical whitening agent such as *Tinopal* GSA (GGY) can also be applied to the wool from this bath.

3. Cool bath to 160°F and neutralize with TSP.

4. Bleach the wool component at 110° to 130°F for two hours or longer as required using:

   26 grams per liter hydrogen peroxide

   Sodium silicate to $p$H 8 to 8.5.

   *NOTE:* 1. Since both wool and spandex are present in the blend, chlorite bleaching is not practical.
   2. The peroxide treatment gives no improvement in color of the *Acrilan* Type 16 component and, since it is applied cold, does not materially improve the color of the spandex either.

## BLUE "C" SPANDEX—CELLULOSIC BLENDS

For this particular fiber combination, a hydrogen peroxide bleach will produce a good white on both the cellulosic and *Blue "C"* spandex components. A suggested procedure is as follows:

1. Scour as described on page 168.

2. Set bath at 120°F with:

   2.50% soda ash
   4.50% sodium silicate
   18.00% hydrogen peroxide (30% $H_2O_2$)
   2.00% *Igepon* T-51. (G)

3. Raise to 200°F over 30-minute period and run 30 to 60 minutes at 200°F.

4. Rinse and scour for 20 minutes at 140°F with:

   1.00% acetic acid.

5. Set a fresh bath at 120°F with:

   TSP to $p$H 7.5
   4.00% sodium bisulfite
   0.80% *Tinopal* 4BMA (GGY)
   0.40% *Phorwite* DCB. (VPC)

6. Heat to 200° to 205°F over 20-minute period and run 30 minutes at 200°F.

## BLUE "C" SPANDEX—NYLON BLENDS

Combinations of *Blue "C"* spandex and nylon, due to the original whiteness of the respective fibers, do not generally require bleaching. If desired, however, the excellent whiteness of the *Blue "C"* spandex and nylon components can be further enhanced through the application of selected optical whitening agents to the respective fibers.

## DYEING

Unlike rubber yarn, *Chemstrand Blue "C"* spandex has excellent dyeability and can be dyed by virtually all classes of dyestuffs, the choice depending on the end use and fastness requirements.

Dyes in the acid, neutral premetalized and chrome classes have excellent shade build-up on *Blue "C"* spandex. Additionally these dyes have excellent washfastness characteristics—a major requirement in dyed fabrics for foundation garments.

The general characteristics of various classes of dyestuffs on *Blue "C"* spandex are itemized in Table 20. Of these classes, the acid, neutral premetalized and disperse dyes are the ones most frequently used. Selections of acid, neutral premetalized, specialty, and disperse colors which give the highest tinctorial value and the best light- and washfastness on *Blue "C"* spandex are listed in Tables 21, 22 and 23. Doubtless many other dyestuffs, in addition to those listed, are also satisfactory for *Blue "C"* spandex. These should, however, be screened before use to insure that their affinity, shade build-up, and fastness properties are adequate.

### DYEING PROCEDURES

Noteworthy is the ease with which blends or combinations of *Blue "C"* spandex with other fibers such as *Chemstrand* nylon, *Acrilan* Type 16, rayon, acetate or cotton can be dyed to union shades having good to excellent fastness to the 120°F A.A.T.C.C. wash test. Procedures for the dyeing to union of four of these blends (all except the last for fabrics made with core-spun yarns) are outlined below.

#### Blue "C" Spandex—Acrilan Type 16 (Core-Spun Combination)

1. Desize if necessary at 140° to 160°F.
2. Scour. (For procedure see page 168).
3. Set dyebath at 120°F with:

| | | |
|---|---|---|
| 0.50% | *Igepal* CO-710 | (G) |
| 0.50% | Retarder RL-895 | (PC) |
| 10.00% | Glauber's salt | |
| 0.50% | acetic acid (glacial) | |

*NOTE:* If the spandex component must be dyed to cover excessive "grin-through" then substitute 2 to 6 per cent (depending on depth of shade) phosphoric acid in place of the 0.50 per cent acetic acid.

4. Circulate 10 minutes at 120°F.

### TABLE 20. PROPERTIES OF VARIOUS CLASSES OF DYES ON CHEMSTRAND BLUE "C" SPANDEX

| Dyestuff Class | Shade Build-up | Lightfastness | Washfastness |
|---|---|---|---|
| Acid | Excellent | Fair-Good | Good-Very Good |
| Chrome | Excellent | Good | Good-Excellent |
| Disperse | Good | Fair-Good | Poor |
| Direct | Poor-Good | Poor | Poor |

Although the tannic acid-tartar emetic aftertreatment gives improved washfastness, considerable dulling of shade and a slight decrease in lightfastness may occur.

### AIDS TO BETTER DYEING

Here are some suggestions for obtaining best results when dyeing fabrics powered with *Blue "C"* spandex.

1. Standardize cloth-to-liquor ratio.
2. Minimize tension during feeding, processing, and take-off, and balance the rolls.
3. Keep steam pressure and temperature uniform to prevent variation in shade.
4. Use both lab and sample lots to establish dyeing procedures.
5. Analyze incoming water frequently.
6. Select dyestuffs with discretion to insure that on-tone dyeings have adequate fastness properties.

## PRINTING

Dimensionally stable fabrics powered with *Chemstrand Blue "C"* spandex can be printed successfully using either roller or screen printing techniques. The choice depends on fabric construction and type. Because when used in combination with other fibers the *Blue "C"* spandex is frequently "buried" in the fabric, conventional printing formulations and techniques are applicable, providing of course, that their effect on the physical properties of *Blue "C"* spandex is not detrimental.

When printing blends of *Blue "C"* spandex and nylon, the possibility of degrading the *Blue "C"* spandex component can be greatly minimized by: 1) using an organic acid such as citric instead of ammonium sulphate, and 2) keeping the steaming time (whether on continuous or batch equipment) to a minimum.

Dyes normally used for printing nylon can also be printed on blend fabrics of *Blue "C"* spandex and nylon. But for swimwear, dyes that give optimum fastness must be used.

## FINISHING

### CHEMICAL FINISHES FOR FABRICS POWERED WITH BLUE "C" SPANDEX

Chemical finishing includes the application of unreacted, partially reacted, and fully reacted resin materials to fabrics powered with *Blue "C"* spandex to improve their hand, dimensional stability, and/or serviceability. The finishing agents used—often in combination—include gums, starches, synthetic sizes, resins and softeners. After impregnating, coating or printing such finishes onto the goods evenly, the fabrics must be dried or cured under relaxed conditions.

#### Softeners

Selected cationic and anionic softeners impart softness, smoothness, fullness, suppleness and flexibility and can be applied either by exhaustion from jig, beck and paddle machines, or by padding.

Silicone compounds can also be used as durable softeners. Some non-ionic softeners are particularly useful in modifying fabric hand when they are co-applied by padding in conjunction with resins and stiffeners.

#### Stiffeners

Resins can be used to impart stiffness and body to fabrics elasticized with *Blue "C"* spandex. They can be applied by either padding and drying or by exhausting from a bath. Types of resins that can be used include methacrylic resins, vinyl resins, sili-

Although the tannic acid-tartar emetic aftertreatment gives improved washfastness, considerable dulling of shade and a slight decrease in lightfastness may occur.

### AIDS TO BETTER DYEING

Here are some suggestions for obtaining best results when dyeing fabrics powered with *Blue "C"* spandex.

1. Standardize cloth-to-liquor ratio.
2. Minimize tension during feeding, processing, and take-off, and balance the rolls.
3. Keep steam pressure and temperature uniform to prevent variation in shade.
4. Use both lab and sample lots to establish dyeing procedures.
5. Analyze incoming water frequently.
6. Select dyestuffs with discretion to insure that on-tone dyeings have adequate fastness properties.

## PRINTING

Dimensionally stable fabrics powered with *Chemstrand Blue "C"* spandex can be printed successfully using either roller or screen printing techniques. The choice depends on fabric construction and type. Because when used in combination with other fibers the *Blue "C"* spandex is frequently "buried" in the fabric, conventional printing formulations and techniques are applicable, providing of course, that their effect on the physical properties of *Blue "C"* spandex is not detrimental.

When printing blends of *Blue "C"* spandex and nylon, the possibility of degrading the *Blue "C"* spandex component can be greatly minimized by: 1) using an organic acid such as citric instead of ammonium sulphate, and 2) keeping the steaming time (whether on continuous or batch equipment) to a minimum.

Dyes normally used for printing nylon can also be printed on blend fabrics of *Blue "C"* spandex and nylon. But for swimwear, dyes that give optimum fastness must be used.

## FINISHING

### CHEMICAL FINISHES FOR FABRICS POWERED WITH BLUE "C" SPANDEX

Chemical finishing includes the application of unreacted, partially reacted, and fully reacted resin materials to fabrics powered with *Blue "C"* spandex to improve their hand, dimensional stability, and/or serviceability. The finishing agents used—often in combination—include gums, starches, synthetic sizes, resins and softeners. After impregnating, coating or printing such finishes onto the goods evenly, the fabrics must be dried or cured under relaxed conditions.

#### Softeners

Selected cationic and anionic softeners impart softness, smoothness, fullness, suppleness and flexibility and can be applied either by exhaustion from jig, beck and paddle machines, or by padding.

Silicone compounds can also be used as durable softeners. Some non-ionic softeners are particularly useful in modifying fabric hand when they are co-applied by padding in conjunction with resins and stiffeners.

#### Stiffeners

Resins can be used to impart stiffness and body to fabrics elasticized with *Blue "C"* spandex. They can be applied by either padding and drying or by exhausting from a bath. Types of resins that can be used include methacrylic resins, vinyl resins, silicone resins, thermo-setting and thermo-plastic resins.

*Methacrylic resins* should be restricted for use on dark shades only.

*Vinyl resins* are extremely effective and are used widely on foundation garment fabrics.

*Silicone resins* have excellent durability and can be used to impart varying degrees of hand.

*Thermo-setting resins*, such as melamine-formaldehyde and urea-formaldehyde are singularly effective, but should be cured using minimum temperature and time. Metallic salt catalysts should be avoided.

*Thermoplastic resins* in general can be cured at a low temperature and some do not need curing at all.

### Water Repellents

Selected renewable water repellents, depending on type, can be applied to the fabrics either by exhaustion from the bath or by padding. Amounts in the range 3 to 6 per cent are usually required to impart full water repellency. After treating, the fabrics should be dried at 200° to 250°F on conventional drying equipment. Durable water repellents may also be used providing that curing temperatures are kept to a minimum.

## MECHANICAL FINISHING OF FABRICS POWERED WITH BLUE "C" SPANDEX

Mechanical finishing includes all operations other than scouring, bleaching and dyeing to which fabrics are subjected (after leaving the loom or knitting machine) which improve the appearance, hand and/or serviceability of the fabric. The mechanical finishing operations to which fabrics powered with *Blue "C"* spandex may be subjected are outlined below. In all of these operations it is essential, where maximum stretch is desired, that minimum tension be applied to the fabrics, especially at elevated temperatures. Excessive tension and high temperatures are detrimental to the elastic properties of *Blue "C"* spandex. On the other hand, low or zero tension permits maximum relaxation of all the yarns in the fabric which contributes to dimensional stability as well as to maximum softness and fullness of hand.

### Extracting

Excess moisture is best removed from fabrics powered with *Blue "C"* spandex by either vacuum extraction in open width form, or centrifuging. Squeeze rolls are also effective. The use of the centrifuge is confined mostly to certain types of knit fabrics.

### Drying

When drying fabrics powered with *Blue "C"* spandex, temperatures should not exceed 250°F, and duration of the operation should be no longer than is necessary to insure complete drying. For best results, the heat should be uniform over the entire fabric and overdrying, which may cause slight yellowing or other shade change, must be avoided.

In the case of circular knit fabrics, these may either be dried on a *Reelax-Jet** dryer, a tubular or loop dryer or, alternatively, tumble dried. Heavily constructed circular knit fabrics may, if desired, be split and dried on a pin tenter frame. Surgical and support hosiery and socks with *Blue "C"* spandex in the tops are normally dried by post-boarding on forms.

*Features of the *Reelax-Jet* drying machine made by Tubular Textile Machinery Corporation 33-61 54th Street, Woodside, New York, include:
*Air Suspension*—Controlled air flow continuously agitates fabric while drying, bulking and relaxing.
*Adjustable Overfeed*—Infinitely variable conveyor speeds allow complete length and width contraction.
*Unlimited Temperature Range*—Gas fired, the *Reelax-Jet* can be delivered to operate at curing and even heat-setting temperatures.
*Limitless Production*—Available in standard widths of 48″ and 72″. Custom built installations available for every requirement.
*Minimum Maintenance*—Walk-in accessibility permits rapid cleaning. Choice of conveyor surfaces prevents chemical buildup and fabric marking.

Relaxed drying usually imparts a sufficient degree of stability to fabrics powered with *Blue "C"* spandex. In the case of fabrics that are not fully stabilized, however, a light steaming will remove residual shrinkage.

### Semi-Decating

Semi-decating smooths or irons the fabric and at the same time modifies its hand. Mild conditions *must* be used when semi-decating fabrics powered with *Blue "C"* spandex. In the final analysis, however, the conditions used will depend on the hand desired and on the other fibers used in conjunction with the spandex.

A typical cycle, which may be varied to obtain the desired hand, consists of 1 to 2 minutes' steaming followed by 1 to 2 minutes' vacuum.

### Palmering

Palmering is carried out on certain styles of woven fabrics powered with *Blue "C"* spandex to flatten or thin the hand and increase luster. The operation, in effect, gives a one-sided ironing by running goods dampened by a spray or steam conditioner through a short tenter frame to remove wrinkles, and against a heated metal cylinder on which the goods are held by a continuous felt belt.

### Calendering

In general, woven fabrics are processed on a silk calender; circular knit fabrics on a steam calender. When calendering woven fabrics, minimum tension and careful control of/and suitable levels of temperature and pressure are necessary to obtain the desired fabric aesthetics. In the case of circular knit fabrics powered with *Blue "C"* spandex, the use of overfeed, full steam (top and bottom) slow fabric speed and minimum roll pressures are recommended as an effective way to remove crack marks produced in dyeing and to increase fabric dimensional stability.

### Pressing

When carried out on conventional rotary presses, pressing imparts a firm, smooth hand and even appearance to the fabric. To avoid excessive surface luster and undesirable glaze, light pressures and moderate temperatures must be used. To conserve the elastic properties of the fabric, tension during pressing should be kept to a minimum.

## HEAT-SETTING

To produce acceptable goods that are dimensionally stable it is necessary, in certain cases, to heat-set fabrics elasticized with *Blue "C"* spandex. Among fabrics that normally require heat-setting in the greige and sometimes again, after wet processing are: most woven fabrics made with core-spun yarns, and other fabrics that:

1. in the boil-off test demonstrate unduly high shrinkage
2. have a greige width that is close to the desired finished width

   (and)

3. demonstrate high stretch potential but require only moderate stretch in the finished state—for example, ski pants.

The specific heat-setting conditions required for a specific fabric will depend on both the composition and construction of the fabric, but to insure the desired degree of dimensional stability, a heat-setting temperature in excess of 300°F will, in most cases, be required. For the majority of stretch woven fabrics made with core-spun yarns, a heat-setting temperature in the range 360° to 380°F for from 20 to 40 seconds normally gives excellent dimensional stability (see the section on the heat-setting of these fabrics starting on page 164).

softer surface next to the body. Thread lubricants and lubricated threads are not required.

## SEAMING

### Locking-In the Blue "C" Spandex Ends

One of the prime requisites in the manufacture of foundation garments from fabrics containing *Blue "C"* spandex is the securing of the spandex yarns in the seam of the garment. This prevents the ends from fraying or running back during flexing and can be accomplished in either of two ways:

1. By a ¼-inch hem

   (or)

2. If the fabric is not folded back, by using a sufficient number of stitches per inch along the edge of the fabric as shown in Figure 86. The higher the number of stitches per inch, the greater the extensibility of the seam.

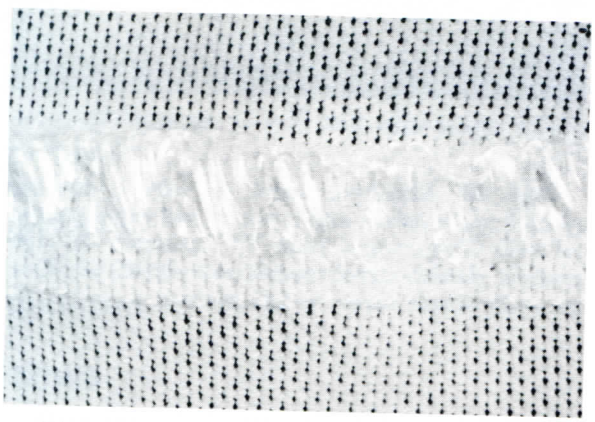


*Fig. 86—Ends of* Chemstrand Blue "C" *spandex secured in the seam of a garment through the use of a sufficient number of stitches per inch.*

### Obtaining Seam Stretch

The seams used must be so constructed as to permit the required amount of stretch without undue strain on either the thread or the fabric. Stretch can be obtained by: 1) using a sewing thread with an elongation comparable to that required in the seam, 2) increasing the length of thread in the seam by increasing the number of stitches, and 3) using a stitch type that will permit the desired degree of stretch. A lock stitch seam with 20 stitches per inch will permit about 25 per cent stretch. A chain stitch seam with 20 stitches per inch will permit about 30 to 35 per cent stretch. Either a plain zigzag stitch or a step zigzag (3 and 3) like that shown in Figure 87 should be used when more than 35 per cent stretch is required.

***Fig. 87—A step zigzag (3 and 3) stitch should be used when more than 35 per cent stretch is required.***

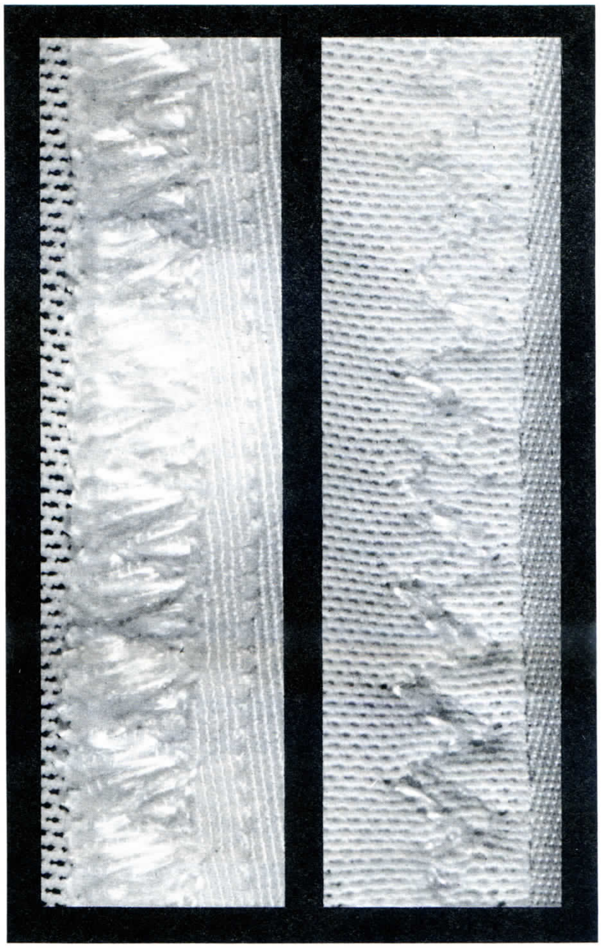
### Suggestions for Joining Fabrics

1. The best alternatives for joining two panels of fabric where the *Blue "C"* spandex yarn runs into the seam are as follows:

   - Using a size No. 15 nylon or polyester sewing thread, make a ¼-inch hem using an overedge stitch with a minimum of 18 stitches per inch and sew the two edges so-stitched together. Do not stretch while sewing.
   - Use a ⅜-inch zigzag stitch with at least 30 stitches per inch. Spread-fell the seam with a zigzag (3 and 3) stitch using a minimum of 42 stitches per inch.
   - Sew twice with a two-needle safety stitch.
   - Leave a one-inch seam allowance for a plain lap seam and sew with a zigzag stitch or a two-needle machine using adequate stitches per inch.

2. To join fabric powered with *Blue "C"* spandex to a tricot fabric or to a one-way stretch satin fabric, make a ¼-inch hem as recommended above and as shown in Figure 88.
3. To join fabric powered with *Blue "C"* spandex to a rigid fabric or to the non-stretch side of a "one-way" fabric, use a single-needle lock stitch seam with a half-inch seam allowance and spread-fell back with adequate stitches on a zigzag or step zigzag machine.
4. To finish the top or bottom of a garment when *Blue "C"* spandex in the fabric is running "up and down", overedge the top and bottom of the fabric ¼-inch with a minimum of 18 stitches per inch. Finish as required. At least a quarter inch of material should be caught in the first zigzag operation when using this stitch for top and bottom finish. One-half inch of fabric should be turned back when facing the top and bottom with any standard single operation, such as lock stitch or step zigzag (3 and 3).

*NOTE:* A single sewing operation using a maximum number of stitches is permissible when fabric is turned back on itself by at least one-quarter inch. A double stitching operation should be used so that the *Blue "C"* spandex will not pull back from the edge of the fabric during flexing when fabric is not turned back on itself.



*Inside View* *Outside View*

*Fig. 88—Stitching used to join a one-way stretch satin fabric and a power net fabric powered with* Chemstrand Blue "C" *spandex. In right picture double layer power net fabric is shown vs. only single layer in left picture.*

## FABRICATION OF APPAREL ELASTICIZED WITH CORE-SPUN YARNS

Stylish and comfortable apparel can be made from fabrics elasticized with *Blue "C"* spandex core-spun yarns. A few suggestions in regard to cutting and sewing are as follows:

### PREPARING FOR CUTTING

The fabrics should be spread for cutting in as near a tension-free state as possible, with the height of the lay as low as practical. Special care should be taken with warp stretch fabrics to avoid stretching during the laying-up operation. Where possible, it is desirable to allow the lay to relax before cutting. If fabrics are cut before they are fully relaxed, there is no guarantee that component parts of the garment will fit properly, since, depending on direction of stretch, some dimensions may shorten or narrow, while others may stay "as-is." Time neces-