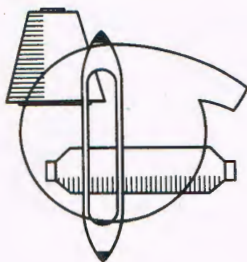


Technical Information on Processing



CHEMSTRAND spandex

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SPANDEX TECHNOLOGY

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INTRODUCTION AND AVAILABILITY

INTRODUCTION

The extent of the market acceptance of garments powered with spandex has been truly phenomenal and one of the most profitable and spectacular ever witnessed by the elastic fabrics industry. This, in a nutshell, sums up the views of industry experts on this relative newcomer to the family of elastic yarns; it also reflects the opinions of coverers, machinery makers, and, as one of the newest but most respected suppliers of spandex to the elastic fabrics industry—*Chemstrand*.

Five years ago, spandex yarns were almost completely unknown. But today, given impetus by their unique properties and high performance characteristics, spandex yarns have: 1) brought to fruition completely new concepts in fabric construction not attainable with conventional elastic yarns, and 2) almost completely replaced rubber yarns—not only in most new lines of foundation garments, but also in an impressive range of other elastic products.

Among the spandex yarns commercially available today, *Blue "C"*® spandex—marketed by *Chemstrand*—ranks with the best. It processes easily. It dyes readily. It is strong. It has excellent stretch and return characteristics. It has exceptional flex life. Additionally, *Chemstrand Blue "C"* spandex is outstandingly white, and is significantly more resistant to combustion fumes and chlorine bleaches than other spandex yarns.

Offering the utmost in quality, performance and proven reliability, *Blue "C"* span-

dex has already made significant inroads into the burgeoning elastic fabrics market in foundation garments, swimwear, support and surgical stockings, and half-hose tops. But undoubtedly, the factor of greatest importance in the yarns' potential for complete market penetration has been the development by *Chemstrand* of a core-spinning technique whereby a *Blue "C"* spandex core is sheathed with man-made and/or natural fibers to produce a "core-spun" yarn. A wide variety of stretch fabrics having the appearance of fabrics made with conventionally spun yarns but with the ability to "give" with body movements, are made possible through the use of core-spun yarns. Besides offering unusual comfort, fabrics made with the new yarns have exceptional stretch and recovery from stretch. Potential markets for their use in men's and boy's wear include: suits, slacks, sports coats, dress and sports shirts, walk shorts, rainwear, half-hose, ski-jackets and swimwear. And in women's and children's wear . . . dresses, blouses, slacks, walk shorts, sweaters, car coats, suits, ski wear, swimwear, golf jackets, snow suits and play suits.

Home furnishings, a wide variety of narrow fabrics, and numerous military and industrial end uses are all seen as other fertile markets for *Blue "C"* spandex in each of its three forms—bare as shipped, covered, and core-spun. The yarn's potential thus extends to virtually every category of textiles where a degree of stretch is required.

AVAILABILITY

COMMERCIAL DENIERS

The commercial deniers in which *Chemstrand Blue "C"* spandex is available are listed in Table 1. These range from the heavy deniers—1680, 2240, 2520 and 3360

(developed expressly for the stretch bra strap market)—down to 70 denier (widely used in core spinning). Itemized in Table 1 also are the approximate number of yards per pound for each of the deniers listed—

data which will serve as a useful guide, for example, in determining covered yarn package sizes and warp lengths. Table 2 lists equivalent cut and extruded rubber yarn gauge numbers for each of the deniers in which Blue "C" spandex is supplied.

LUSTER AND FORM

Blue "C" spandex has a semi-dull luster and is supplied with zero twist in fused multifilament form. The yarn is sold without a covering and may be processed direct-

ly into fabrics bare—as shipped, or alternately either first covered spirally with textile yarns or core-spun.

PACKAGE DIMENSIONS

Blue "C" spandex is wound with a straight wall build on a disposable paper tube core and is supplied in 0.5-lb., 1.0-lb. (see Figure 1), and 2.0-lb. packages. Nominal dimensions of the core and packages are listed in Tables 3 and 4.

TABLE 1. CHEMSTRAND BLUE "C" SPANDEX DENIER AND PACKAGE DATA

Denier (Relaxed)	Yards Per Pound*	Approx. Package Weight (Lb.)	Approx. Yards Per Package	Color of Tube Core	
				Inside	Outside
70	63,780	0.5	31,890	Orange	White
140	31,890	0.5	15,945	Green	White
280	15,945	1.0	15,945	Yellow	Blue
420	10,630	1.0	10,630	Orange	Blue
		(or) 2.0	21,260	Orange	Blue
560	7,972	1.0	7,972	Green	Blue
		(or) 2.0	15,944	Green	Blue
840	5,315	1.0	5,315	Gray	Blue
		(or) 2.0	10,630	Gray	Blue
1,120	3,986	1.0	3,986	Yellow	Red
		(or) 2.0	7,972	Yellow	Red
1,680	2,657	1.0	2,657	Orange	Red
		(or) 2.0	5,314	Orange	Red
2,240	1,993	1.0	1,993	Green	Red
		(or) 2.0	3,986	Green	Red
2,520	1,772	1.0	1,772	Blue	Red
		(or) 2.0	3,544	Blue	Red
3,360	1,329	1.0	1,329	Red	Red
		(or) 2.0	2,658	Red	Red

*Based on relaxed, finish-free yarn.

TABLE 2. RUBBER YARN GAUGE VS. DENIER (BASED ON SPECIFIC GRAVITY OF RUBBER = 1.0)

Rubber Yarn Gauge		Denier	Yards Per Pound
Extruded	Cut		
16	18	17,898	250
21	24	10,066	445
26	30	6,443	695
30	34	5,017	893
32	36	4,476	1,000
34	38	4,017	1,115
36	40	3,625	1,235
38	42	3,360	1,329
40	44	2,997	1,494
41	46	2,741	1,634
42	48	2,520	1,772
44	50	2,320	1,930
45	51	2,240	1,993
48	54	1,989	2,251
50	56	1,850	2,420
52	58	1,680	2,657
60	64	1,416	3,162
62	70	1,183	3,785
64	72	1,120	3,986
65	74	1,059	4,228
74	83	840	5,315
75	85	802	5,583
85	96	614	7,292
89	98	560	7,972
90	100	580	7,720
95	106	516	8,652
100	112	461	9,157
103	114	420	10,630
110	124	371	12,069
120	135	318	14,876
125	140	284	15,680
126	140	280	15,945
135	152	253	17,699
140	158	230	19,468
150	170	202	22,167
160	180	176	25,442
180	200	140	31,890
200	226	113	39,626
250	280	70	63,779

NOTE:

- 1) Deniers in which *Chemstrand Blue "C"* spandex is supplied are printed in *blue*.
- 2) The normal range of gauges in which extruded rubber yarns are supplied is printed in *red*.
- 3) The normal range of gauges in which cut rubber yarns are supplied is printed in *yellow*.

PROPERTIES

TABLE 7. PHYSICAL PROPERTIES OF CHEMSTRAND BLUE "C" SPANDEX AS SHIPPED

Item	Data
Deniers Available	70, 140, 280, 420, 560, 840, 1120, 1680, 2240, 2520, and 3360. All deniers are supplied as zero twist yarn in which the individual filaments are joined to form a fused, coalesced multifilament yarn.
Tenacity (grams per denier)	0.55-0.75
Tensile Strength (pounds per sq. in.)	8,800-12,000
Elongation at Break (per cent)	500-600
Power on Second Cycle at 50% Elongation	0.020 grams per denier or 320 p.s.i.
Power on Second Cycle at 200% Elongation	0.048 grams per denier or 768 p.s.i.
Power on Second Cycle at 300% Elongation	0.085 grams per denier or 1,360 p.s.i.
Tensile Recovery from 50% Elongation (per cent)	94-98
Moisture Regain at 65% R.H.—70°F (per cent)	1.3
Shrinkage in Boiling Water (per cent)	6 (approx.)
Specific Gravity	1.25
Melting Point	290°C or 554°F
Sticking Temperature	278°C or 534°F
Luster	Semi-dull
Color	An excellent white
Flexlife	Exceptionally high
Resistance to Abrasion	Good
Dielectric Constant (film)—1000 cps.	5.1
— 60 cps.	6.1
Static and Friction Levels	Develops less static and runs with less friction than other commercial spandex type yarns.
Effect of 10 Hours' Sunlight Exposure on Color	Slight.

NOTE: Data reported was obtained in tests carried out on 420 denier Blue "C" spandex.

THE FORMS IN WHICH CHEMSTRAND BLUE "C" SPANDEX IS UTILIZED

Chemstrand Blue "C" spandex may be utilized by the fabric manufacturer in any of three forms: 1) bare—as shipped, 2) spirally-covered with textile yarns, or 3) core-spun. The decision as to whether bare, covered, or core-spun *Blue "C"* spandex is used depends primarily on fabric construction, fabric styling, on the amount of holding power desired, and—most important of all—on the fabric end use. In Raschel power net fabrics powered with *Blue "C"* spandex, the spandex is normally used either covered or bare. Bare *Blue "C"* spandex makes for lighter and more supple garments because there are no covering yarns to add to the weight of the fabric. On the other hand, by wrapping *Blue "C"* spandex with nylon or other covering yarns, it is possible to regulate the amount of stretch in the fabric and increase its modulus. Similar considerations in regard to the choice of bare or covered *Blue "C"* spandex likewise apply in the case of circular knit fabrics for swimwear, girdles and support hosiery elasticized with the yarn. In the weaving of fabrics for foundation and support garments, covered spandex is almost always employed.

While the use of bare and covered *Blue "C"* spandex is confined mostly to fabrics for foundation and other types of *support garments*, *Blue "C"* spandex core-spun yarns offer unlimited potential in fabrics for virtually every area of apparel including suits, slacks, sports coats, sports shirts, rain wear, walk shorts, outer jackets, half-hose and sweaters.

The many new fabrics being powered with core-spun *Blue "C"* spandex are designed not for form-fitting garments, but primarily for garments having the proper amount of stretch to induce wear comfort. *Besides offering unusual comfort, the new fabrics have exceptional recovery from stretch with the ability to return time and time again to their original dimensions.*

The characteristics of covered *Blue "C"* spandex and the technique of covering are discussed on pages 25 to 36. Bare *Blue "C"* spandex is discussed briefly on page 39. For the characteristics of yarns spun with a core of *Blue "C"* spandex together with a description of Chemstrand's core-spinning technique see pages 43 to 58.

COVERING

COVERING

The objects and advantages of covering *Chemstrand Blue "C"* spandex are briefly as follows:

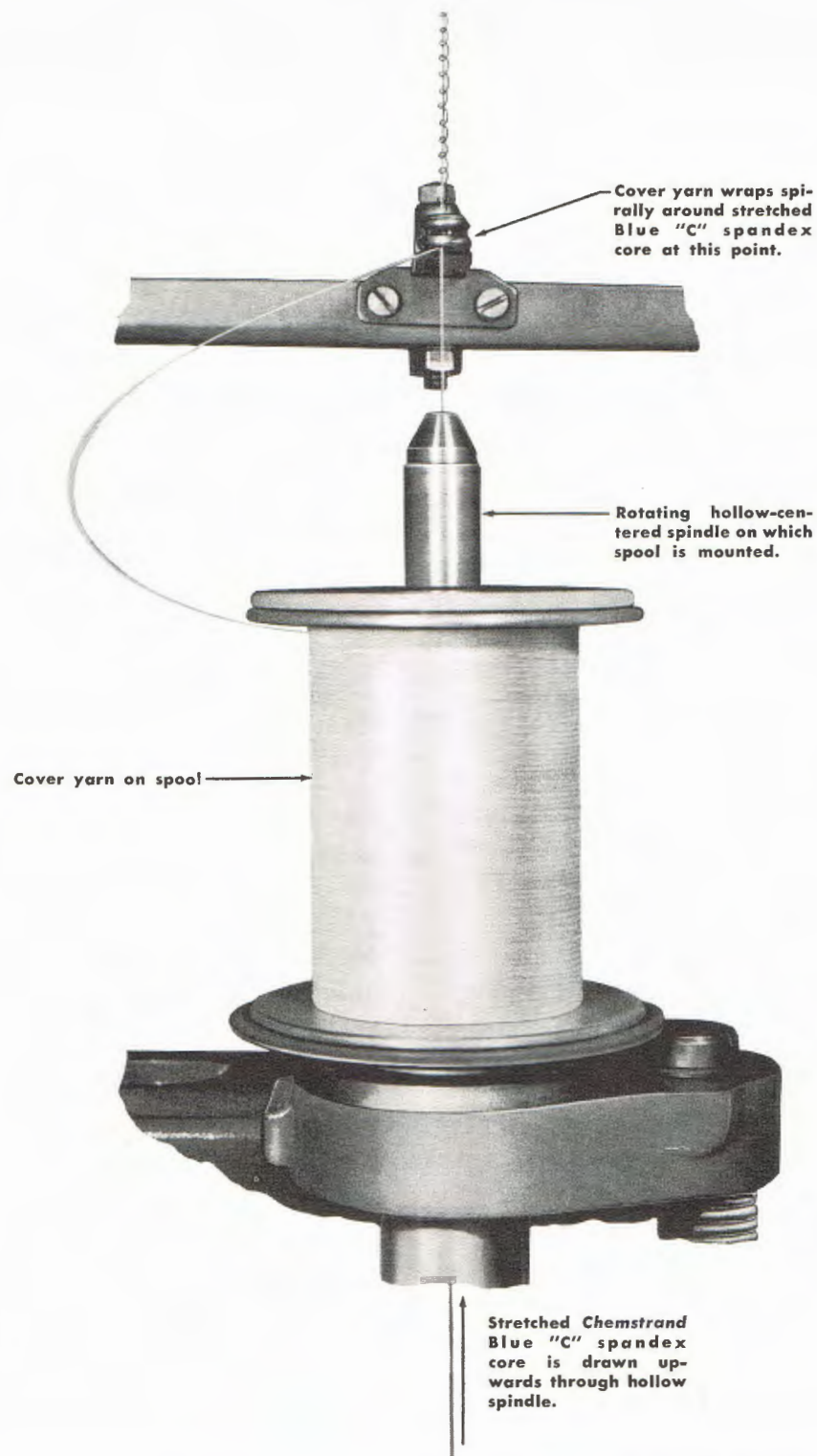
1. Covering creates greater opportunities for engineering fabrics because the only control over *Blue "C"* spandex when used bare is in the knitting, weaving, or other fabric manufacturing operation. In the case of covered *Blue "C"* spandex however, control of stretch and holding power begins in the covering operation before construction of the fabric is even started. And further control is built in via fabricating and styling.
2. Covered *Blue "C"* spandex can be made to give the proper modulus for any type of foundation garment, and is essential for high modulus fabrics designed for maximum figure control.
3. The covering yarns add to the textile hand and appearance of the fabric.
4. Covering *Blue "C"* spandex reduces some of the causes of chafing and contributes to a stronger, more tear-resistant fabric.
5. Finer deniers of *Blue "C"* spandex can be used because of the extra strength and protection afforded by the cover yarns.
6. Covered yarns are easier to control and utilize in knitting and weaving operations.

Blue "C" spandex covers with extreme ease. The reasons: 1) its high strength and great uniformity which result in excellent processability on both conventional flyer and high-speed flyerless covering machines, and 2) its resistance to abrasion which is great enough to permit the use of the finest denier covering yarns without loss of machine efficiency or covered yarn quality.

THE PRINCIPLE OF COVERING

The principle of covering *Chemstrand Blue "C"* spandex is a simple one, and is illustrated in Figure 6. Note that the textile covering yarn, which may be single or multi-end, is held on a spool or bobbin, which in turn is mounted on a rotating hollow-centered spindle. The covering yarn passes over-end from the bobbin as the stretched *Blue "C"* spandex core is drawn upward through the spindle, and in so-doing

wraps spirally around the core yarn above the nose of the spindle. If a double covered yarn is required, the *Blue "C"* spandex core wrapped with the first or bottom cover is passed vertically through a second hollow spindle. This is mounted directly above the bottom (first) spindle but rotates in the opposite direction and applies the second or top cover.



Courtesy: Schaffhouse Knitting Machine Works Limited

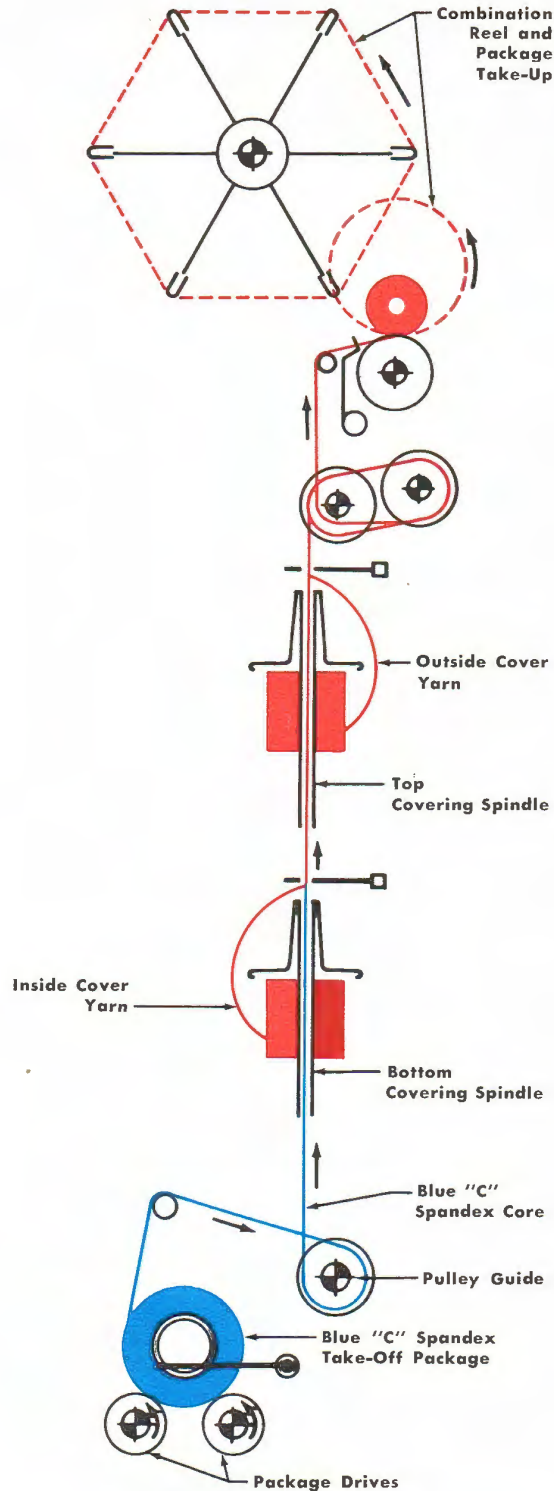
Fig. 6—Representation of the principle of covering—in this case on the flyerless high-speed spindle of a SUMA covering machine.

The covered spandex is taken off on a suitable package—generally in single end form. The relationship between spindle speed, spandex feed and covered spandex take-off determine the characteristics of the covered yarn, and all play a vital role in the production of balanced yarns having the required elongation, modulus, spandex content and appearance.

A threadline diagram of a typical high-speed flyerless covering operation is shown in Figure 7. Note in Figure 7 that the *Blue "C"* spandex core is being covered with two yarns, and that these are being applied in opposite directions ("S" and "Z" directions respectively) so that the resultant yarn, i.e., the covered *Blue "C"* spandex yarn is "balanced," or in effect has zero torque. In the event that four covering yarns were to be applied, two ends—not plied—would be fed from each of the two rotating spindles shown on the machine.

Because the covering process results in a yarn in which the *Blue "C"* spandex is held in an elongated state, the initial modulus and power of covered yarns are distinctly higher than those of bare yarns. There are two principle reasons for this:

1. The covering yarns limit the amount of elongation of the total yarn structure since the covers jam at a pre-determined point as the yarn is stretched.
2. As the core yarn contracts, the covering yarns also jam at a pre-determined minimum tension. This fixes the length of the yarn at rest and permits construction of more open fabrics. The two jamming points control the maximum and minimum tension limits between which the yarn will operate, and thus control the power and elongation of the final fabric.



Courtesy: Officine Meccaniche Menegatto.

Fig. 7—Threadline diagram of a typical covering operation—in this case on an O.M.M. high-speed flyerless type covering machine.

DEGREE OF STRETCH IN COVERED YARNS

As discussed earlier, the principal reason for covering *Chemstrand Blue "C"* spandex is to control its elongation and modulus (power). Because of this, the specific elongation built into the covered yarn depends primarily on the specific end-use application. Covered *Blue "C"* spandex for weaving, for example, will normally have an elongation in the range of 110 to 130 per cent, while for power net fabrics an elongation in

the range 185 to 200 per cent is generally required. Both these elongation ranges are, of course, considerably less than the 500 to 600 per cent elongation present in bare (uncovered) *Blue "C"* spandex.

Because of the number of variables* involved in covering spandex, a variation of 10 to 20 per cent stretch in any given lot of covered yarn is generally commercially acceptable in the trade.

OPERATING SUGGESTIONS FOR COVERING CHEMSTRAND BLUE "C" SPANDEX

Methods have been developed for covering *Chemstrand Blue "C"* spandex which enable operating efficiency and product quality to be maintained at a very high level. Effective and practical modifications to present practice for covering rubber yarns, as well as practical hints that will help insure optimum processing when covering *Blue "C"* spandex, are outlined below:

1. In threading a rubber core yarn through a covering machine, the general practice is to run the yarn from the supply package through a pigtail guide before wrapping the yarn several times around the feed "star" wheel. But a rubber yarn is a monofilament yarn, whereas the form of *Blue "C"* spandex is that of a coalesced or fused multifilament structure. This explains why *Blue "C"* spandex—to avoid plucks and snags which often result in broken individual filaments, poor quality covered yarn and (eventually) ends down—should always be fed around the star wheel,

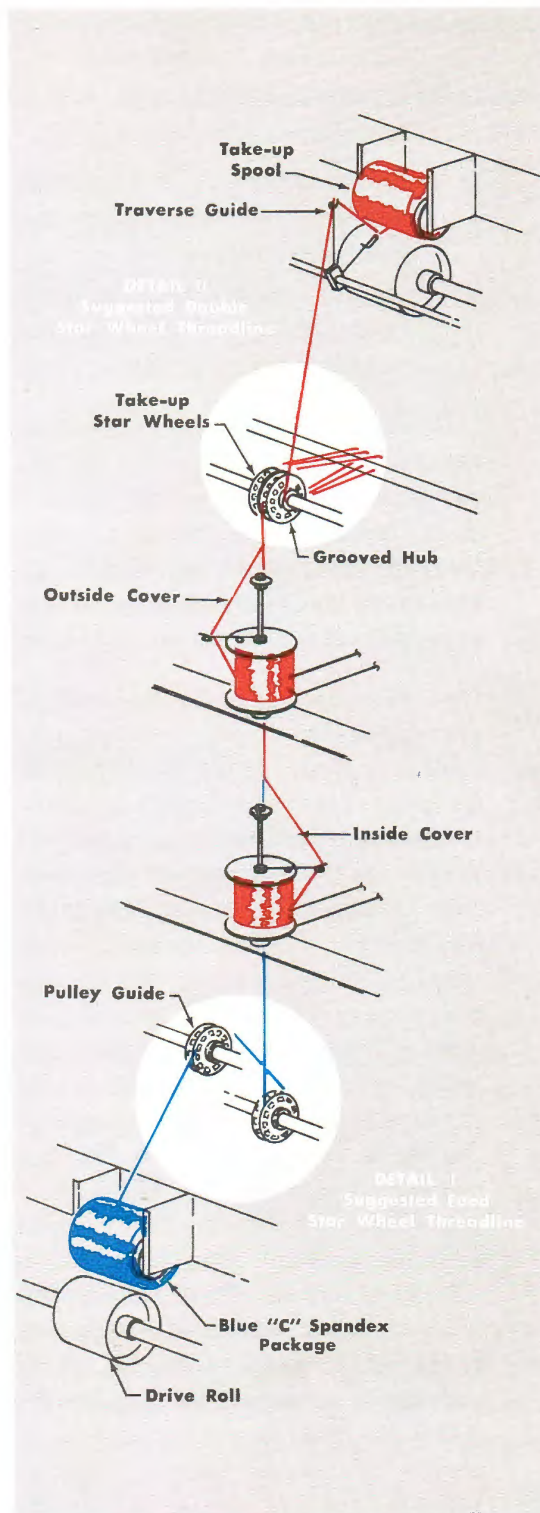
not several times, but less than once, as shown in Figure 8, detail I. To maintain sufficient friction on the yarn with the feed "star" wheel, the arc of contact of the yarn should be increased to the maximum possible without actually making a full wrap.

2. Frequent inspections should be carried out to insure that there are no burrs or nicks on the feed "star" wheel that might cause breaks in the individual filaments of the *Blue "C"* spandex core. In removing wraps, care should be exercised to prevent damage to the "star" wheels. In this regard, the use of a hook to lift the wrap from the "star" wheel will not only facilitate removal of the wrap, but also prevent damage to the "star" wheels.
3. To keep the *Blue "C"* spandex taut without excessive stretching, a slight draft greater than 1.0 (ratio of delivery surface speed to feed surface speed) is necessary between the feed rolls and the feed "star" wheel. A draft

*Just two of the variables liable to be encountered in covering synthetic elastomer yarns such as *Chemstrand Blue "C"* spandex include: basic differences between covering yarns and differences in the degree of choke used.

of 1.30 is normally adequate in this section. Use of a higher draft may cause the supply package to slip on the feed rolls with consequent loss of control.

4. In order to maintain uniformity in the covered yarn, steps should be taken to prevent slippage of the covered yarn over the take-up "star" wheel. A satisfactory method to prevent slippage and resultant production of uneven yarn is to use two "star" wheels on the same shaft with the threadline arrangement as shown in Figure 8, detail II. This method of threading will control variation in stretch between positions within five percentage points.
5. Well-balanced, smooth-appearing covered yarns having excellent stretch and return characteristics can be made using core drafts of 3.5 to 4.0 (250 to 300 per cent elongation) for 280-, 420- and 560-denier *Blue "C"* spandex and core drafts of 2.5 to 4.0 (150 to 300 per cent elongation) for 70- and 140-denier *Blue "C"* spandex. Core yarn drafts exceeding 400 per cent should be used only with extreme caution. The reasons: 1) excessive drafts that approach the ultimate elongation of the spandex core too closely will cause core breaks and excessive ends down, and 2) covered yarns produced using excessive drafts have a softer hand, poorer appearance, and take longer to produce.
6. The covering operation must be carried out with precision.
7. Covering yarns must be free of coning oils detrimental to the spandex core. A simple test to determine whether a particular covering yarn finish is harmful to the *Blue "C"* spandex core can be carried out as follows:



Courtesy: H. H. Arnold Co., Inc.

Fig. 8—Threadline diagram of a covering operation on a conventional flyer type covering machine.

- i.) immerse a sample of the spandex in the coning oil for 24 hours.
- ii.) remove sample and rinse well in carbon tetrachloride.
- iii.) air dry sample and allow to condition in a standard atmosphere with the control yarn.
- iv.) compare tensile properties of the sample with those of the control yarn on an incline plane tester.

If the tensile properties of the spandex sample immersed in coning oil are comparable to those of the control yarn, then the coning oil used on the covering yarns can be considered suitable from the point of view of not being detrimental to the spandex core.

8. The diameter and the amount of stretch of a covered yarn will vary from beginning to end of the take-up package unless prior adjustments are made to correct, in part, this occurrence. The reason: as the diameter of the covering yarn bobbins decreases, the tension of the covering yarns on the core increases. This, of course, changes the diameter of the covered yarn as it is made. To compensate for this action and to insure a uniform product, the covering machine should be set so that the wraps per inch decrease with the increase in tension. This will produce a covered yarn with a uniform diameter and uniform elongation. There will, however, be a variation in the yards per pound from the beginning of the take-up spool to the end, which will result subsequently in a weight difference from beginning to end in section and warp beams. Because, however, the unevenness is uniform within the set of bobbins as they are taken from the machine, the resulting fabric will vary slightly in weight,

again from beginning to end, but will be free from warp streaks.

9. Take-up packages should be filled to run out at the same time, and both top and bottom decks should be doffed at the same time.
10. In double covered yarns, the relative speeds of the top and bottom spindles *must* be adjusted so that the resulting covered yarn is torque free. It is also important that a good "break" be achieved, i.e., when the covered thread is taken beyond its ultimate stretch limit, the covering yarns should break at the same time, or very slightly before the spandex core breaks.
11. Any guide surfaces on the covering machine that cannot be eliminated should be made to rotate. Rotating guides must be free-running and have a low coefficient of friction.
12. Best results are obtained when atmospheric conditions in the covering room are maintained at 65 per cent R.H.—70° to 75°F or thereabouts.
13. A word on cleanliness. In order to minimize "seconds" and run a successful operation, the maintenance of high standards of housekeeping and cleanliness in the covering room is vital. To this end:
 - i.) Encourage, and stress to operators the necessity for personal cleanliness.
 - ii.) Clean machines frequently and keep all guide surfaces and other yarn contact points free of finish, dirt and other foreign matter.
 - iii.) Avoid over-lubrication.
 - iv.) Do not remove the cellophane wrappers from *Blue "C"* spandex packages until the packages have

actually been placed on the covering machine.

14. Effective quality control in covering is essential to the production of a uniform end product. This control must be exercised from receipt of both covering yarns and *Blue "C"* spandex alike.
15. To achieve the best covering results it is advisable to have the assistance or services of those experienced on the specific equipment to be used for

this purpose. Each covering machine has its own peculiarities based on gearing system, diameter compensation system, and take-up package. Only those skilled in the covering of elastic yarns can achieve the desired yarn with a minimum of lost time and costly experimentation. The various types of machines currently used for covering spandex differ considerably from each other. All of them however, use the hollow spindle principle of covering.

COVERED YARN CONSTRUCTIONS

Typical *Chemstrand Blue "C"* spandex covered yarn constructions for various end uses are outlined in Table 11. Spun cotton (usually combed cotton) and continuous filament rayon, acetate and nylon yarns are all used extensively as covering yarns for *Blue "C"* spandex either by themselves or in combination with each other.

COTTON COVERING YARNS

The counts of cotton yarns used for covering *Blue "C"* spandex normally range from 40/1 to 80/1. Long staple blends with fibers ranging from 1.10 to 1.15 inches long are used in most cases. The turns per inch of twist in cotton covering yarns should be higher than those normally used in common warp, filling or knitting yarns. For 50's combed cotton yarns use 30 t.p.i.; for 60's yarns, 32 t.p.i.

CONTINUOUS FILAMENT COVERING YARNS

For better appearance and sheerness, particularly where the filling yarns are more on

the surface, continuous filament rayon, acetate, or nylon yarns in deniers ranging from 70 to 140 are used as covering yarns for *Blue "C"* spandex. In the foundation field (one of the largest markets for elastic fabrics) two of the most predominant fabrics are nylon and rayon power net. In nylon power nets, the non-elastic yarn component can be a 50- to 140-denier nylon with the elastic component (spandex) covered with rayon and/or acetate, either 100-denier top and 100-denier bottom or 100 by 50. Rayon power net is generally constructed with 150-denier rayon and/or acetate as the non-elastic component, while the spandex is usually covered with 50/1 cotton or 150-denier rayon and/or acetate. A few turns per inch are usually inserted in filament yarns used in covering *Blue "C"* spandex. In the case of 150 den.-24 fil. acetate yarn for example, 2½ t.p.i. are generally satisfactory.

TABLE 11. TYPICAL CHEMSTRAND BLUE "C" SPANDEX COVERED YARN CONSTRUCTIONS

End Use	Core	Inner Covering	Outer Covering	Stretch Per Cent
Surgical Hosiery	70-denier <i>Blue "C"</i> spandex	20-denier <i>Chemstrand</i> nylon	20-denier <i>Chemstrand</i> nylon	200
Power Net	420-denier <i>Blue "C"</i> spandex	100-denier acetate	100-denier acetate	140
Power Net	420-denier <i>Blue "C"</i> spandex	75-denier acetate	75-denier acetate,	190-200
Power Net	560-denier <i>Blue "C"</i> spandex	100-denier acetate	100-denier acetate	175-200
Power Net	1680-denier <i>Blue "C"</i> spandex	100-denier rayon	100-denier rayon	150
Power Net	560-denier <i>Blue "C"</i> spandex	50/1 cotton	50/1 cotton	140
Swimwear	140-denier <i>Blue "C"</i> spandex	40-denier <i>Chemstrand</i> nylon	40-denier <i>Chemstrand</i> nylon	130

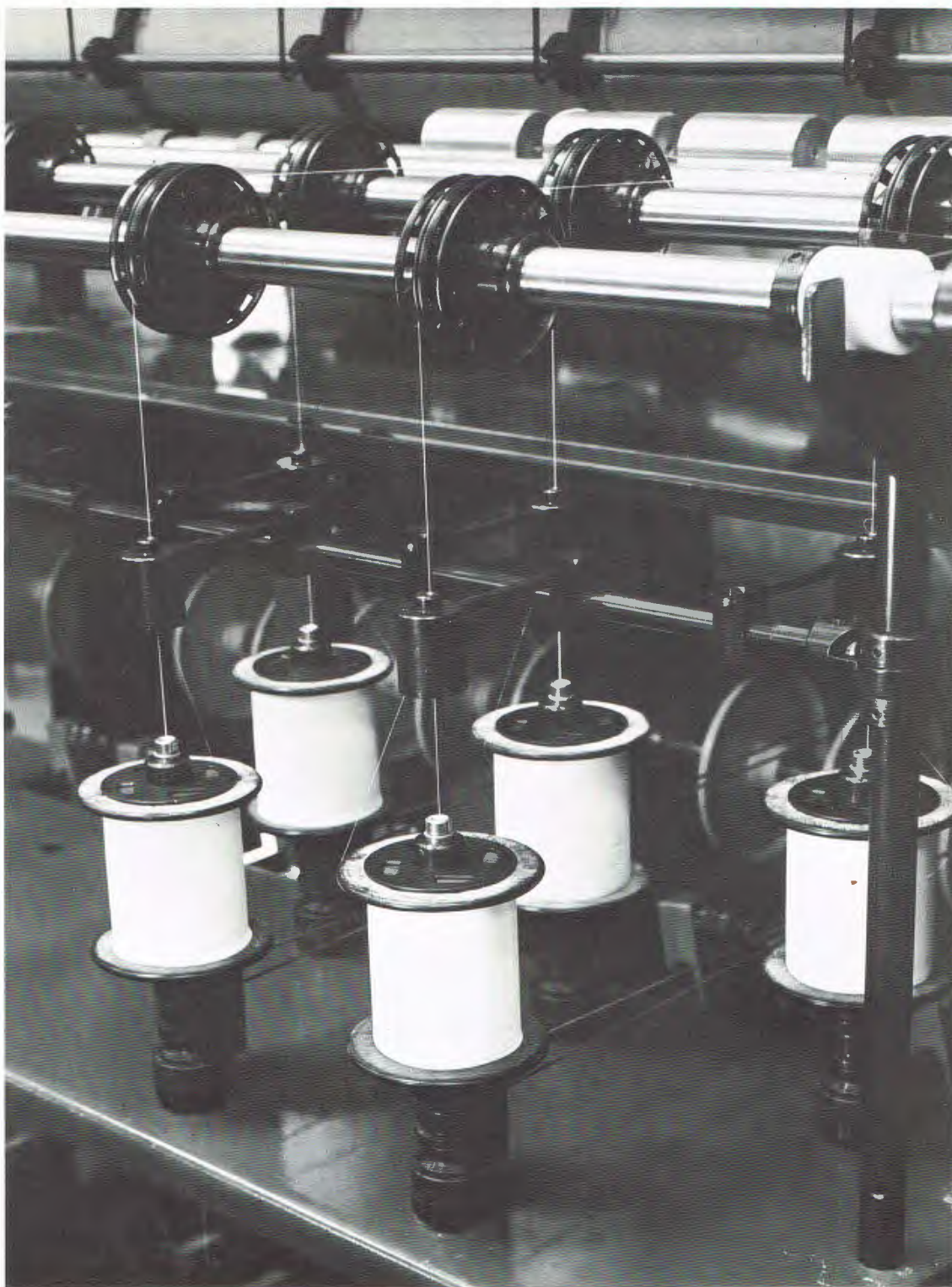
TYPES OF COVERING MACHINES

There are two types of covering machines: 1) conventional flyer type machines such as the one shown in Figure 9 (these operate at spindle speeds in the range of 5,000 to 10,000 rpm), and 2) the more recently developed high-speed flyerless covering machines such as the ones shown in Figures 10, 11 and 12. Machines of this type op-

erate generally at spindle speeds in the range of 6,000 to 16,000 rpm. The substantial increase in spindle speeds and hence in productivity of the high-speed flyerless covering machines over the conventional type machines is made possible by the use of air-drag to tension the textile covering yarn instead of a flyer or ring traveler.



Fig. 9—The Arnold Conventional Flyer Type Covering Machine, a machine used extensively in the U.S. for the covering of Blue "C" and other spandex yarns.



Courtesy: H. H. Arnold Co., Inc.

Fig. 10.—Close-up showing the flyerless spindles of an Arnold Model F7 High-speed Covering Machine.

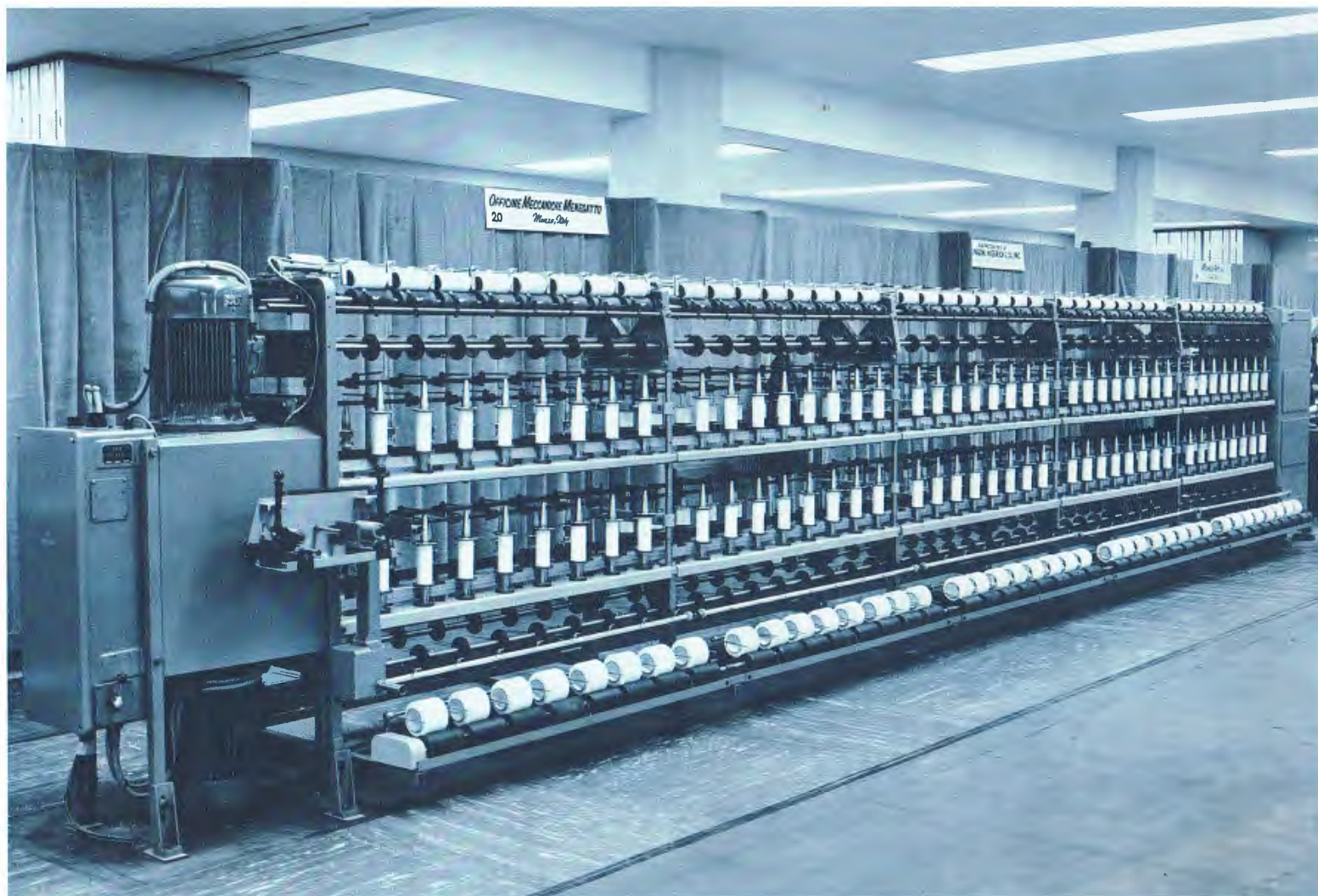
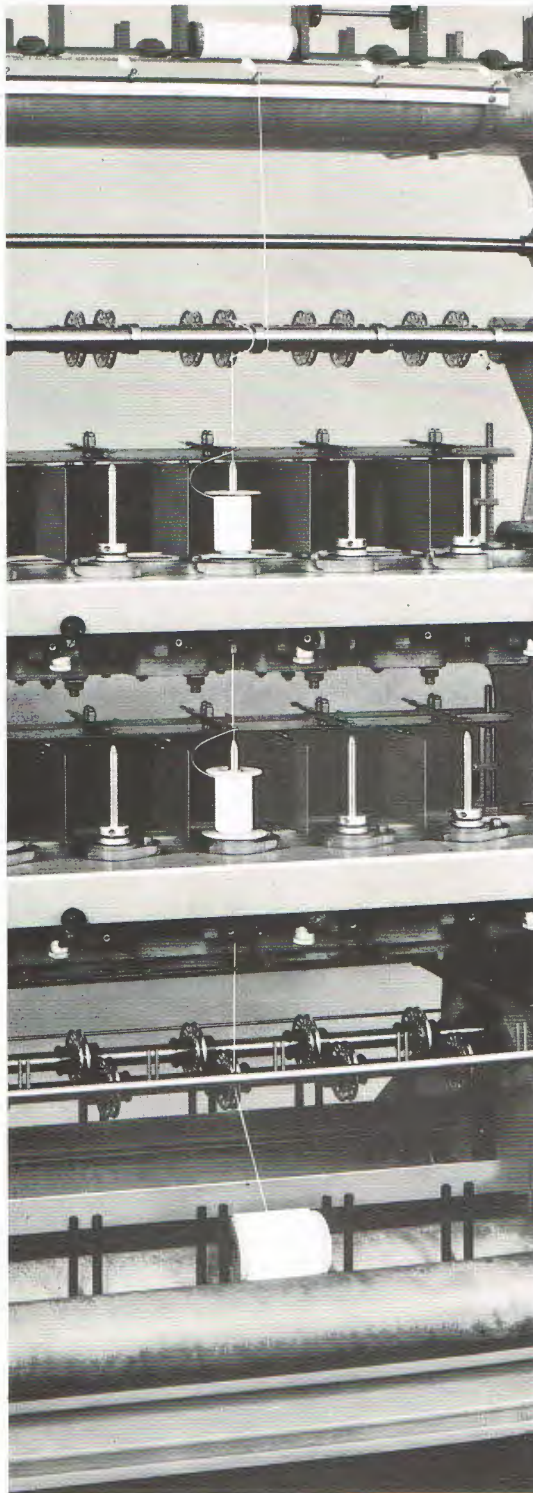


Fig. 11—The O.M.M. Model 63 High-speed Flyerless Covering Machine.

Courtesy: Officine Meccaniche Menegatto.



Courtesy: Schaffhouse Knitting Machine Works Limited.

Fig. 12—A section of the SUMA High-speed Flyerless Covering Machine.

CORE SPINNING

CORE SPINNING

Yarns spun with a core of *Chemstrand Blue "C"* spandex make possible an unlimited variety of fabrics having astonishing stretch properties for virtually every area of apparel including women's and children's dresses, blouses, slacks, shorts, anchored pants, suits, swimwear, ski wear, rainwear, sweaters, car coats and uniforms. And in men's and boys' wear: suits, slacks, sports coats, dress and sports shirts, walk shorts, swimwear, ski wear, rainwear, golf jackets, half-hose, and zip-lined outer coats. In terms of their general ease of processing and handling, their great uniformity, and their high performance characteristics, the new core-spun yarns are unexcelled, and offer tremendous potential to all manufacturers of stretch fabrics—both woven and knitted.

The new yarns, made by a unique core spinning technique developed by *Chemstrand**, (see Figures 13 and 14) have a center filament (core) of bare *Blue "C"* spandex which is sheathed by man-made and/or natural textile fibers. Almost any cotton, worsted, or woolen spinning frame, with a few simple and relatively inexpensive modifications, can be adapted for spinning core-spun yarns using *Chemstrand's* technique. Rates of production are high, and process costs are only a fraction more than those incurred in the production of regular spun yarns.

Some idea of the potential of core-spun yarns may be gauged from recent market studies which forecast that by 1970, the market in the U.S. for spandex will have increased from the current rate of 10 million pounds plus, to 40 million pounds, with core-spun yarns accounting for the major portion of this growth. Key factors contributing to the rising production of core-spun yarns include: their great popularity in

sweaters, half-hose, sportswear and other items of apparel; their excellent stretch and recovery from stretch under *all* conditions; the permanence of their stretch-recovery characteristics; and the fact that core-spun yarns can be spun into high counts and used therefore, in new, lighter weight, stretch fabric constructions. Other advantageous features of yarns spun with a *Blue "C"* spandex core include:

1. Because of its high elongation (500 to 600 per cent), a low percentage of *Blue "C"* spandex in the core-spun yarn (5 to 10 per cent) can impart high degrees of stretch to a fabric. Alternately, through proper selection of processing conditions, a medium or a short stretch can be achieved. In other words, any desired degree of stretch can be built into the core-spun yarn during spinning to meet the requirements of the fabric in use.
2. The aesthetic properties of the sheath fibers are maintained. This means that fabrics for example, woven from a core-spun *Blue "C"* spandex—polyester—cotton blend, in addition to having remarkable elastic properties, look like, feel like, and generally perform like the basic blend of polyester and cotton fibers.
3. The *Blue "C"* spandex core readily accepts the dyes used on the sheath fibers.
4. The fact that *Blue "C"* spandex can be heat-set insures good dimensional stability in the fabrics in which the core-spun yarns are used.
5. Fabrics made from yarns spun with a core of *Blue "C"* spandex have complete washability and dry-cleanability.

*Patent applied for.

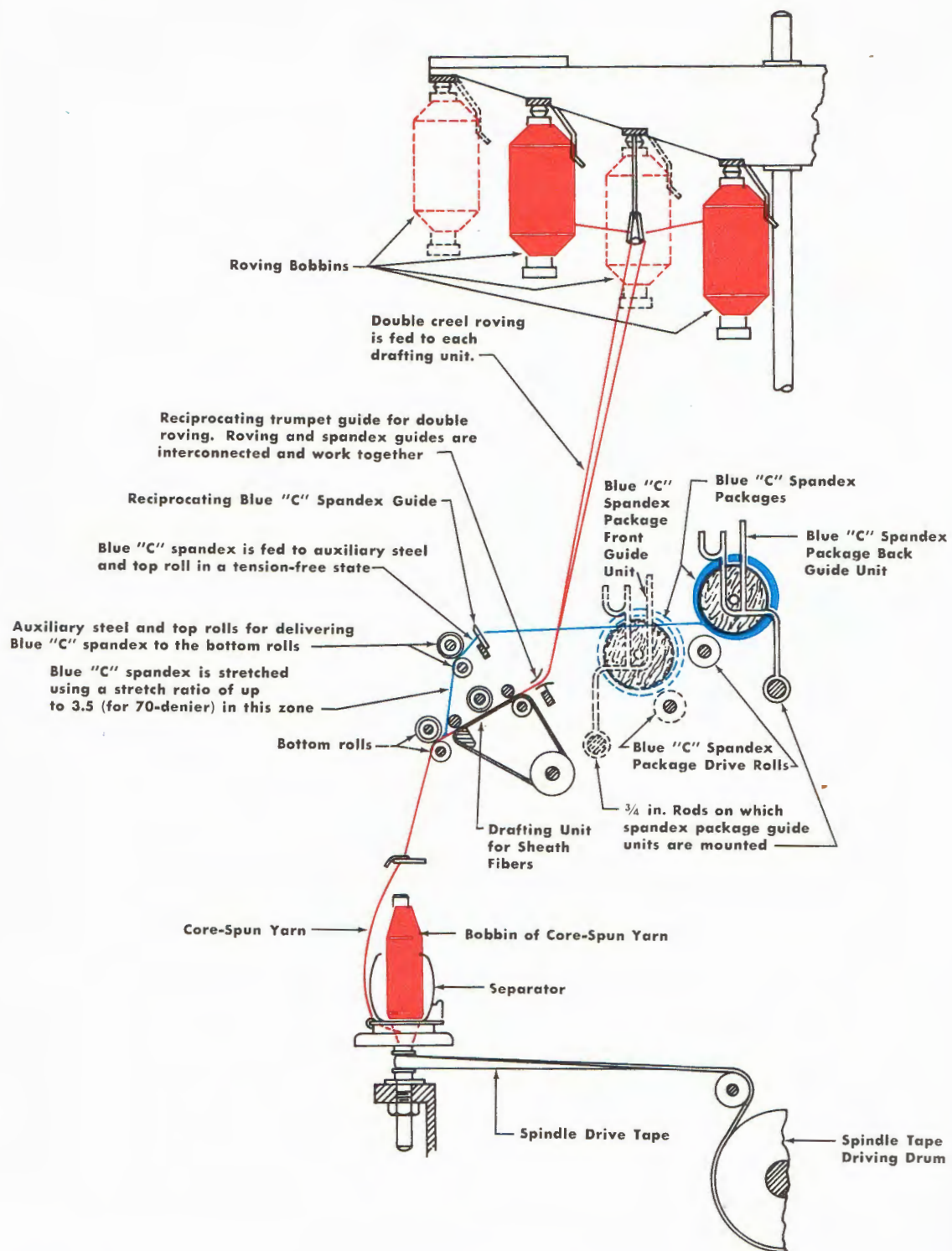


Fig. 13.—Diagrammatic representation of a cotton system spinning frame adapted for core spinning Blue "C" spandex.

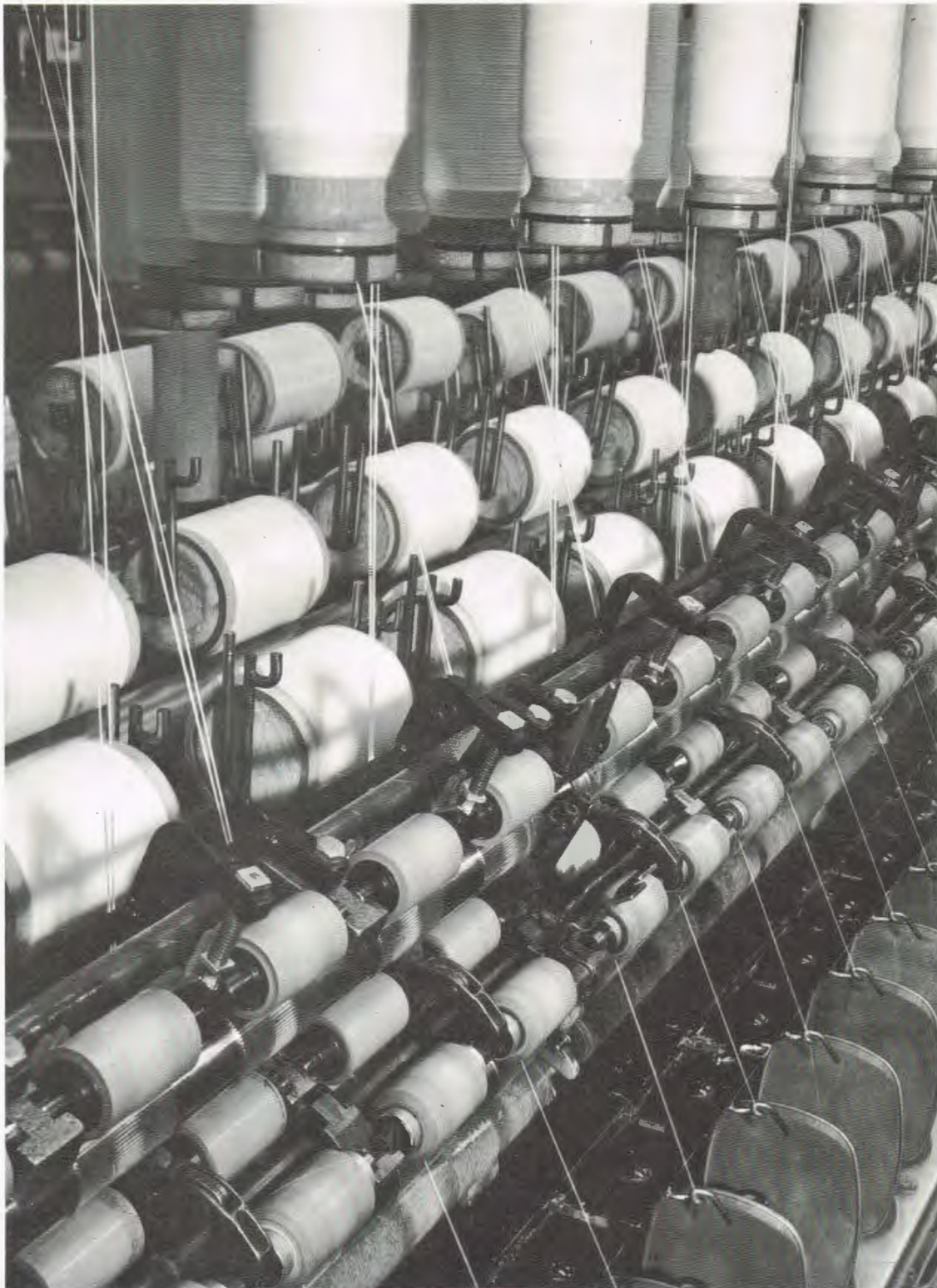


Fig. 14—Core spinning Chemstrand Blue "C" spandex on a Saco Lowell Z2 spinning frame in Chemstrand's Applications Research and Service Department.

6. Finally, fabrics made with core-spun yarns fulfill a need felt by millions of Americans for apparel items which combine freedom of movement with excellent appearance . . . shape recovery with long wear . . . and unmatched functionalism with easy care. Whether it be in a pair of slacks that give slightly at the knee when the wearer sits, or a pair of socks that stays up, or ski pants that fit like a second skin, or automotive upholstery that conforms to the contour of the car seat, stretch can be an advantage. Additionally, clothing made with the proper amount of stretch is more comfortable

to wear. And bagging and sagging at the elbows, knees, or other anatomical salients are virtually eliminated. In other words, if conformity of fabric to contour is desired, the use of core-spun yarns is one of the best ways to get it.

A cotton system spinning frame in Chemstrand's Applications Research and Service Department, adapted for core spinning *Blue "C"* spandex using the technology developed by Chemstrand is shown diagrammatically in Figure 13 and pictorially in Figure 14. Briefly, the technique is as follows:

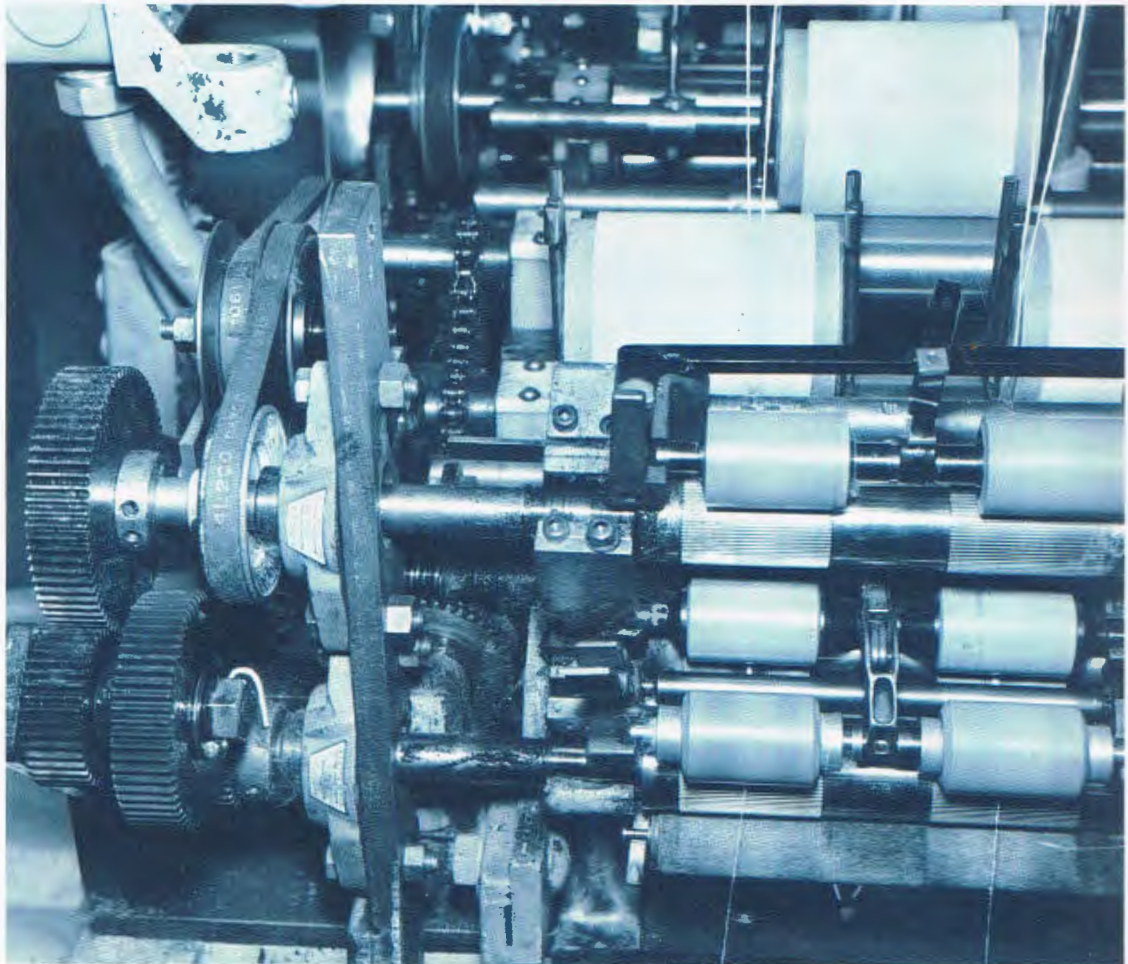


Fig. 15—Drive end of the spandex package drive roll assembly and auxiliary steel roll of a cotton system spinning frame customized for core spinning.

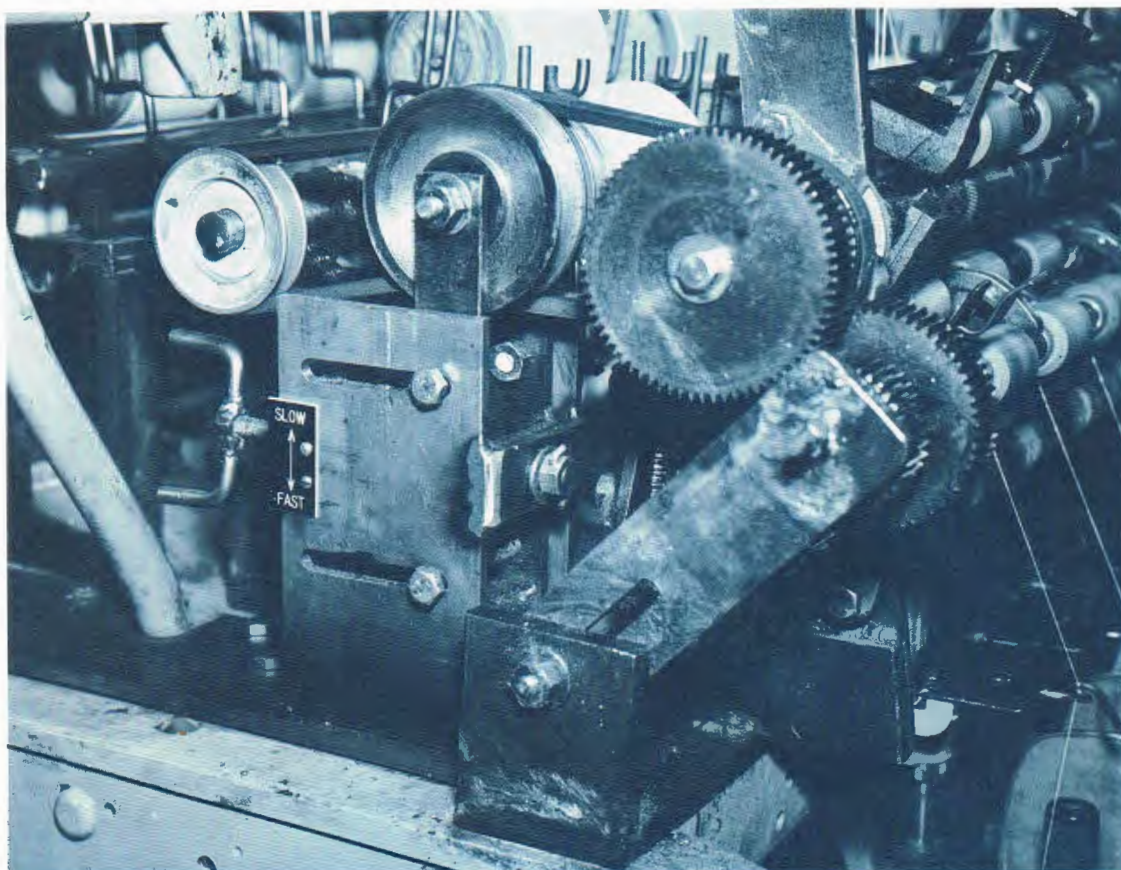


Fig. 16—Side view of the V-belt drive to the spandex package drive rolls through a variable speed pulley from the auxiliary steel roll.

1. Double creel roving of the textile fiber or blend of textile fibers is fed through the drafting elements using standard drafts, settings and speeds. As a point of interest, spinning frames equipped with either conventional drafting systems, or high or superdraft drafting elements of both the single- and double-apron types may all be used satisfactorily.

NOTE: Although if desired, single creel roving can be used for yarn counts up to 20/1 c.c. double creel roving always gives the best results.

2. The Blue "C" spandex is fed in a tension-free state to the auxiliary steel and top rolls. These, in turn, deliver the spandex (under controlled tension), to the nip of the bottom rolls where the spandex joins the double creel textile fiber roving.

3. On emerging from the nip of the bottom rolls, twist is inserted and the textile fibers form a sheath around the Blue "C" spandex core to form a core-spun yarn.

EQUIPMENT

Essentially, the customizing of a spinning frame for core spinning using Chemstrand's proven technique calls for the installation of 1) a spandex creel and package roll drive assembly, and 2) an auxiliary steel roll with top rolls for feeding the spandex.

Close-up views of a cotton system spinning frame adapted for core spinning in this manner are shown in Figures 15 and 16. Suitable spandex package drive rolls can be constructed from sections of 1½-inch

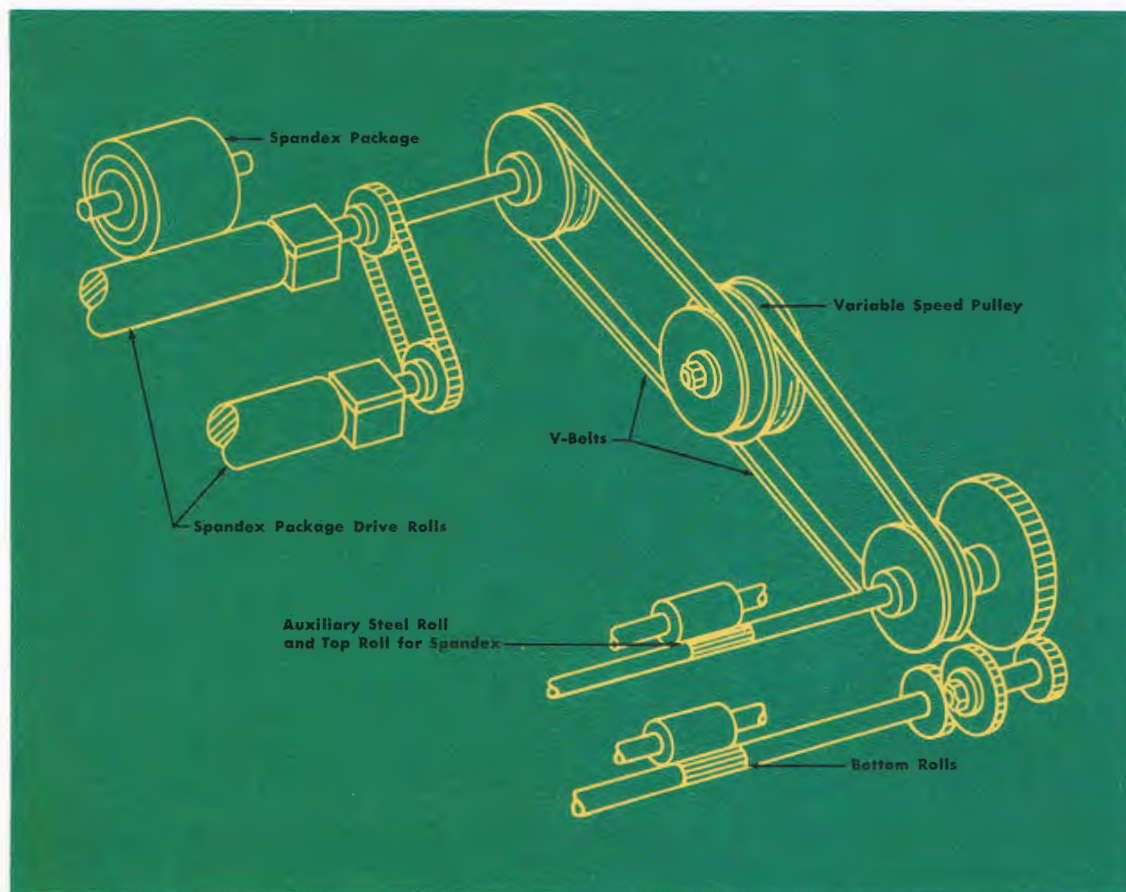


Fig. 17—Sketch showing gear, V-belt and chain drives to the auxiliary steel roll and the spandex package drive rolls.

stainless steel pipe Sch. 10 $1\frac{1}{16}$ -inch I.D. with intermediate journals running in nylon bearings between each section, and neck journals running on roller bearings at each end. The length of each roll section will naturally depend on the circumstances, but in general should not exceed 70 inches. The package drive rolls are driven by a V-belt drive through a variable speed pulley from the auxiliary steel roll as shown pictorially in Figures 15 and 16, and diagrammatically in Figure 17.

Spandex Package Guides

Back and front spandex package guide units can be fabricated from $\frac{1}{4}$ -inch stainless steel rod. Drawings of these guide units are shown in Figure 18.

Auxiliary Steel Roll

The auxiliary steel roll and top rolls for feeding the spandex can usually be purchased from the maker of the spinning frame on which they are to be installed.

Arbors

A wooden arbor is inserted inside the paper tube core of each Blue "C" spandex package to facilitate unwinding in the creel. Each arbor is $4\frac{5}{8}$ in. long $\times$ $2\frac{5}{8}$ in. in diameter and—to insure a snug fit inside the core—is fitted with either two $\frac{1}{4}$ -inch metal strips as shown in Figure 19, or with round head tacks around the perimeter at each end, as shown in Figure 20. A $\frac{1}{4}$ -inch diameter steel rod runs through the center of the arbor and extends $\frac{1}{4}$ -inch on each side.

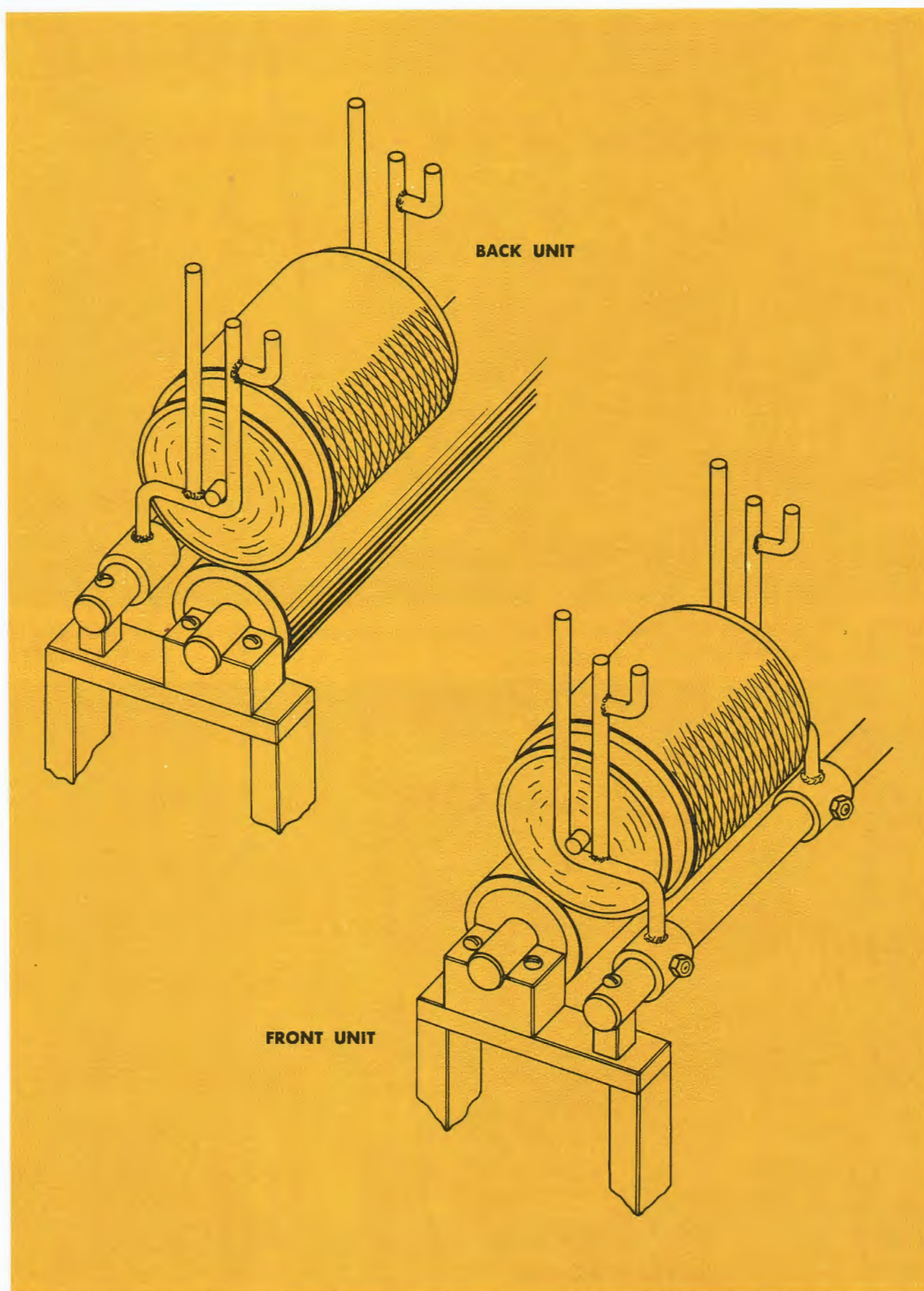


Fig. 18—Spandex package drive and guide assembly.



Fig. 19—A wooden arbor with two 1/4-inch metal strips fits snugly inside the paper tube core of each Blue "C" spandex package.



Fig. 20—If desired, a wooden arbor with round head tacks around the perimeter at each end may be used as an alternative to the arbor shown in Figure 19.

TECHNOLOGY

The following information and suggestions in regard to the production of *Blue "C"* spandex core-spun yarns are offered as a guide to assist mills in obtaining optimum results.

BLENDS USED

Fiber combinations that have been core spun with complete success in Chemstrand's Applications Research and Service Department using Chemstrand's core-spinning technique include:

*Acrilan** acrylic fiber—*Blue "C"* spandex.

Acrilan—wool—*Blue "C"* spandex.

Polyester—cotton—*Blue "C"* spandex.

Cotton—*Blue "C"* spandex.

Polyester—*Blue "C"* spandex.

Rayon—*Blue "C"* spandex.

Wool—*Blue "C"* spandex.

COUNTS SPUN

For any given type, length and denier of staple, a *Blue "C"* spandex core in the yarn increases the spin limit of that yarn above

*Reg. T.M. for Chemstrand's acrylic fiber.

and beyond that of a regular yarn spun from the same stock. The counts of core-spun yarns spun successfully in Chemstrand's Applications Research and Service Department range from 60/1 c.c. (when using 70-denier *Blue "C"* spandex in conjunction with 2 d.p.f. *Acrilan* Type 16) down to 8/1 c.c.

In most instances, 70-denier *Blue "C"* spandex is used in core-spinning. For applications however, where the emphasis is on power and control rather than simply the ability to "give" with body movements, e.g., as in swimwear, home furnishings and socktops, it is not uncommon to find a core of 140-, 280-, or even 420-denier *Blue "C"* spandex being used.

SETTINGS AND SPEEDS

There are no fixed rules for roll settings, draft distribution or roll weighting required in processing the textile fiber through spinning. These can only be determined after trials in the mill under that mill's specific conditions. In regard to the *Blue "C"* spandex component, however:

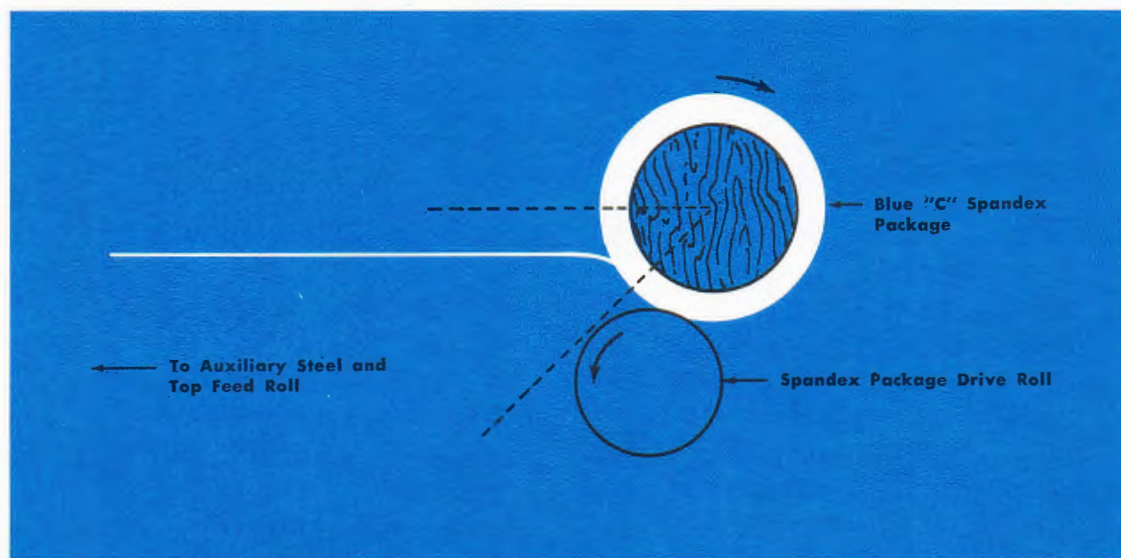


Fig. 21—*Blue "C"* spandex should unwind or peel from the package at a point between the extremities imposed by the dotted lines shown in the sketch above. This will insure that the spandex passes to the auxiliary steel roll in a tension-free state.

1. The spandex must be fed from the spandex package to the auxiliary steel and top rolls without tension. For this reason, a variable speed pulley is incorporated into the package roll drive so that small, but possibly critical adjustments in speed can be made as required. How does one know when the spandex package drive roll speed is correct? By noting the point where the spandex unwinds or peels from the package. For best results this point should fall in the area between one-quarter and half-way up the front of the package as shown in Figure 21.
2. The maximum stretch ratio between the auxiliary steel and top rolls (for delivering the spandex) and the bottom rolls should not exceed 3.5 when utilizing a core of 70-denier *Blue "C"* spandex. A stretch ratio of 3.5 is normally used for weaving yarns, while for knitting yarns, which in general require less stretch than weaving yarns and which additionally are sometimes heat-set on spin bobbins as described on page 58 for stabilization purposes and to reduce the stretch even further, a stretch ratio in the range 1.25 to 3 is called for in most cases. For both weaving and knitting yarns spun with core deniers heavier than 70, higher drafts may be used. For example in the case of weaving yarns having a core of 420-denier *Blue "C"* spandex, stretch ratios on the spandex of up to 5.0 have been used successfully.
3. Spindle speeds of up to 9000 rpm and higher have been used for core spinning in Chemstrand's Applications Research and Service Department with excellent results.

TRAVELERS

Travelers for core-spun yarns should be selected to give a bobbin of medium hard-

ness. They should be heavy enough to prevent whipping of adjacent balloons, or beating against separators, yet light enough to prevent excessive stretching. In general, a traveler weight two or three numbers higher than that normally required for the composite count of yarn being spun will give satisfactory results.

TWIST MULTIPLIERS

Twist multipliers generally must be increased for core-spun yarns versus conventional yarns. This is necessary not only to decrease the chance of sheath fiber slippage, but also to equate final yarn strength. If, for example, a 100 per cent cotton yarn with 14 t.p.i. is completely adequate strengthwise in fabric form after resin treating, it would be necessary to increase the twist in the same count core-spun spandex yarn. If equal twist were used, the degradation of the fabric could make it totally inadequate strengthwise—not because the spandex has in any way deteriorated, but because the sheath fibers in the yarn cross-section, being considerably fewer would be more seriously affected by the resin, making strength appreciably lower. In other words, to equal the strength of a conventional yarn of equivalent count, the core-spun yarn must have more twist because there are fewer hard fibers in the yarn cross-section.

A twist multiplier of 3.5 makes a good starting point toward arriving at the optimum level of twist for the particular yarn being spun. Work upwards from the 3.5 level.

DEFECTS IN CORE-SPUN YARNS

It has often been stated that dyeing and finishing will either make or break fabrics containing core-spun spandex. This is true only to a degree, and certainly does not absolve other processing areas of their responsibilities—especially that of spinning,

where the one thing that is absolutely necessary to avoid yarn imperfections is careful and proper control of processing. The three most common faults in core-spinning are "grin-through," core voids and sheath voids.

Grin Through

In quality Blue "C" spandex core-spun yarns, the spandex core is completely buried in the sheath fibers. If the spandex core is insufficiently covered by the sheath fibers then this results in "grin-through", i.e., the core becomes visible through the sheath covering. To prevent "grin-through," take the following precautions:

1. Position the spandex core relative to the roving at the front roll so that:
 - a.) When double roving is used, the core yarn is positioned between the two roving strands as shown in sketch A.

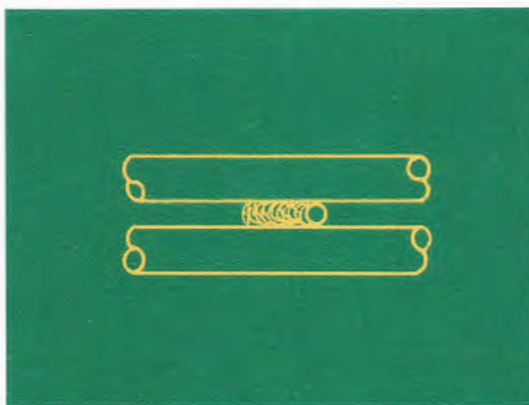


SKETCH A—Double creel roving, "S" or "Z" twist yarn, Blue "C" spandex in center.

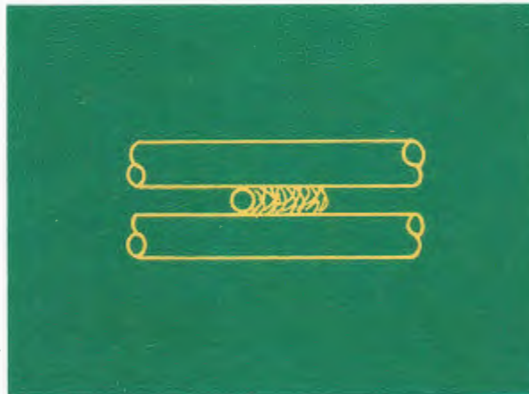
- b.) When spinning "S" twist yarn from one end of roving, the spandex core is placed just to the right side of the roving as shown in sketch B so that the fibers fold to the right as they emerge from the nip of the front roll.
 - c.) When spinning "Z" twist yarn from one end of roving, the span-

dex core is placed just to the left side of the roving as shown in sketch C so that the fibers fold to the left as they emerge from the nip of the front roll.

2. Use a higher level of twist and a heavier traveller than would normally be required in the spinning of a 100 percent hard fiber yarn of equivalent count.



SKETCH B—Single creel roving, "S" twist yarn, Blue "C" spandex to right.



SKETCH C—Single creel roving "Z" twist yarn, Blue "C" spandex to left.

Core Voids

Core voids are short lengths in the yarn (from one to three inches), which have no stretch due to the spandex core having been broken inside the sheath after the composite yarn was formed. Defects of this type are usually associated with faulty travelers and/or rings. Longer length voids consisting of many yards of defective yarn sometimes

occur, but these are almost always due to inadequate surveillance on the part of the operator.

Sheath Voids

Sheath voids are defects in the yarn characterized by lengths of yarn (from 1 to 36 inches) in which the sheath fibers are missing, leaving only the bare spandex core. Short length sheath voids are caused when the hard fibers break during drafting and disappear into the *Pneumafil*® device for a short period of time before being spotted by the operator and being picked up again by the core. Longer length sheath voids (like longer length core voids), are generally caused by either inadequate operator surveillance, insufficient operator training, or insufficient patrolling.

QUALITY CONTROL

From the foregoing it will be readily apparent that the core-spinning operation, though simple, requires careful control, and that good yarn quality can be obtained only through the use of optimum spinning conditions and methods. In this regard, high quality, uniform roving is a basic requirement, as are well-maintained drafting elements, gear trains, rolls, and cots. In addition, rings and spindles must be well-aligned and in good condition; travelers must be of proper weight and shape, and changed as required for quality spinning.

It is also recommended that yarns be inspected frequently both in knitted and woven fabric form, and on mirror board and drum devices. Plans for spindle by spindle inspection should be set up and followed carefully. In short, every precaution must be taken to insure core-spun yarn of the highest quality.

In properly spun yarn where the core is completely covered by the sheath fibers, the union dyeing of the spandex and cover fiber

presents no problem since the core is never seen whether the resultant fabric is in the relaxed or stretched form. But defects due to core spinning that are allowed to get into the greige fabric are there to stay. There is nothing that can be done in dyeing and finishing to correct these faults, the prevention of which rests entirely with the spinner.

YARN CALCULATIONS

Determining Sheath Fiber Count

Knowing: 1) the denier (or count) of the core-spun yarn (sheath plus core) desired, 2) the denier of the *Blue "C"* spandex core, and 3) the stretch ratio to be applied to the *Blue "C"* spandex core between top and bottom rolls, then the denier (or count) to which the sheath fibers must be spun to produce a core-spun yarn of the desired count can be calculated using the following formula:

$$SFD = DCSY - \frac{DS}{SR}$$

where:

SFD = sheath fiber denier
DCSY = denier of core-spun yarn
DS = denier of spandex core
SR = stretch ratio

For example, to make 20/1 c.c. core-spun yarn having a 70-denier *Blue "C"* spandex core using a stretch ratio of 3.5, the spinning frame would have to be set up to spin a 21.5/1 c.c. sheath fiber count as shown below:

$$\begin{aligned} SFD &= 20/1 \text{ c.c.} - \frac{70 \text{ den.}}{3.5} \\ &= 266 \text{ den.} - 20 \text{ den.} \\ &= 246 \text{ den. or } 21.5/1 \text{ c.c.} \end{aligned}$$

Determining Core Content

To calculate the core content of a core-spun yarn, apply the following formula:

$$CC = \frac{DS}{SR} \times \frac{100}{DCSY}$$

where:

CC = Core content per cent
DS = Denier of spandex core
SR = Stretch ratio
DCSY = Denier of core-spun yarn

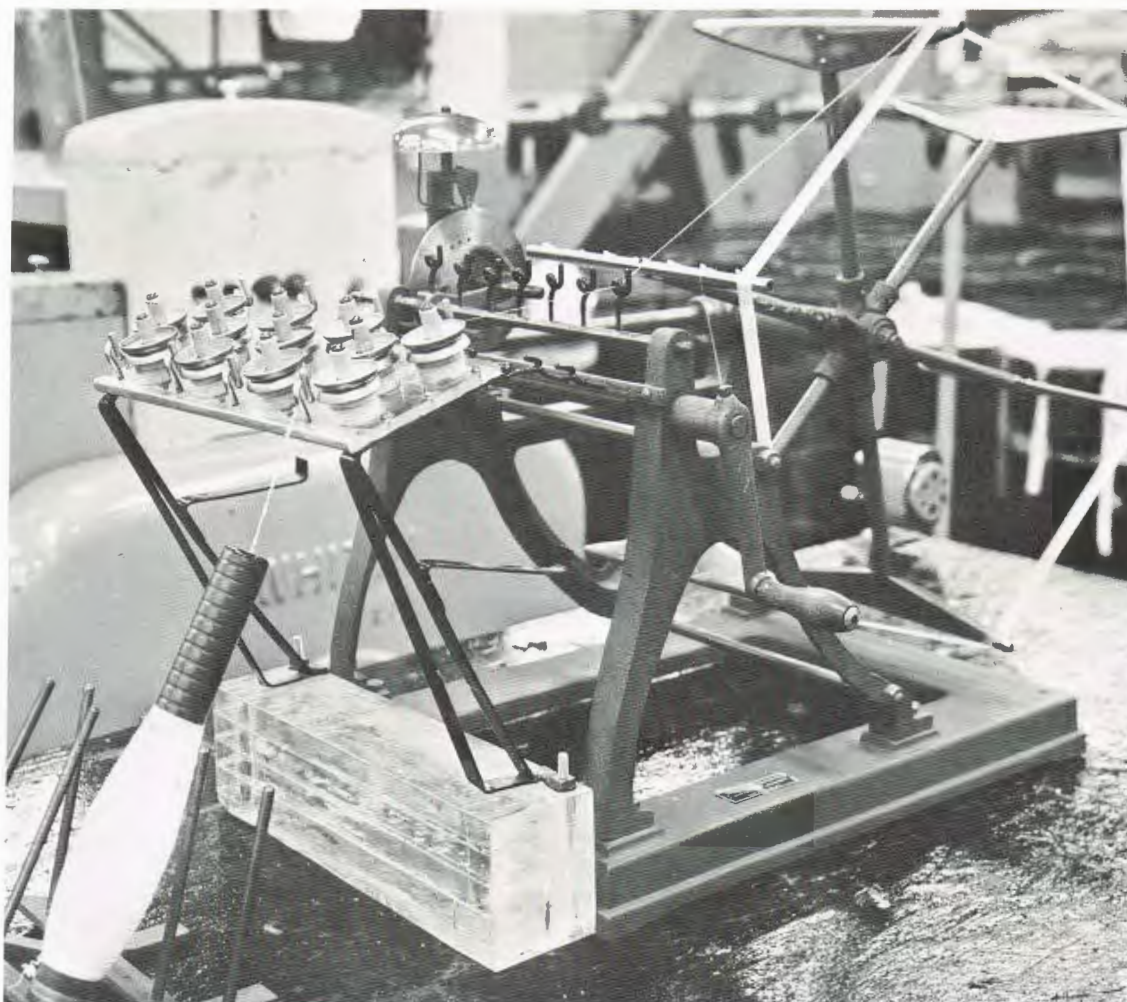


Fig. 22—A typical reeling set-up for core-spun yarns.

Thus for a 20/1 c.c. core-spun yarn made utilizing a 70-denier *Blue "C"* spandex core and employing a stretch ratio of 3.5 the core content would be determined as follows:

$$\begin{aligned} \text{Core content} &= \frac{70}{3.5} \times \frac{100}{266} \\ &= \frac{2000}{266} = 7.5 \text{ per cent} \end{aligned}$$

As an alternative to the method described above, the core content can, if desired, be calculated by means of a simple laboratory test wherein the yarn is: 1) scoured, dried and conditioned, 2) sampled in an extended (as spun) condition, 3) sheath separated from the core and the two components

weighed separately, 4) per cent core content determined from the weights recorded.

REELING

When reeling skeins as part of the process of determining the yarn number or count, it is most important that just sufficient tension be applied to the core-spun yarn to remove the kinks inherent in the yarn structure. This can be accomplished quite well by running the core-spun yarn onto the reel through three pairs of tension discs as shown in Figure 22. Plan and end views of the yarn tensioning bed shown in Figure 22 are drawn in Figure 23.

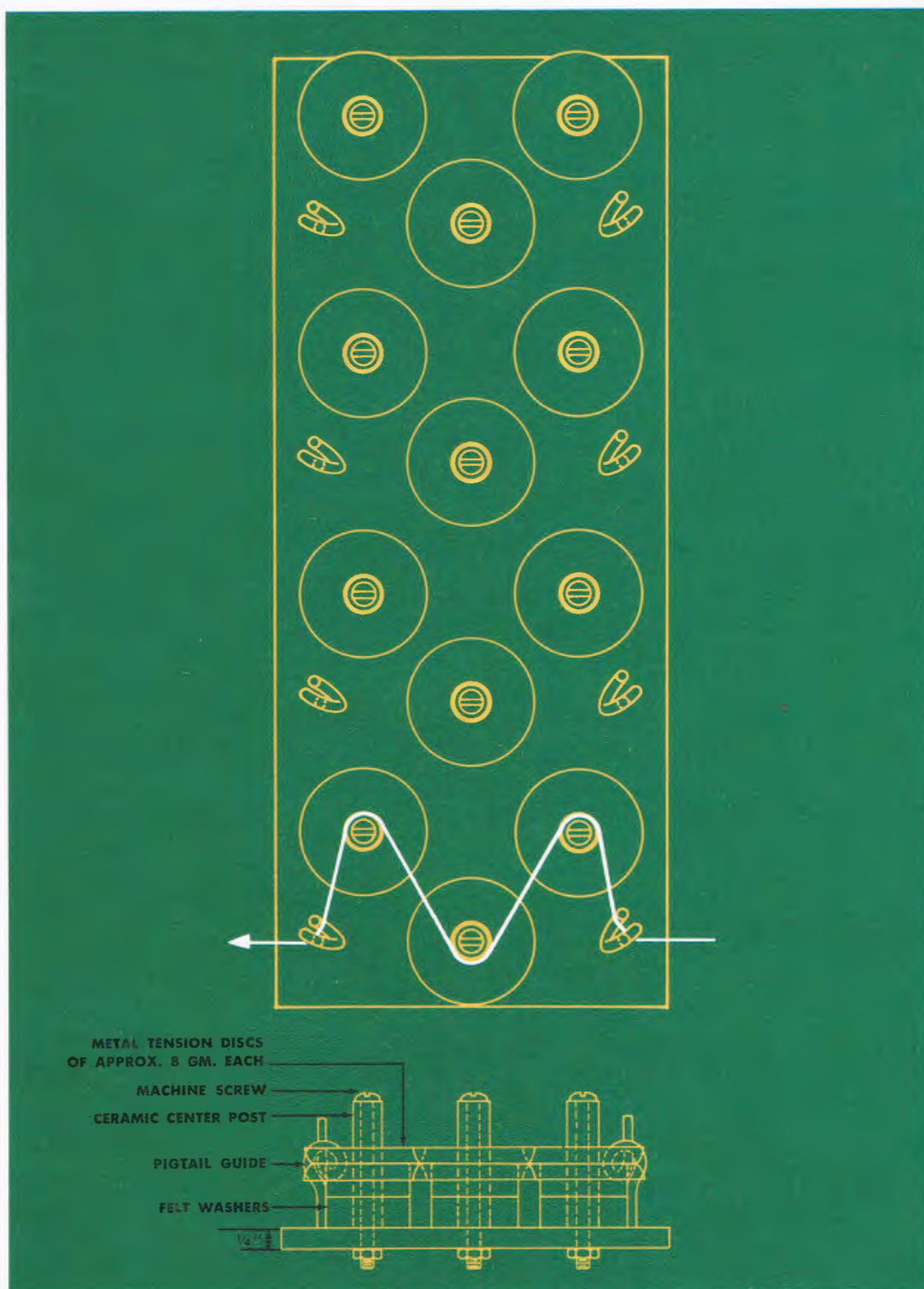


Fig. 23—Plan and end views of the yarn tensioning bed used when reeling core-spun yarns.

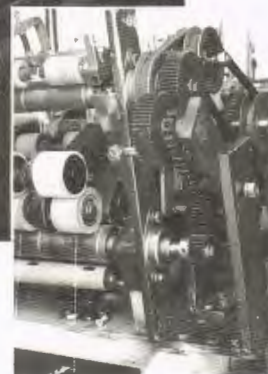
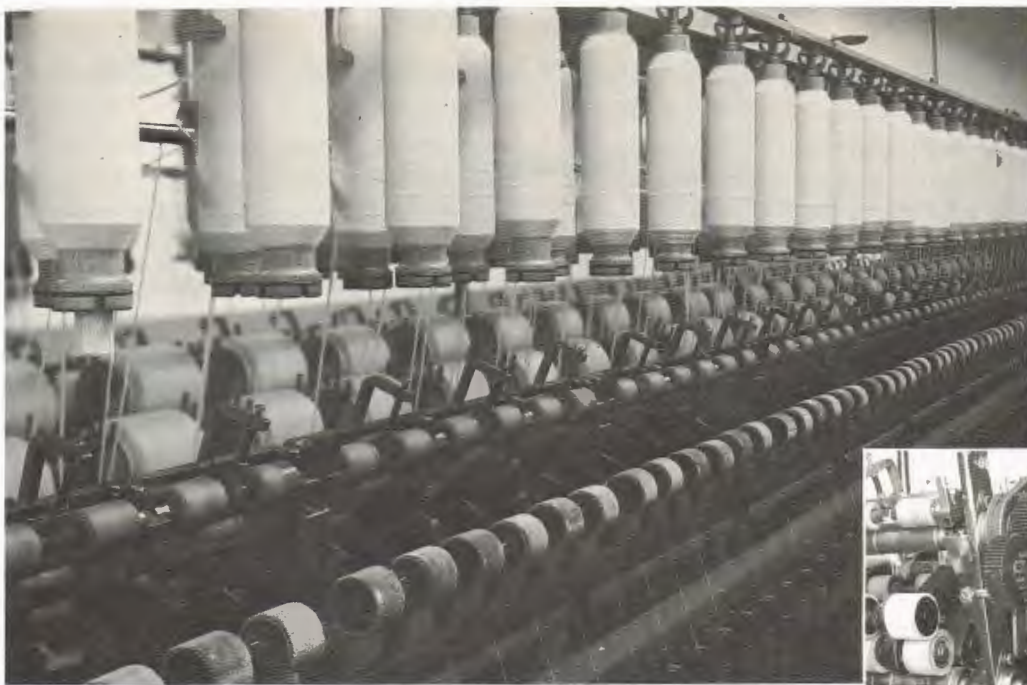


Fig. 23-A—Worsted spinning frame equipped for core spinning using Chemstrand's technique. Insert shows drive to spandex package drive rolls and auxiliary steel rolls.

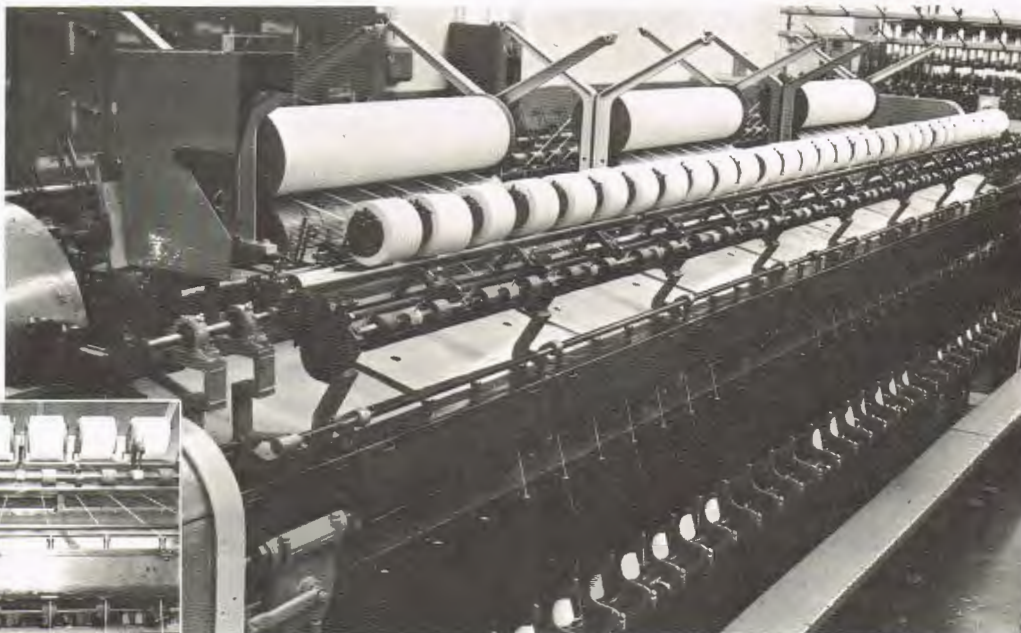


Fig. 23-B—Woolen spinning frame equipped for core spinning using Chemstrand's technique. Insert shows front view of frame in detail.

KNITTING CORE-SPUN YARNS

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.

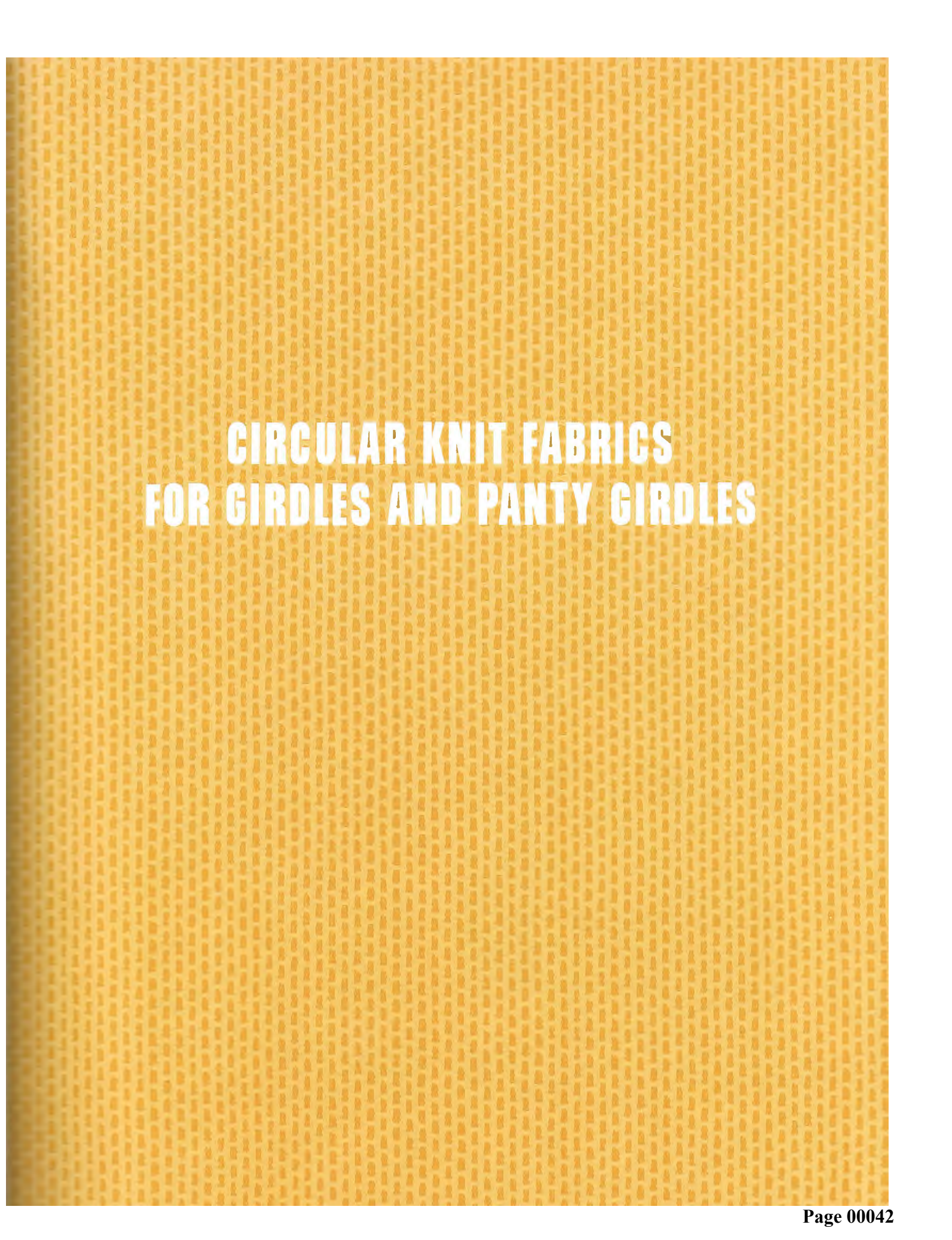
The knitting of core-spun yarns in welt stitch structures on jersey sinker top pattern wheel machines induces stretch characteristics into what would otherwise be fairly rigid twill fabrics.

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.



CIRCULAR KNIT FABRICS FOR GIRDLES AND PANTY GIRDLES

of the feeds and stretch or bulk nylon at the other four.

PATTERNS

Most circular knit girdle blanks are knit using plain, tuck, and welt stitches with various combinations of each. Typical fabric constructions are shown in Figures 52 and 53.

KNITTING COVERED CHEMSTRAND BLUE "C" SPANDEX

Covered *Blue "C"* spandex can be knit in the same manner as covered rubber yarns using single- or double-disc compensator tension devices, or alternately any one of the elastic yarn feed devices shown in Figures 44, 45 and 46.



Fig. 52—A few of the numerous patterns currently popular in girdle blanks powered with Chemstrand Blue "C" spandex.

SURGICAL AND SUPPORT HOSIERY

point. From the feeder, the metered spandex is guided over pulleys until it is in a direct tangential line with the needles at the knitting point. Depending upon the construction of the machine to which the system is applied, the spandex is fed either through or under the latch ring in a tangential path with the needles in such a manner that when it is being knit, it makes only slight or no contact with stationary parts of the machine. In addition, a new yarn finger has been designed which is equipped with a device for positive introduction of the spandex to the needles. With this new straight line feeding to the needles, it is possible to run extremely fine elastic yarns under low tension without puckering effects resulting from fibers grabbing and releasing erratically. The combination in the new feeder of its exact cycling and accurate metering of the spandex yarn together with the new feeding method which guides it to the needles freely without unforeseen drags, enables the manufacturer to produce high quality elastic stockings without the normal

problems usually associated with this type of knitting.

KNITTING COVERED SPANDEX

Covered *Blue "C"* spandex can be knit in surgical and support hose in a similar manner to covered rubber yarn using either a conventional post-and-disc type tension device or any one of the several spandex furnishers available. A typical construction for surgical stockings powered with covered *Blue "C"* spandex is as follows:

In course 1, 70-denier *Blue "C"* spandex covered with 20-denier *Chemstrand* nylon is knit on needles 1, 3, and 5 and welted or floated on needles 2, 4, and 6.

In course 2, all needles knit 40- — 13-denier *Chemstrand* nylon.

In course 3, the covered yarn is knit on needles 2, 4, and 6 and welted or floated on needles 1, 3, and 5.

In course 4, all needles knit nylon.

The welts, heels, and toes of the stockings are generally knit using stretch nylon.

HALF-HOSE AND SOCK TOPS

in the feeding of *Blue "C"* spandex into half-hose tops are:

1. **The Lawson* Top Tension Attachment** shown in Figure 56. This attachment accurately controls the pre-stretching of elastic yarns going into half-hose tops. It is simply designed, easily threaded and set, requires practically no maintenance, and requires no drive. The Lawson Top Tension Attachment has a special reduced tension feature which operates independently from the basic tension setting through a bowdoin cable. This cable extends from the bottom of the device to a convenient lever on the knitting machine, and its actuation is synchronized with the desired knitting sequences. The reduced tension range operates without disturbing the basic setting and is used when a) changing the character of the stitch—that is, from a knitting stitch which requires reduced tension to an inlay stitch which requires increased tension, and b) when the elastic yarn is taken from feeding to the sock top into the binder to be cut and held for the next sock.
2. **The Spantrol† Compensator** shown in Figure 57. Consisting of a U-bracket with a specially designed drum equipped with an adjustable brake mechanism to retard or increase the flow of yarn as desired, this device feeds uniform amounts of elastic yarn to the knitting elements at the desired tension.
3. **The Scott and Williams Variable Feed Elastic Yarn Furnisher‡** shown in Figure 58. This device is designed

to feed a specified amount of elastic yarn under tension into half-hose tops. It is positively driven at a uniform rate with the cylinder, and the quantity of spandex furnished is easily set by a simple adjustment of the feed rate. The clamping and severing of the spandex at the time of its removal or introduction is accomplished by the automatic changing of the rate of feed which, in changing, suddenly relieves the tension on the yarn. The furnisher is quickly returned to its basic setting after the spandex has been introduced.

In the finished sock, the *Blue "C"* spandex component should be almost relaxed. Too much tension will produce a narrow top. Conversely, too little tension will cause the *Blue "C"* spandex to "loop-out" of the knit structure. The optimum knitting tension for best results in any particular style can only be determined by trial and error. On Komet type machines excellent results using bare *Blue "C"* spandex in sock tops have been achieved using tensions in the ranges outlined below:

SPANDEX DENIER	TENSION (GRAMS)
140	6 to 10
280	15 to 20

COVERED YARNS

Covered *Blue "C"* spandex can be knit in the same manner as covered rubber yarn using conventional post and disc tension or any of the rubber yarn feed devices available. To permit an acceptable cross-stretch in the sock, i.e., 8 inches or more, the covered yarn should have an elongation of around 300 per cent.

Insofar as the covered yarn itself is concerned, *Blue "C"* spandex single or double

*Manufactured by Lawson Engineering Company, 543 Mineral Spring Avenue, Pawtucket, Rhode Island.

†Manufactured by Morpul Mfg. Co., Jefferson Standard Building, Greensboro, N.C.

‡Manufactured by Scott & Williams, Inc., Laconia, New Hampshire.

covered with cotton or spun rayon yarns will give better results in the socks than *Blue "C"* spandex covered with continuous filament acetate or nylon.

CONSTRUCTION

To insure against loss of retractive force and a poor appearance of the sock top, the bare *Blue "C"* spandex component—especially in rib tops—should be locked in the structure. On a Komet machine, this can be accomplished quite readily by modifying the elastic feed cam to:

1. Knit the bare *Blue "C"* spandex yarn into the first course of the welt.
2. Lay in the *Blue "C"* spandex throughout the ribbed top
and
3. Knit the *Blue "C"* spandex yarn on to the last ten to fifteen needles as the yarn finger moves into the inactive position.

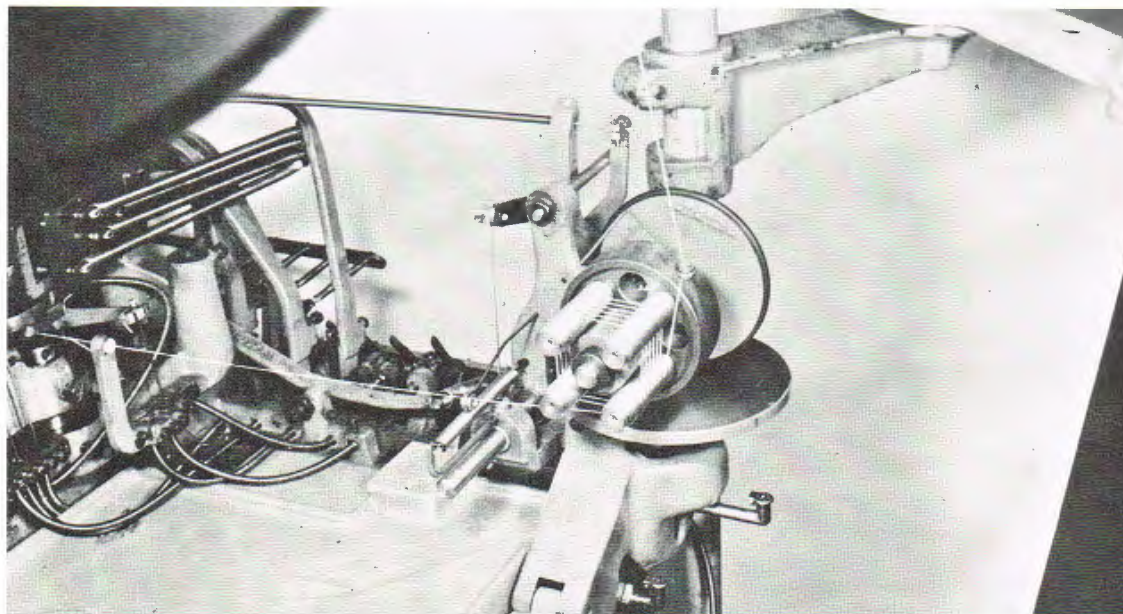
In non-rib constructions where the *Blue "C"* spandex component is held more

securely by the interlace structure, the locking-in of the *Blue "C"* spandex at either end of the sock top is not quite as essential. Nevertheless, check each line of sock to make sure that the *Blue "C"* spandex will not slip during wear.

Enough *Blue "C"* spandex should be fed into the half-hose top to insure that when the sock top is in its fullest stretch position, the spandex will not break.

A considerable poundage of 70-denier *Blue "C"* spandex is used in fine gauge children's anklets, but the two deniers used predominantly in sock-top applications are 140 and 280. The factors which determine the denier are the retraction force desired and the knitting machine gauge. In most cases, 140-denier *Blue "C"* spandex is used on machines with 132 needles or more, with 280-denier being used on coarser machines having 84 or 108 needles.

By following the procedures recommended above, *Blue "C"* spandex will impart to sock tops qualities that are excellent in all respects in stay-up power . . . appearance . . . and wear-life durability.



Courtesy: Scott & Williams, Inc.

Fig. 58—The Scott and Williams Variable Feed Elastic Yarn Furnisher.