International Institute For Cotton

Technical Research Division

Manchester

Research Record No. 170

The Use Of Silicone Elastomer In The Finishing Of Interlock And 1x1 Rib Fabrics

Robert D. Leah

May 1983

Classification: Fabrics/Knitted/Processing

Key Words: Interlock, 1x1 Rib, Crosslinking, Silicone Elastomer, Reference State, Shrinkage

Digital Version: May 2012

Contents

1. Introduction

A class of compounds based on polydimethyl siloxanes, which have reactive hydroxyl groups at each end of the polymer chain, was first introduced into the UK textile auxiliary market by Ciba-Geigy in 1973.

These compounds go under the generic name of silicone elastomers and were first introduced for application to fabrics made from acrylic yarns in an attempt to improve the resistance to pilling.

The early products were solvent based and their application was carried out in batch solvent scouring equipment. A later development was the introduction of aqueous emulsions of these products which could be applied on conventional padding equipment. When applied to cellulosic fabrics they are claimed to:

- improve garment shape retention,
- improve dimensional stability,
- improve stitch lubrication,
- improve stretch and recovery properties, amongst others.

After application and curing, three-dimensional, structured elastomeric lattices of very high molecular weight are formed on the fibre surfaces. These elastomer films are very stable and have a high resistance to washing and dry cleaning.

Although relatively expensive, their use in the finishing of knitted fabrics made from cotton yarns appears to be on the increase. They are usually applied in conjunction with a crosslinking agent, mainly because they counteract the dry handle which is usually associated with crosslinked knitted cotton fabrics and also because it is claimed they contribute to dimensional stability, and therefore can replace part of the crosslinking agent, and hence reduce bursting strength losses.

An on-going part of the STARFISH programme is an evaluation of crosslinking treatments on Interlock, 1x1 rib, and eventually single jersey fabrics. It was therefore felt that the effects of the inclusion of a silicone elastomer into a crosslinker formulation ought to be investigated to determine whether or not the Reference State of the fabric is affected. If this were the case, then the STARFISH predictive model would have to take into account any change directly attributable to the inclusion of an elastomer in the crosslinker formulation.

2. Procedure

Research Record No. 126 describes the practical details of the application of a 2½% o.w.f. crosslinker level to the full range of Central Project fabrics, both mercerised and unmercerised. Since then a further set has been treated at a level of 1% o.w.f. and *Research Record No. 159* describes the mathematical analysis of both sets of data.

In the current evaluation a full set of fabrics was treated with a crosslinker level of 1¾% o.w.f. A second set was also treated at a level of 1¾% but the usual softener & lubricants were replaced with the three components of the silicone elastomer. The concentration of elastomer used was that recommended by Ciba-Geigy technical personnel. The actual baths used were as follows.

1¾% o.w.f. crosslinker

40 g/l Fixapret CPN

6 g/l $MgC1_2$ 6H20

25 g/l Siligen E

25 g/l Perapret PE40

1 g/l Synperonic

1 cc/l Acetic Acid

1¾% o.w.f. crosslinker and elastomer

40 g/l Fixapret CPN

6 g/l $MgC1_2$ 6H20

30 g/l Dicrylan WK*

6 g/l Phobotone WS*

3g/l Phobotone Catalyst ZF*

1 cc/l Acetic Acid

* Elastomer components

The two pre-assembled sets of fabrics (62 constructions in each) were each padded through one of the above formulations at a wet pick-up of 99% and dried on the Shirley Artos stenter at 120°C to a width of 80-81 cm.

Maximum overfeed possible was applied commensurate with crease free running. It was noted that the fabric which had been treated with the elastomer-containing formulation had a tendency to crease at the overfeed wheel and the amount of overfeed applied had to be reduced slightly. This was due to slippage between the rubber wheel and the fabric due, presumably, to a coating of silicone on the rubber wheel.

After drying, the fabrics were cured by re-running them down the stenter at a temperature of 170°C with a delay of 45 seconds. All fabrics were submitted to the testing laboratory for comprehensive testing.

3. The Analytical Procedure

All the test data were entered onto the Central Project data base with the following identifiers.

JDX3	Crosslinked 1¾% level
MJDX3	Mercerised, crosslinked 1¾% level
JDX3E	Crosslinked 1¾% + elastomer
MJDX3E	Mercerised, crosslinked 1¾% + elastomer

The fabric properties considered to be of particular interest, especially after applying a chemical crosslinking treatment, are length shrinkage, courses /cm, wales /cm, weight gsm, stitch density \cm^2, bursting strength.

The following mathematical relationships were taken and tested with the data from these latest treatments, where L is the Stitch Length and T is the average yarn Tex, both measured in the Starfish Reference State, whilst SES is the average single-end yarn strength.

	Output Parameter	**Equation Form**
1	Courses /cm	$Y = a + b/L + c.\sqrt{T}$
2	Wales /cm	$Y = a + b/L + c.\sqrt{T}$
3	Weight, gsm	$Y = a + b.T/L$
4	Stitch Density, \cm^2	$Y = a + b/L^2 + c.T$
5	Burst Strength	$Y = a + b/L^2 + c.T + d.SES$

In each case the equations predict the property in the fully-relaxed or Reference state. For each property in turn the regression coefficients and the correlation coefficients were obtained using the Tektronix statistical software package.

4. Presentation Of Results

The results are presented and illustrated in the following Tables and Figures.

	1x1 Rib	**Interlock**
Test Data		
JDX3	*Table 1*	*Table 5*
JDX3E	*Table 2*	*Table 6*
MJDX3	*Table 3*	*Table 7*
MJDX3E	*Table 4*	*Table 8*
Regression & Correlation Coefficients		
Courses /cm	*Table 9*	
Wales /cm	*Table 10*	
Stitch Density	*Table 11*	
Weight	*Table 12*	
Bursting Strength	*Table 13*	
Tex	*Table 14*	
Stitch Length	*Table 15*	

Graphs: Measured Data & Calculated Regression Curves		
Courses /cm	*Figures 22-24*	*Figures 1-3*
Wales /cm	*Figures 25-27*	*Figures 4-6*
Stitch Density	*Figures 28-30*	*Figures 7-9*
Weight	*Figures 31-33*	*Figures 10-12*
Bursting Strength	*Figures 34-36*	*Figures 13-15*
Tex	*Figures 37-39*	*Figures 16-18*
Stitch Length	*Figures 40-42*	*Figures 19-21*

5. Discussion Of Results

5.1. Interlock

Relaxed courses /cm

Figures 1-3 show the effect of including elastomer in a crosslinking bath on the fully-relaxed courses of unmercerised and mercerised interlock fabric. There is no evidence to suggest that there is any additional effect other than that of the crosslinking agent itself.

Relaxed wales /cm

Figures 4-6 show the effect of elastomer inclusion on the fully relaxed wales. Although the correlation coefficients are rather on the low side due to scatter of points, over the three yarn counts there is no concrete evidence to suggest that the fully relaxed wales will be influenced by the inclusion of elastomer in the formulation.

Relaxed Stitch Density

Figures 7-9 confirm the conclusions of the previous two paragraphs in that, since relaxed courses and wales are unaffected by the inclusion of elastomer, then stitch density is also unaffected.

Relaxed Weight

Figures 10-12 show the effect of elastomer inclusion on the fully relaxed weight. Over the three yarn counts there is the suggestion that the elastomer-treated fabrics have a slightly lower fully relaxed weight than the non elastomer-treated fabrics but the differences are so small that they are probably insignificant and can probably be ignored.

Relaxed Bursting Strength

Figures 13-15 show the effect of elastomer inclusion on the fully-relaxed bursting strength of both unmercerised and mercerised interlock fabrics.

With the unmercerised fabrics there appears to be no effect on bursting strength but with the mercerised fabrics the inclusion of elastomer appears to result in a slight reduction in the bursting strength values. The reduction is of the order of 7%.

There is however a fair degree of scatter in the results and the correlation coefficients of the elastomer-treated fabrics are rather on the low side (0.90 and 0.92).

Relaxed Distension at Burst

Figures 16-18 show the distension measured on the fabrics at burst. The unmercerised fabrics do not exhibit any systematic differences whereas the mercerised fabrics treated with elastomer almost always show a lower distension figure than the corresponding non elastomer-treated fabrics. The differences, however, are very small and are of the order of 1-l2 millimetres or 10% of total distension. The effect can, therefore, probably be considered to be insignificant.

Length Shrinkage

Since it has already been established that elastomer has no effect on the fully-relaxed courses and wales of interlock fabric, any differences in residual length shrinkage can be directly attributable to fabric handling characteristics. *Figures 19-21* show the effect of elastomer inclusion on the residual length shrinkage values. It has already been reported in the text that the fabrics behaved differently in the feeding section of the stenter and that the elastomer treated fabrics tended to cause some slippage of the feeding wheels resulting in some creasing.

From the length shrinkage figures, however, the elastomer-treated mercerised fabrics tend to exhibit marginally higher length shrinkages whereas the elastomer-treated unmercerised fabrics tend to show marginally lower length shrinkages.

Since the mercerised and unmercerised fabrics were treated together these differences can not be attributable to the changes in stenter settings which had to be made to prevent creasing.

5.2. 1x1 Rib

Relaxed Courses /cm

Figures 22-24 show the effect of the inclusion of an elastomer in the finishing bath on the fully-relaxed courses of unmercerised and mercerised 1x1 Rib fabrics. Unlike the interlock fabrics there are very slight consistent differences between the elastomer and non-elastomer treatments. The elastomer-treated fabrics tend to show an additional 2 courses per cm in the reference state over their non elastomer-treated counterparts.

Relaxed Wales /cm

Figures 25-27 show the effect of elastomer inclusion on the fully relaxed wales. Although, as with the interlock fabrics, there is some scatter in the elastomer treatments, there does not appear to be a systematic effect on the fully-relaxed wales directly attributable to the elastomer component.

Relaxed Stitch Density

Figures 28-30 show the effect of the inclusion of elastomer on the fully-relaxed stitch density of 1x1 rib fabrics.

In keeping with the observations of relaxed courses and wales, there does appear to be a very slight increase in the stitch density across the three yarn counts. The differences are rather small but nevertheless consistent and are higher for the elastomer treated fabrics.

Relaxed Weight

Figures 31-33 illustrate the effect of elastomer inclusion on the fully-relaxed weight of unmercerised and mercerised 1x1 rib fabrics.

Unlike the interlock fabrics, a systematic difference, although small, is observed. The elastomer-treated fabrics are nearly always slightly heavier by about 10-15 gsm which is approximately 5% of the total weight.

Relaxed Bursting Strength

Figures 34-36 show the effect of elastomer on bursting strength. Although very slight, there is a systematic difference between the non elastomer-treated and elastomer-treated fabrics. This difference, however, shows a reverse to that observed with the interlock fabrics. With the rib fabrics the bursting strength is nearly always slightly higher in the case of the elastomer treatment, whereas with the interlock fabrics it was nearly always slightly lower.

Distension at Burst

Figures 37-39 show the distensions at burst measured on the rib fabrics and over the three yarn counts. There is no concrete evidence to suggest that elastomer is having any systematic effect on this property.

Length Shrinkage

The effect on length shrinkage caused by the inclusion of an elastomer is shown in *Figures 40-42*. There is some evidence to suggest that the elastomer-treated fabrics have lower residual shrinkage (length) figures even though the overfeed settings of the stenter had to be reduced to avoid creasing. This could be due to the effect of reduced yarn friction which allows the fabrics to relax easier as they "flutter" during the passage through the stenter and/or to the effect of the elastomer on recovery from stretching, mentioned below.

6. Conclusions

The main reason why a finisher is likely to use an expensive chemical such as an elastomer in the finishing formulation is if the benefits conferred by such a product are very considerable.

In terms of handle the elastomer certainly does confer a much better feel to the fabric when compared with the relatively dry handle of the conventionally softened fabrics (crosslinked). The other major benefit which is conferred by the elastomer is that of superior stretch-and-recovery behaviour. Although not systematically tested here, due to lack of a suitable test method, it is very evident by handling the fabrics that this improvement is, in fact, considerable and could certainly help with many of the garment bagging problems which can occur.

As far as an effect on fabric Reference State is concerned, however, the inclusion of elastomer does not have any dramatic effect. Slight changes in the Reference State have been observed which differ somewhat between interlock and 1x1 rib.

These can be summarised as follows.

	Interlock	**Mercerised Interlock**	**Rib**	**Mercerised Rib**
Courses	No effect	No effect	Slight Increase	Slight Increase
Wales	No effect	No effect	No effect	No effect
Stitch Density	No effect	No effect	Slight Increase	Slight Increase
Weight	Slight Reduction	Slight Reduction	Slight Increase	Slight Increase
Burst	No effect	Slight Reduction	Very Slight Increase	Very Slight Increase
Distension	No effect	Slight Reduction	No effect	No effect
Length Shrinkage	Slight Reduction	Slight Increase	Slight Reduction	Slight Reduction

When compared with the effect that would be experienced if the concentration of crosslinking agent were to be varied by, for example, ± 1% o.w.f., then the changes brought about by the inclusion of elastomer (if they are in fact real) are rather insignificant.

Until such time as we have case studies where elastomer has been used and the STARFISH model can be tested, it would seem that there is sufficient evidence at this stage to ignore the presence of elastomer and predict on the basis of crosslinking agent level only.

Table 1

1X1 RIB FINISH JDX3 TABLE 1

Sample	c/cm JDX3	w/cm JDX3	Wt. AW JDX3	Bst. AW JDX3	DistAW JDX3	%Shr. L JDX3	l cm JDX3	Tex JDX3
R26/350	12.2	9.5	178.8	303	16.1	14.3	0.353	22.8
R26/326	13.4	9.8	187.1	344.3	16	12	0.331	22.9
R26/306	14.73	10.3	202.4	380.5	15.9	11.5	0.309	22.1
R26/285	16.6	10.6	222.6	428.7	15.8	8.6	0.285	22.6
R26/267	18.43	11.13	241.5	455.8	16.1	8	0.268	23
R30/350	11.5	9.8	148.8	266.3	16	15.1	0.353	19.3
R30/326	12.63	10.17	161.8	308.9	15.7	13.5	0.33	19.7
R30/306	13.93	10.5	173.2	309.7	16.3	12.1	0.309	19.9
R30/285	15.83	11.03	187	322.6	16	10.7	0.284	19.6
R30/267	17.6	11.27	203.3	383.3	16.1	9.1	0.267	19.6
R34/350	11.43	9.57	128.3	249.4	14.5	13	0.354	17.2
R34/326	12.47	10.07	138.7	241	16.1	13.8	0.33	17
R34/306	13.27	10.7	146.6	268.4	16.2	12.9	0.31	17
R34/285	15.03	11.2	161.7	282.4	15.4	10.1	0.286	17
R34/267	16.67	11.57	166.9	329.3	16.1	10.4	0.269	17
R34/248	18.77	11.97	186.3	376.6	15.7	9.2	0.25	16.9

Table 2

1X1 RIB FINISH JDX3E TABLE 2

Sample	c/cm JDX3E	w/cm JDX3E	Wt. AW JDX3E	Bst. AW JDX3E	DistAW JDX3E	%Shr. L JDX3E	l cm JDX3E	Tex JDX3E
R26/350	12.8	9.37	186.7	341.5	15.7	11.1	0.354	22.6
R26/326	13.63	9.7	195.7	365.3	15.7	10.8	0.33	22.5
R26/306	15.13	10.03	209.2	384.6	16.3	9.3	0.309	22.5
R26/285	17.27	10.43	230.9	434.1	16.1	5.5	0.284	22.6
R26/267	18.93	11.03	244	505.8	16	6.6	0.268	22.2
R30/350	12.07	9.33	154.3	306.3	16.3	12.1	0.352	19.5
R30/326	13.33	10.1	169.5	321.7	16.3	10.5	0.329	19.5
R30/306	14.3	10.4	176.1	356.2	15.2	10.9	0.31	19.6
R30/285	16.03	10.93	195.5	364.1	15.3	9.6	0.285	19.1
R30/267	17.73	11.4	206.3	367.1	16.5	8.3	0.268	19.8
R34/350	11.4	9.6	129.4	266.7	15	14.3	0.355	17
R34/326	13.13	9.83	142.8	287.5	16.4	11.2	0.331	16.9
R34/306	13.9	10.43	153.5	290.6	15.3	11.1	0.31	17.1
R34/285	15.57	11.1	163.6	310.6	16.1	10	0.287	17
R34/267	16.97	11.33	175.2	301.8	15.6	9.6	0.27	17
R34/248	19.63	11.97	196.3	389.7	16.5	6.3	0.249	17

Table 3

1X1 RIB FINISH MJDX3 TABLE 3

Sample	c/cm MJDX3	w/cm MJDX3	Wt. AW MJDX3	Bst. AW MJDX3	DistAW MJDX3	%Shr. L MJDX3	l cm MJDX3	Tex MJDX3
R26/350	12.57	11.07	207.6	544.8	15.8	12.8	0.322	24.3
R26/326	13.6	11.37	227	589.4	16	11.9	0.307	24
R26/306	15.17	11.87	242.7	625.9	16.5	10.4	0.285	24
R26/285	16.77	13.03	262.9	688.9	16.5	8.6	0.263	24.2
R26/267	18.17	12.77	276.5	705.4	17.5	7.3	0.253	23.9
R30/350	12.4	11.13	173.9	468.2	15.3	13.8	0.33	20.7
R30/326	12.87	11.9	188.1	460.2	14.8	10.7	0.308	20.9
R30/306	14.6	12.2	203.3	539	15.8	10.9	0.287	21.3
R30/285	15.23	13.03	220	586.7	16	9.4	0.265	20.9
R30/267	17.23	13.57	234.7	611.1	17.5	7.9	0.243	20.8
R34/350	11.87	11.47	147.4	424.1	15.1	15.3	0.334	18.2
R34/326	12.53	11.87	163.4	477.7	15	13.9	0.301	18.6
R34/306	13.37	12.7	176.7	499.6	15.1	11.5	0.29	18.9
R34/285	15.27	13.53	189.7	493.6	14.9	9.8	0.267	18.4
R34/267	16.6	14.17	206.2	541.1	15.3	8.8	0.251	18.3
R34/248	18.8	14.53	232.5	595	16.4	7.2	0.229	18.3

Table 4

1X1 RIB FINISH MJDX3E TABLE 4

Sample	c/cm MJDX3E	w/cm MJDX3E	Wt. AW MJDX3E	Bst. AW MJDX3E	DistAW MJDX3E	%Shr. L MJDX3E	l cm MJDX3E	Tex MJDX3E
R26/350	12.8	10.93	213	565	15.4	11.6	0.33	24.1
R26/326	13.73	11.7	234.9	614.6	14.9	11.6	0.308	24.9
R26/306	15.27	11.83	248.1	612.4	15.5	9.1	0.291	24
R26/285	17.6	12.53	276.5	685.2	15.3	7.5	0.266	24.3
R26/267	18.73	13	285.6	666.4	16.1	6.2	0.25	23.7
R30/350	12.07	11.63	188.5	497	15.1	13.5	0.332	20.4
R30/326	13.07	12.57	200.3	493.4	16.4	9.6	0.304	21
R30/306	14.73	12.37	217	589.1	15.2	11.3	0.286	21
R30/285	15.5	13.93	224.2	600	15.4	8.3	0.268	20.6
R30/267	17.8	13.67	245.6	619.9	15.5	7.2	0.253	20.7
R34/350	11.87	11.6	159	439.3	14.9	14.7	0.337	18.2
R34/326	12.67	12.37	167.9	475.7	15.9	12.1	0.314	18.1
R34/306	13.77	13.17	184	448.7	15.7	10.1	0.289	18.2
R34/285	15.33	13.67	199.2	517.3	15.7	7.7	0.264	18.5
R34/267	16.7	13.93	209.7	533.8	15.1	8.4	0.251	18
R34/248	19.07	14.57	232.8	595.5	15.4	5.9	0.23	18.7

Table 5

INTERLOCK FINISH JDX3 TABLE 5

Sample	c/cm JDX3	w/cm JDX3	Wt. AW JDX3	Bst. AW JDX3	DistAW JDX3	%Shr. L JDX3	l cm JDX3	Tex JDX3
I34/377	11.63	13.17	184.5	395.4	14.7	12.9	0.374	17.2
I34/359	12.23	13.53	192.2	425.3	14.6	11.5	0.358	17.3
I34/340	13.63	13.9	210.4	441.3	15.5	11.4	0.337	17.5
I34/324	14.47	13.97	215.3	482.4	14.8	10.5	0.323	16.9
I34/307	16	14.4	234.8	508.3	15.9	9.8	0.305	17.1
I38/377	10.97	13.67	170.7	355.5	14.8	12.9	0.378	15.8
I38/359	11.9	14.03	174.3	377.7	14.2	13.5	0.358	15.5
I38/340	13.2	14	186.4	405.3	14.6	11.8	0.34	15.7
I38/324	14	14.47	195.4	439	15.2	10.9	0.323	15.2
I38/307	15.3	14.87	208.5	438.9	15.1	10.4	0.306	15.3
I42/377	11.1	14.1	151.7	299.5	14.6	12.6	0.377	14.3
I42/359	11.7	14.17	159.2	329.1	14.3	13	0.36	14.1
I42/340	12.77	14.53	171.9	372.7	13.6	12.7	0.337	14.4
I42/324	13.63	15.4	180.1	408	15	12	0.323	14
I42/307	14.3	15.27	181.1	424.5	14.3	9.1	0.306	14.5

Table 6

INTERLOCK FINISH JDX3E TABLE 6

Sample	c/cm JDX3E	w/cm JDX3E	Wt. AW JDX3E	Bst. AW JDX3E	DistAW JDX3E	%Shr. L JDX3E	l cm JDX3E	Tex JDX3E
I34/377	11.9	12.73	188.3	411.4	15.5	11	0.376	17.3
I34/359	12.17	13.27	189.4	410.4	15.7	9.8	0.359	16.6
I34/340	12.87	13.8	200.5	461.2	15.5	10.7	0.339	16.9
I34/324	14.23	14.2	218	480.4	14.9	10	0.323	17.2
I34/307	15.43	14.53	229.6	541.7	15.1	9.2	0.306	17
I38/377	11.73	12.97	171.9	374.1	15.1	11.6	0.374	15.5
I38/359	12	13.23	172	374.5	14.8	11.7	0.358	15.3
I38/340	13.07	13.63	180.5	387.1	14.2	10.8	0.341	15.3
I38/324	13.37	14.37	189.2	474.7	14.6	10	0.323	15.3
I38/307	15.03	15.03	206.3	435.2	15.5	10.2	0.306	15.3
I42/377	11.27	13.27	153.3	306.6	16.1	11.4	0.378	14.1
I42/359	11.1	14.13	155.2	320.2	14.9	12.6	0.36	14
I42/340	12.57	14.67	163.4	371.7	14.8	11.4	0.339	13.9
I42/324	13.3	14.6	173.1	396.2	15.1	11	0.321	14
I42/307	14.87	14.87	185.8	383.7	15.3	8.6	0.306	14

Table 7

INTERLOCK FINISH MJDX3 TABLE 7

Sample	c/cm MJDX3	w/cm MJDX3	Wt. AW MJDX3	Bst. AW MJDX3	DistAW MJDX3	%Shr. L MJDX3	l cm MJDX3	Tex MJDX3
I34/377	11.47	15.7	229	735.5	14.8	8.8	0.347	19
I34/359	12.5	15.87	240.1	769.2	15.4	9.5	0.332	18.7
I34/340	13.1	16.67	253.2	830	15.2	8.4	0.312	19.2
I34/324	14.17	17.03	258.8	812.2	15	7.4	0.3	18.4
I34/307	15.23	17.63	278.6	863	15.2	6.7	0.284	18.8
I38/377	11.53	15.83	210.9	645.8	14.6	9.2	0.347	17
I38/359	12.23	16.4	221	679.7	14.6	9	0.331	17.7
I38/340	13	16.87	227.6	715.1	14.7	8.2	0.315	17.3
I38/324	14.03	17.3	243.8	716.1	15.1	7.2	0.299	17.2
I38/307	14.6	18.1	249.7	796.7	14.4	6.5	0.284	16.8
I42/377	11.27	15.77	184	562.9	14.5	9.8	0.348	15.2
I42/359	12.07	16.33	196.6	567.2	15	8.8	0.329	15.5
I42/340	12.83	17.9	210.5	631.2	14.7	8.2	0.311	15.5
I42/324	13.5	18.17	220.1	690.9	14.4	6.7	0.3	15.6
I42/307	14.63	18.53	230	708.2	14.6	6	0.286	14.8

Table 8

INTERLOCK FINISH MJDX3E TABLE 8

Sample	c/cm MJDX3E	w/cm MJDX3E	Wt. AW MJDX3E	Bst. AW MJDX3E	DistAW MJDX3E	%Shr. L MJDX3E	l cm MJDX3E	Tex MJDX3E
I34/377	11.53	15.3	223.8	720	14	9	0.342	18.6
I34/359	12.57	15.53	233	705.1	14.6	6.7	0.332	18.5
I34/340	13	16.4	242.7	768.2	13.7	8.7	0.323	18.3
I34/324	13.47	17.07	245.8	744.9	13.5	8.7	0.287	16.7
I34/307	14.53	17.43	264	802	14.1	8.4	0.291	18.5
I38/377	11.4	15.57	199.3	600.3	14	9.2	0.35	16.3
I38/359	11.57	16.53	208.1	607.4	13.9	10.4	0.339	16.7
I38/340	12.03	17.63	216.1	658.8	14	9.3	0.326	16.7
I38/324	13.57	17.17	231.4	659.9	13.9	7.7	0.305	17
I38/307	14.13	18.3	240.8	726.5	13.6	7.4	0.298	17.7
I42/377	10.77	16.7	180.8	525	14.4	11.1	0.354	15
I42/359	11.23	16.7	184.4	545.3	13.3	9.9	0.337	15.1
I42/340	12.07	17.67	196.3	521.8	14.1	9.3	0.322	14.8
I42/324	13.03	18.1	213.6	545.2	14.3	8.4	0.307	15.1
I42/307	13.47	18.77	216.7	634.5	13.6	8.3	0.286	15

Table 9

PREDICTION OF FFR COURSES/CM FROM FFR TEX AND FFR STITCH LENGTH

Model: $y = a + b/l + c\sqrt{\text{av. Tex}}$

FABRIC AND ROUTE	a	b	c	d	r^2
Interlock JDX3	-15.1733	6.5284	2.2792		0.9806
JDX3E	-11.2889	5.7963	1.8269		0.9439
MJDX3	-7.9837	5.3071	1.0003		0.9851
MJDX3E	-8.6780	4.4475	1.7828		0.8877
1 x 1 Rib JDX3	-15.6572	6.5375	1.9601		0.9907
JDX3E	-14.9887	6.6120	1.8652		0.9876
MJDX3	-12.8677	5.3251	1.8960		0.9658
MJDX3E	-15.5159	5.6894	2.2810		0.9733

Table 10

PREDICTION OF FFR WALES/CM FROM FFR TEX AND FFR STITCH LENGTH

Model: $y = a + b/l + c\sqrt{\text{av. Tex}}$

FABRIC AND ROUTE	a	b	c	d	r^2
Interlock JDX3	17.9581	2.0219	-2.4507		0.9329
JDX3E	11.5458	2.9026	-1.5689		0.9076
MJDX3	12.2608	3.7656	-1.7736		0.9377
MJDX3E	20.6417	3.4865	-3.5815		0.8336
1 x 1 Rib JDX3	6.9141	1.8631	-0.5677		0.9743
JDX3E	6.5107	1.9977	-0.6093		0.9733
MJDX3	9.5977	2.3676	-1.2101		0.9575
MJDX3E	12.1486	2.0997	-1.5046		0.9262

Table 11

PREDICTION OF FFR STITCH DENSITY FROM FFR TEX AND FFR STITCH LENGTH

Model: $y = a + b/l^2 + c$ av. Tex

FABRIC AND ROUTE	a	b	c	d	r^2
Interlock JDX3	10.5536	20.1514	0		0.9867
JDX3E	-6.6847	20.2005	0.7579		0.9806
MJDX3	14.6193	21.7876	-0.8679		0.9922
MJDX3E	59.3268	18.7470	-1.8732		0.8820
1 x 1 Rib JDX3	-32.1498	14.5237	1.4006		0.9983
JDX3E	-29.5152	15.0192	1.1515		0.9959
MJDX3	-9.8901	14.2359	0.6425		0.9804
MJDX3E	-7.9944	14.5942	0.7462		0.9915

Table 12

PREDICTION OF FFR WEIGHT FROM FFR TEX AND FFR STITCH LENGTH

Model: $y = a + b$ Tex/l

FABRIC AND ROUTE	a	b	c	d	r^2
Interlock JDX3	-13.8535	4.3630			0.9649
JDX3E	-8.9315	4.2559			0.9866
MJDX3	9.1534	4.0528			0.9726
MJDX3E	15.7165	3.8970			0.9740
1 x 1 Rib JDX3	-19.5220	3.0363			0.9932
JDX3E	-20.8188	3.1657			0.9899
MJDX3	-30.6022	3.2118			0.9843
MJDX3E	-10.4161	3.0895			0.9850

Table 13

PREDICTION OF FFR BURSTING STRENGTH FROM FFR TEX, FFR STITCH LENGTH AND FFR SINGLE END STRENGTH

Model: $y = a + b/l^2 + c \text{ av. Tex} + d \text{ av. SES}$

FABRIC AND ROUTE	a	b	c	d	r^2
Interlock JDX3	-283.9445	30.4773	29.3112	-0.3071	0.9660
JDX3E	-472.1786	28.6959	53.5940	-2.0812	0.8966
MJDX3	-397.7499	34.6108	27.3751	1.7979	0.9632
MJDX3E	-446.4233	23.3221	29.5573	2.9015	0.9221
1 x 1 Rib JDX3	-185.6043	18.8542	0	2.0950	0.9392
JDX3E	-175.1516	15.6723	12.5858	0.8218	0.8775
MJDX3	-125.7673	19.3816	0	2.0981	0.9453
MJDX3E	933.1469	16.5229	-202.9556	20.7305	0.9230

Table 14

PREDICTION OF FFR TEX FROM TEX AS KNITTED

Model: $y = a + bx$

FABRIC AND ROUTE	a	b	c	d	r^2
Interlock JDX3	0.5657	0.9715			0.9947
JDX3E	0.0587	0.9909			0.9980
MJDX3	-0.8656	1.1573			0.9966
MJDX3E	0.8534	1.0174			0.9811
1 x 1 Rib JDX3	-1.8459	1.1007			0.9960
JDX3E	-1.2663	1.0654			0.9956
MJDX3	-0.3184	1.0931			0.9926
MJDX3E	-1.4246	1.1455			0.9876

Table 15

PREDICTION OF FFR STITCH LENGTH FROM STITCH LENGTH AS KNITTED

Model: $y = a + bx$

FABRIC AND ROUTE	a	b	c	d	r^2
Interlock JDX3	0.0077	0.9728			0.9991
JDX3E	0.0059	0.9780			0.9995
MJDX3	0.0166	0.8731			0.9976
MJDX3E	0.0372	0.8273			0.9769
1 x 1 Rib JDX3	0.00004	0.9925			0.9995
JDX3E	0.0024	0.9861			0.9998
MJDX3	-0.0016	0.9261			0.9990
MJDX3E	-0.0088	0.9576			0.9991

Figure 1

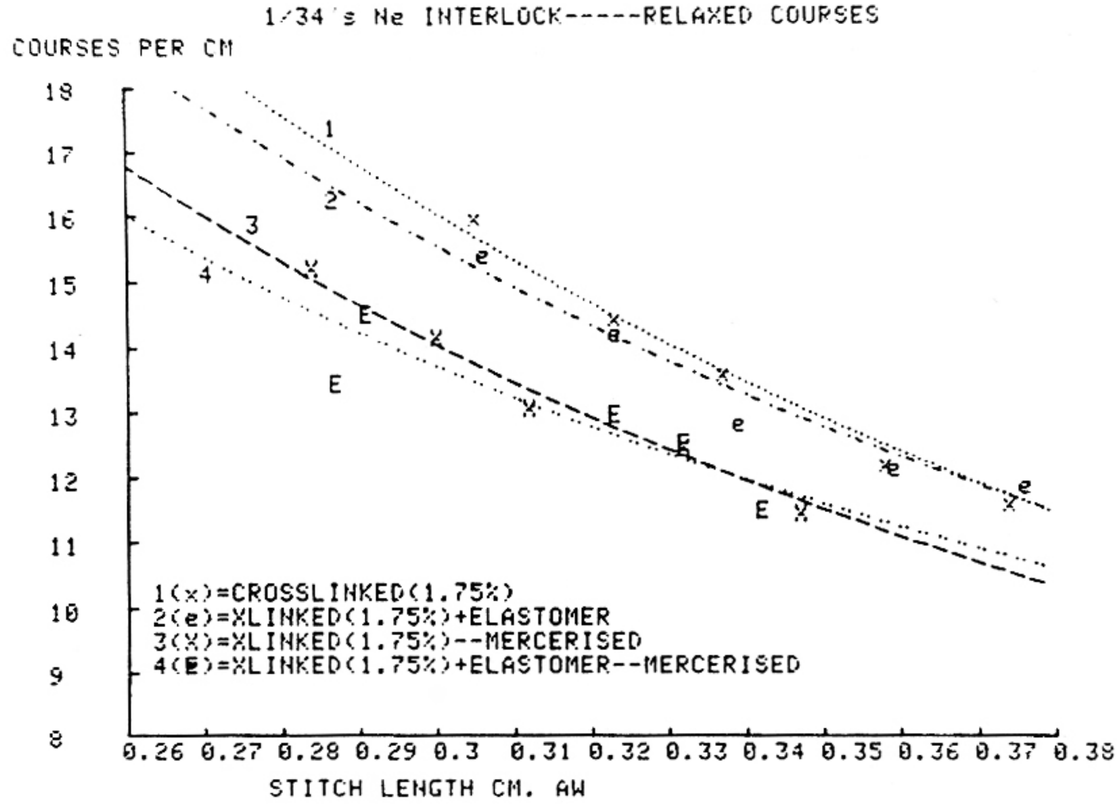

Figure 2

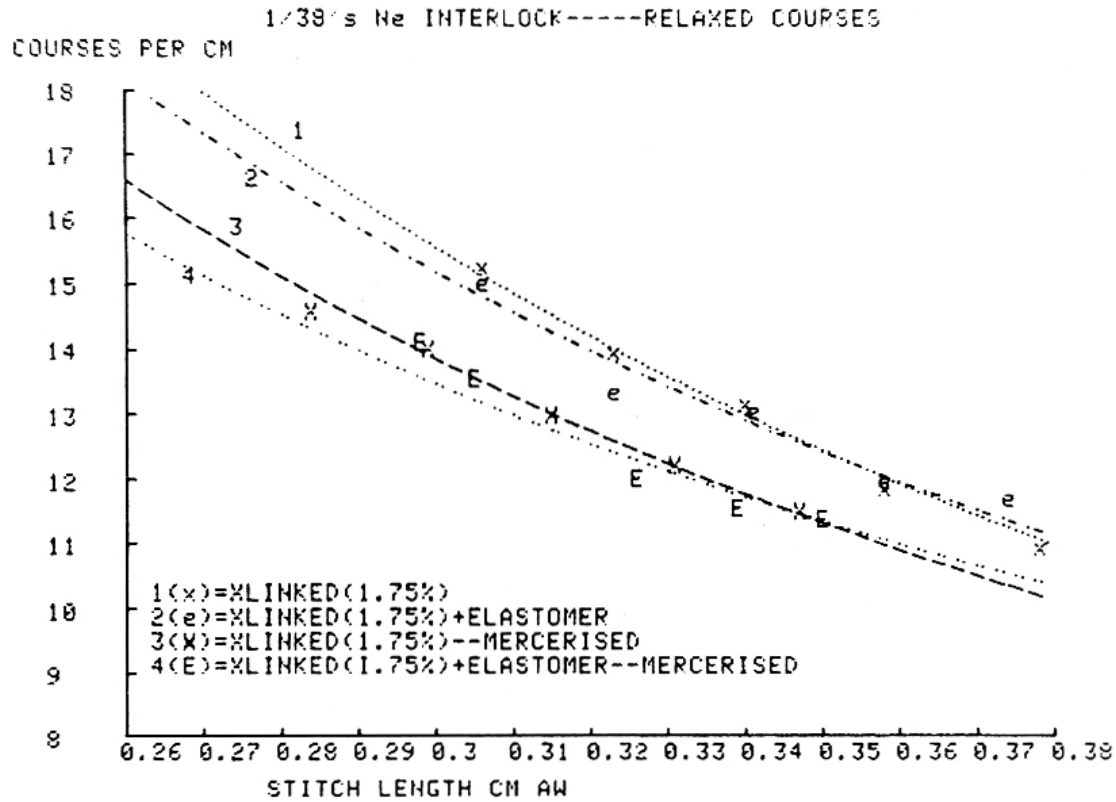

Figure 3

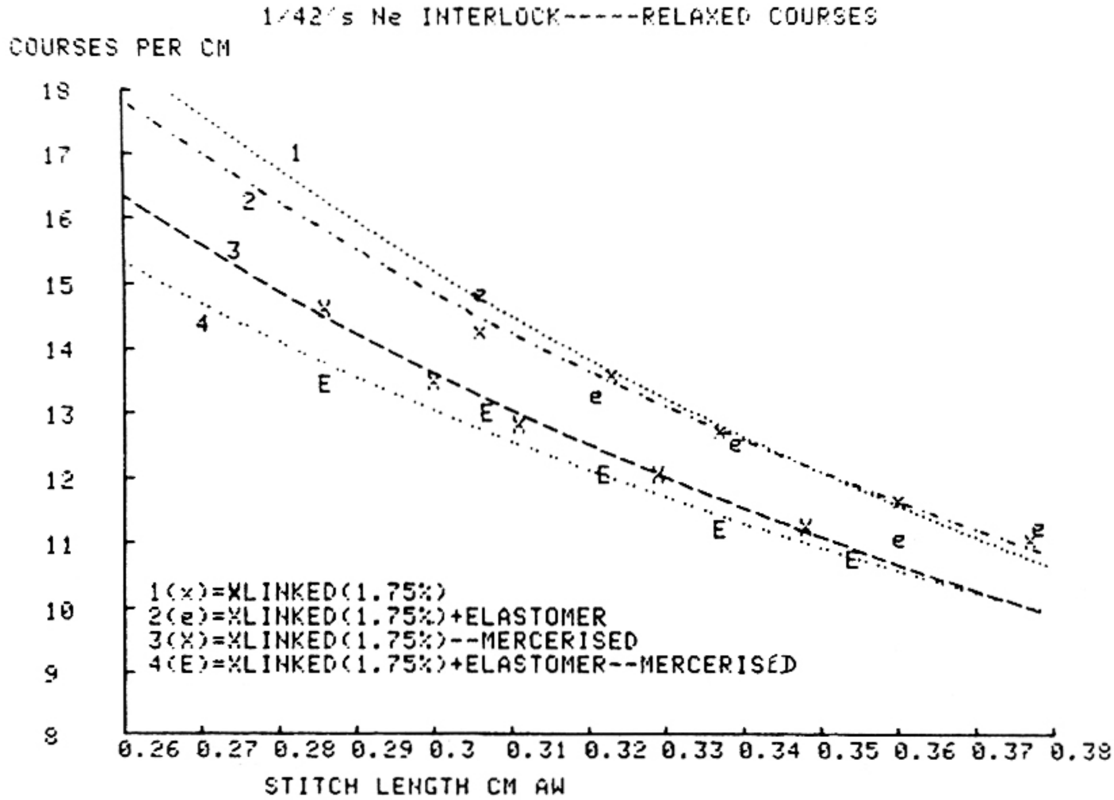

Figure 4

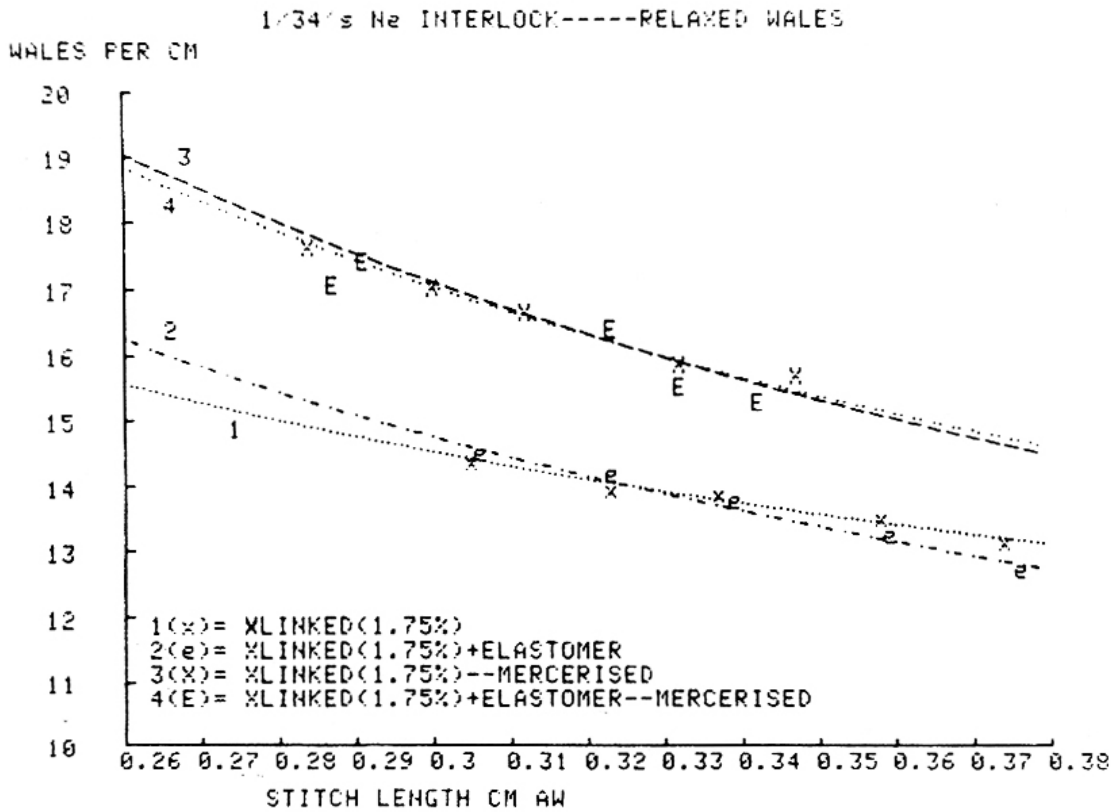

Figure 5

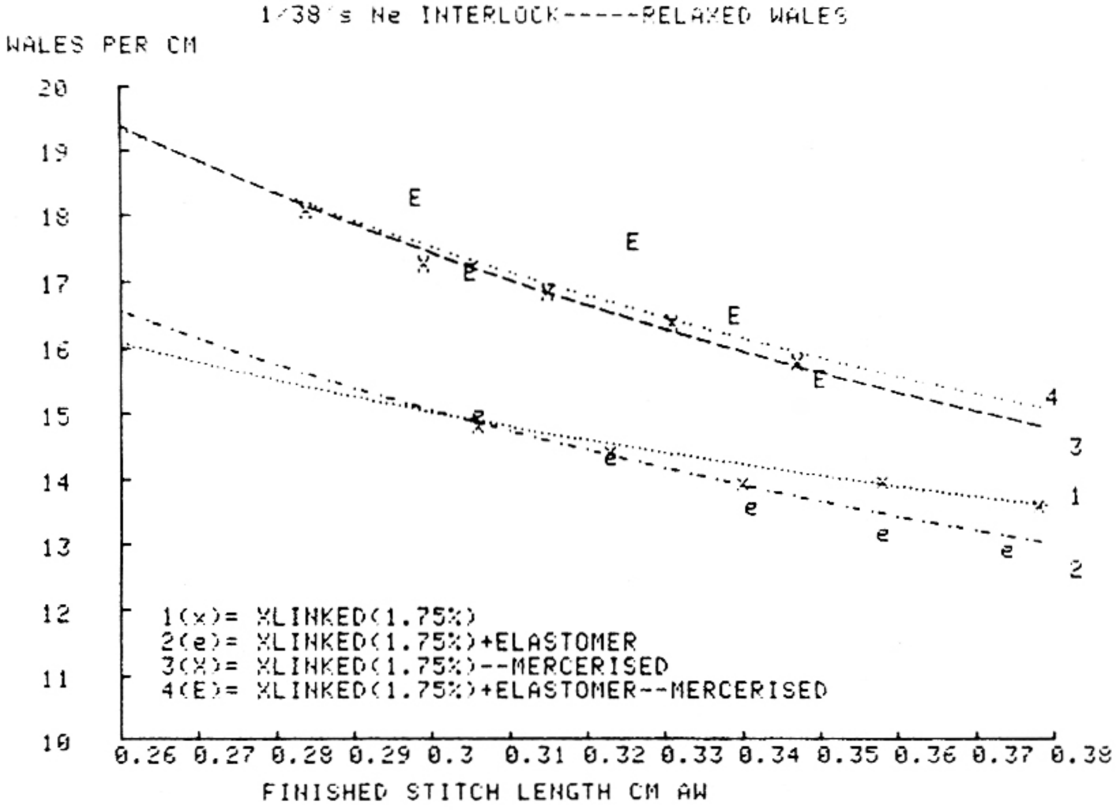

Figure 6

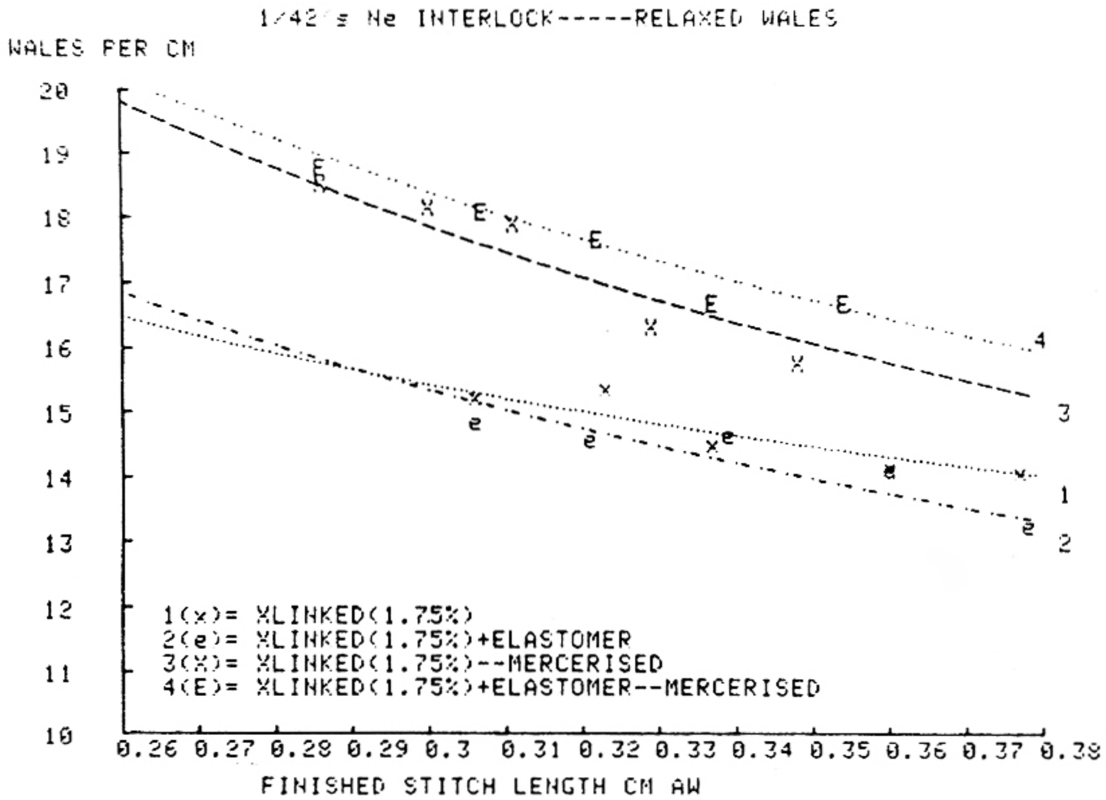

Figure 7

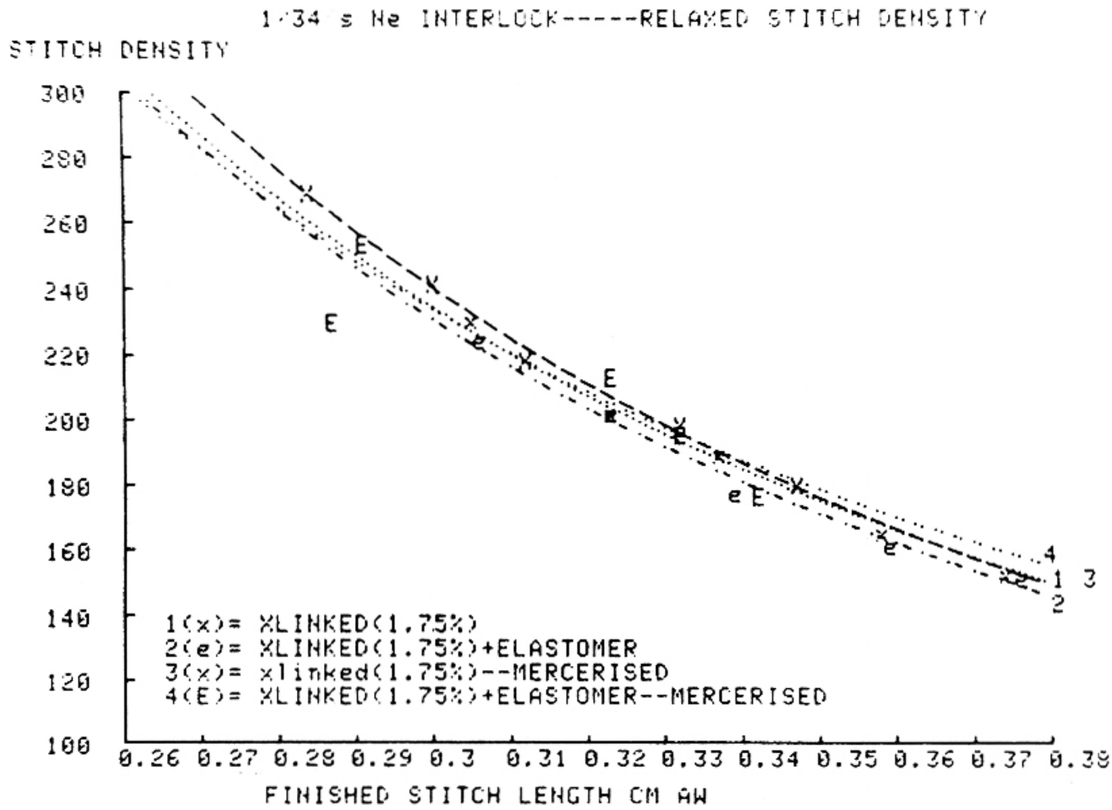

Figure 8

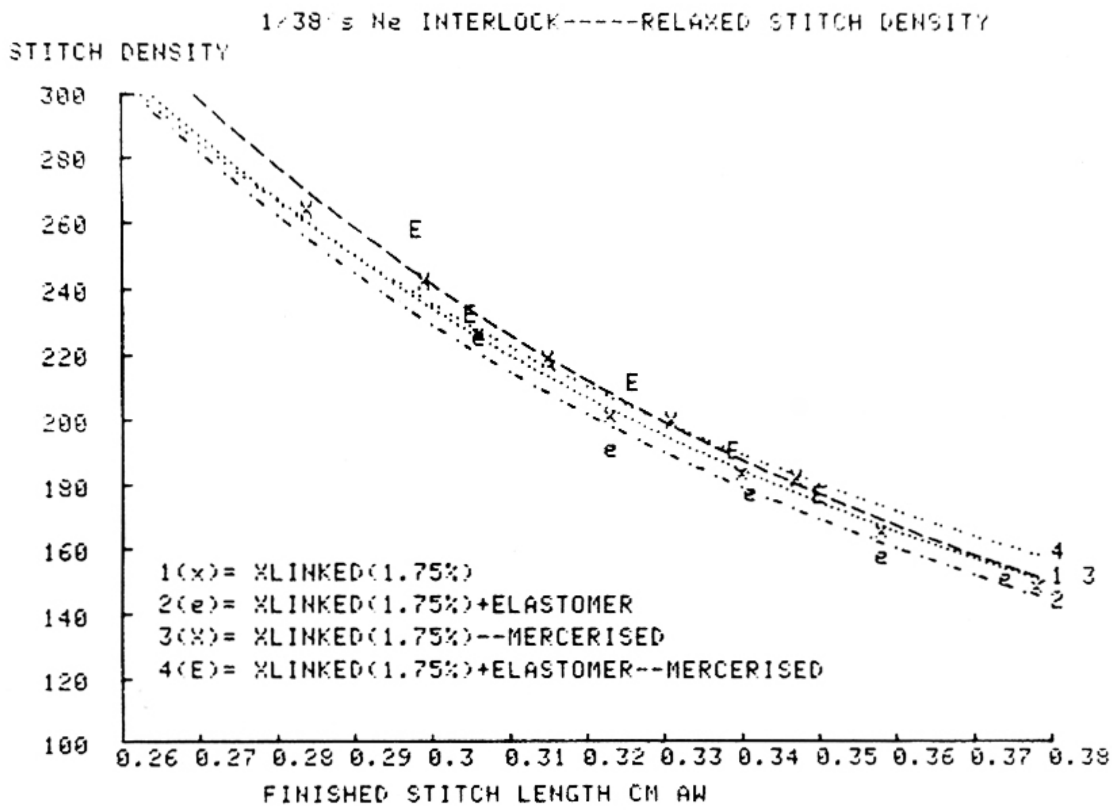

Figure 9

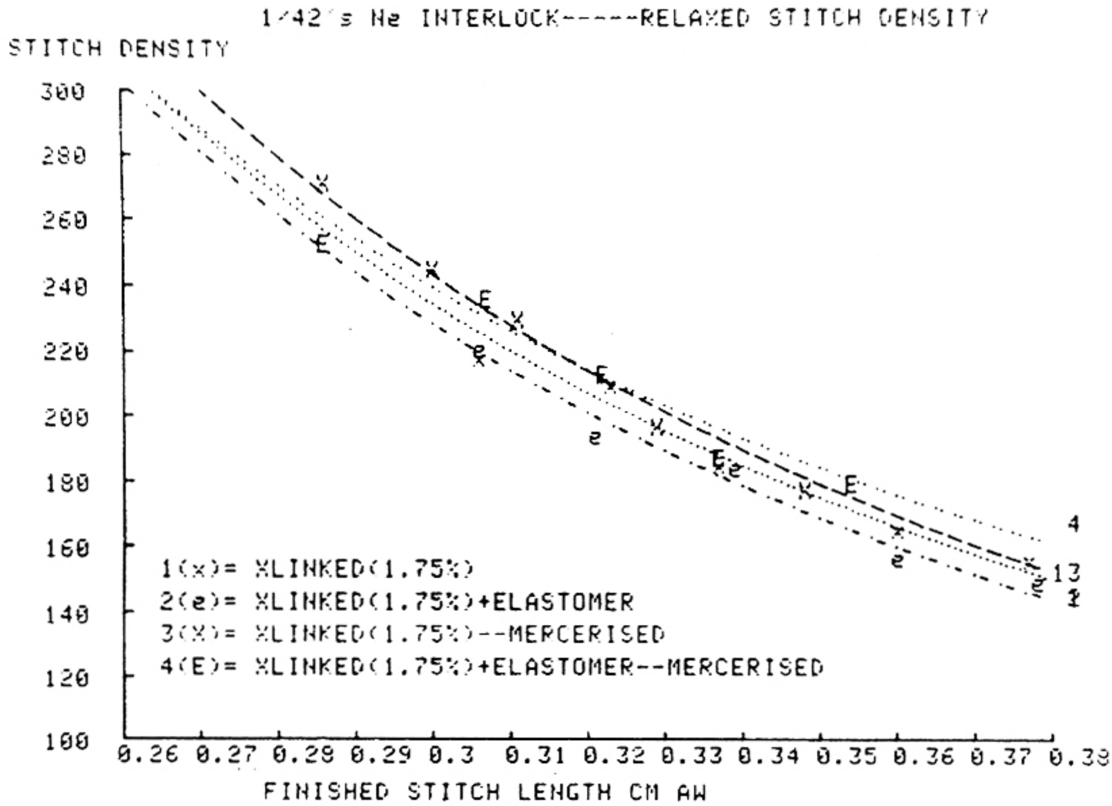

Figure 10

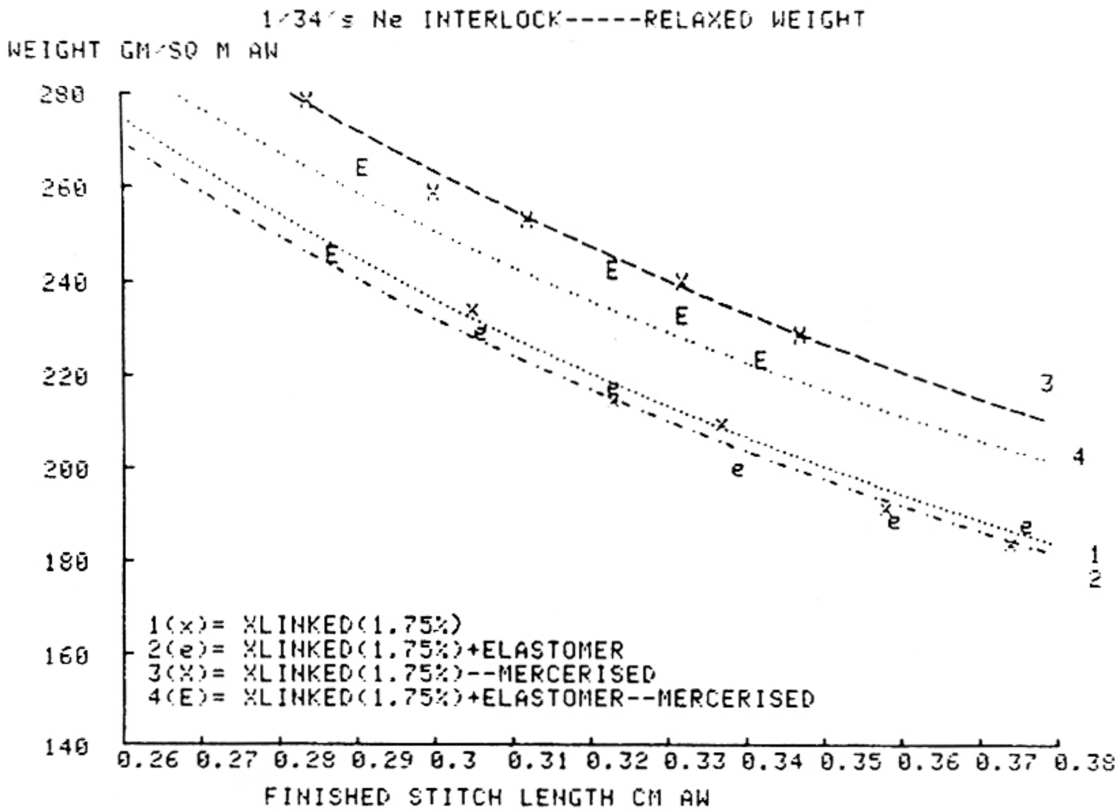

Figure 11

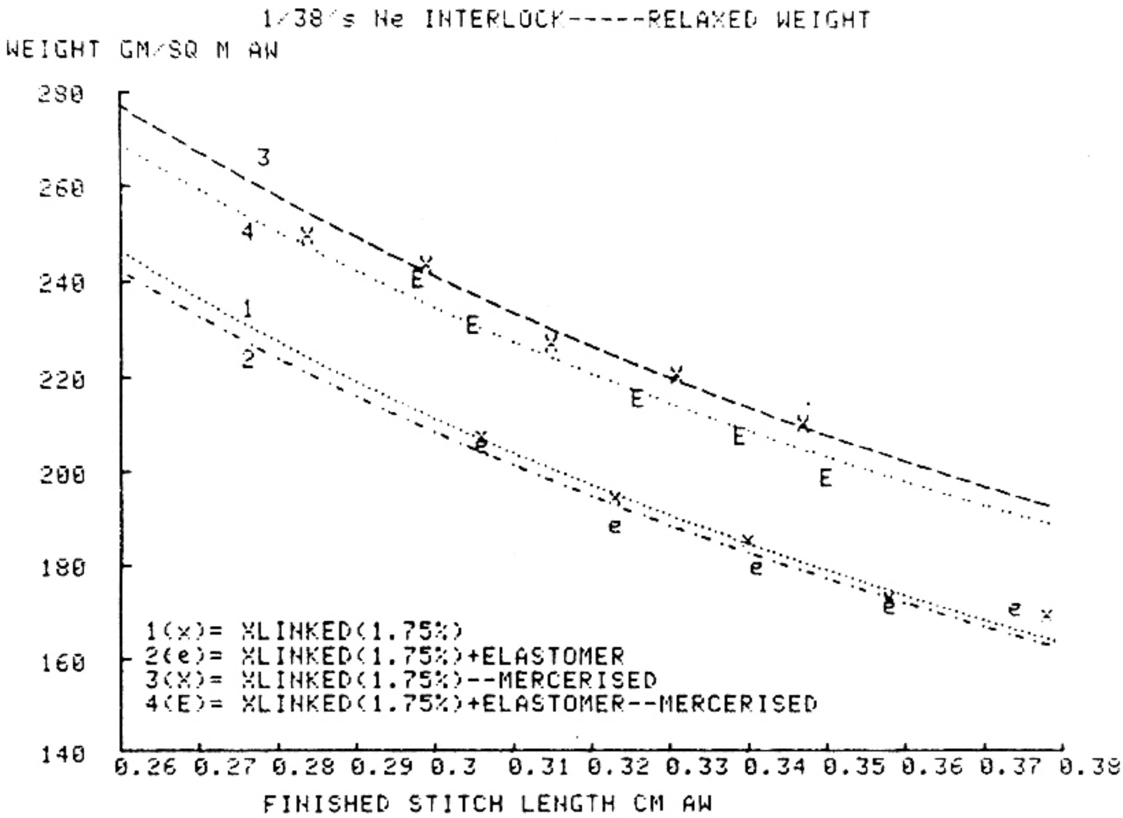

Figure 12

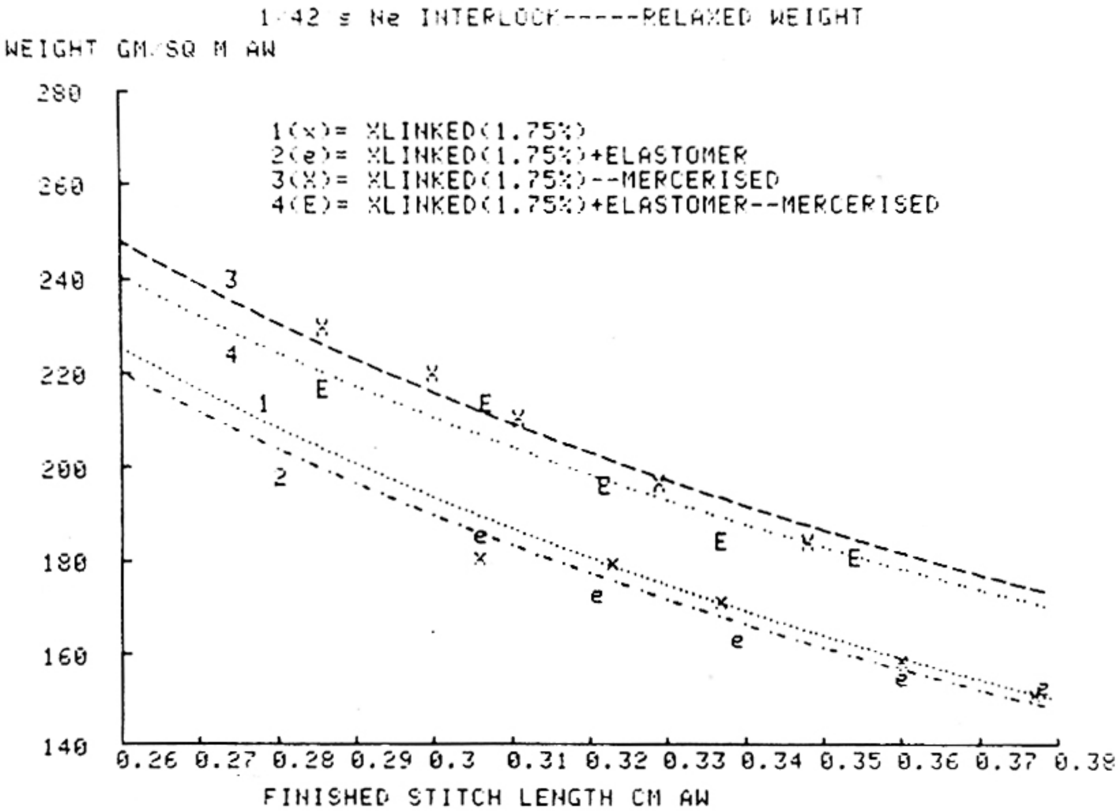

Figure 13

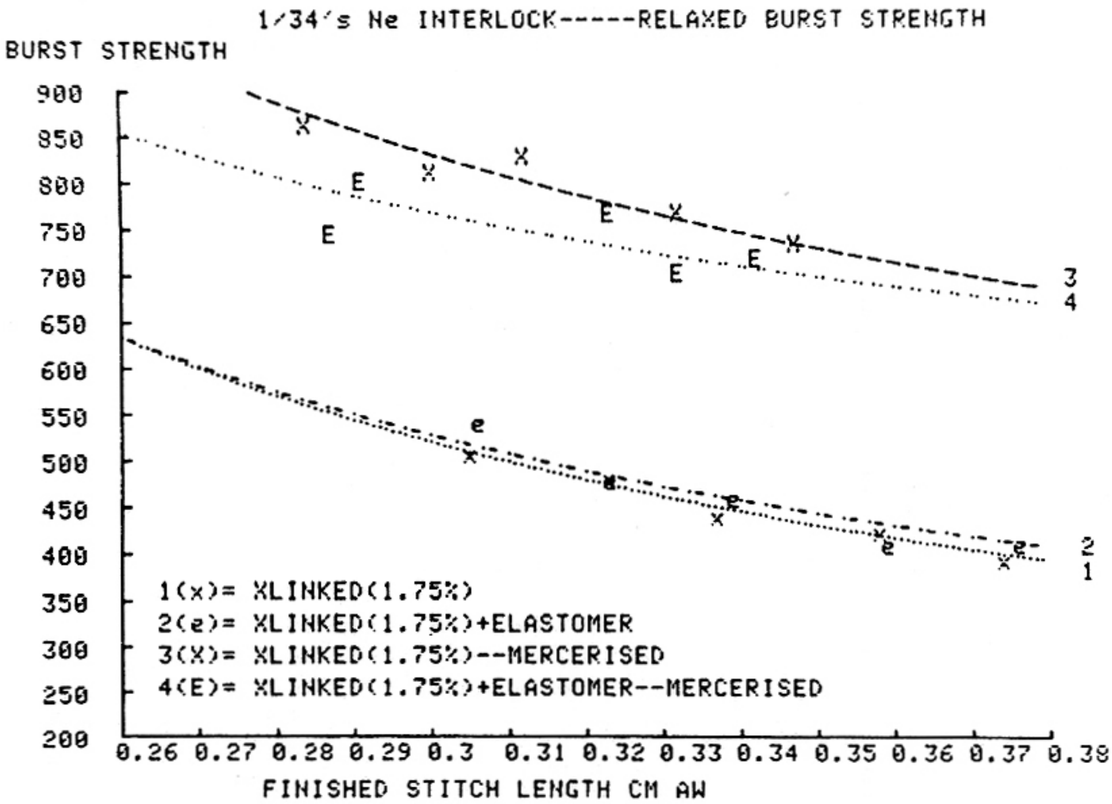

Figure 14

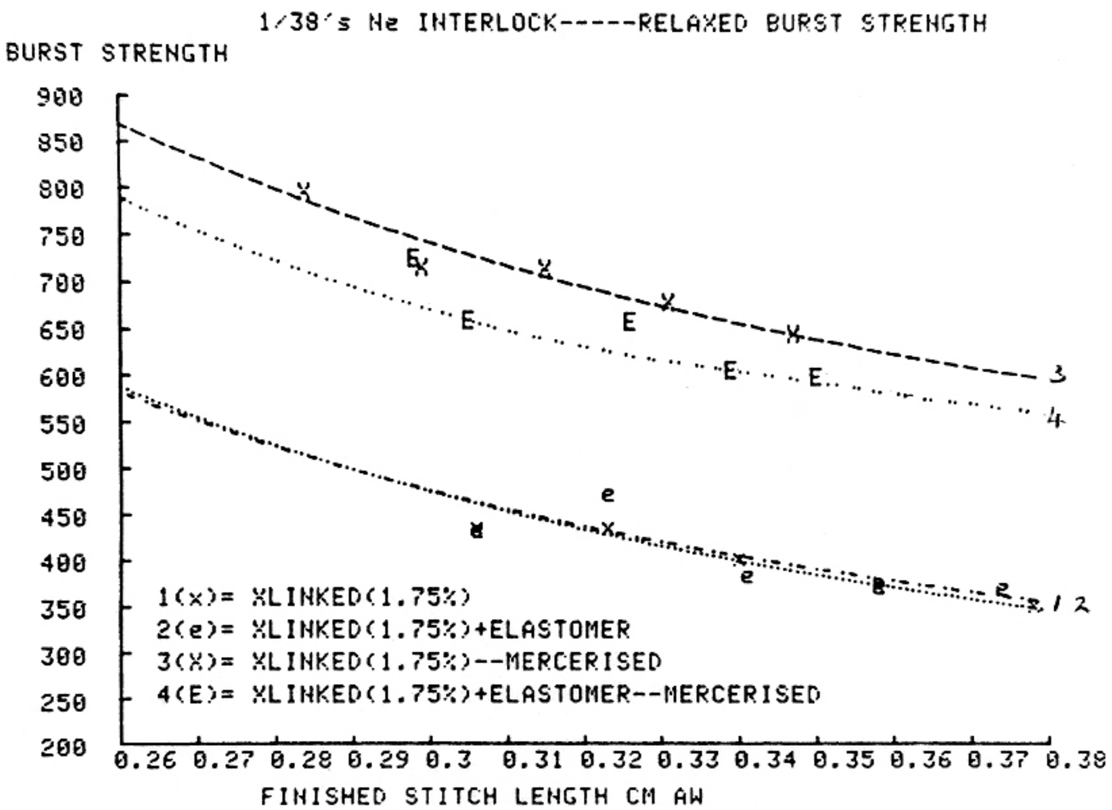

Figure 15

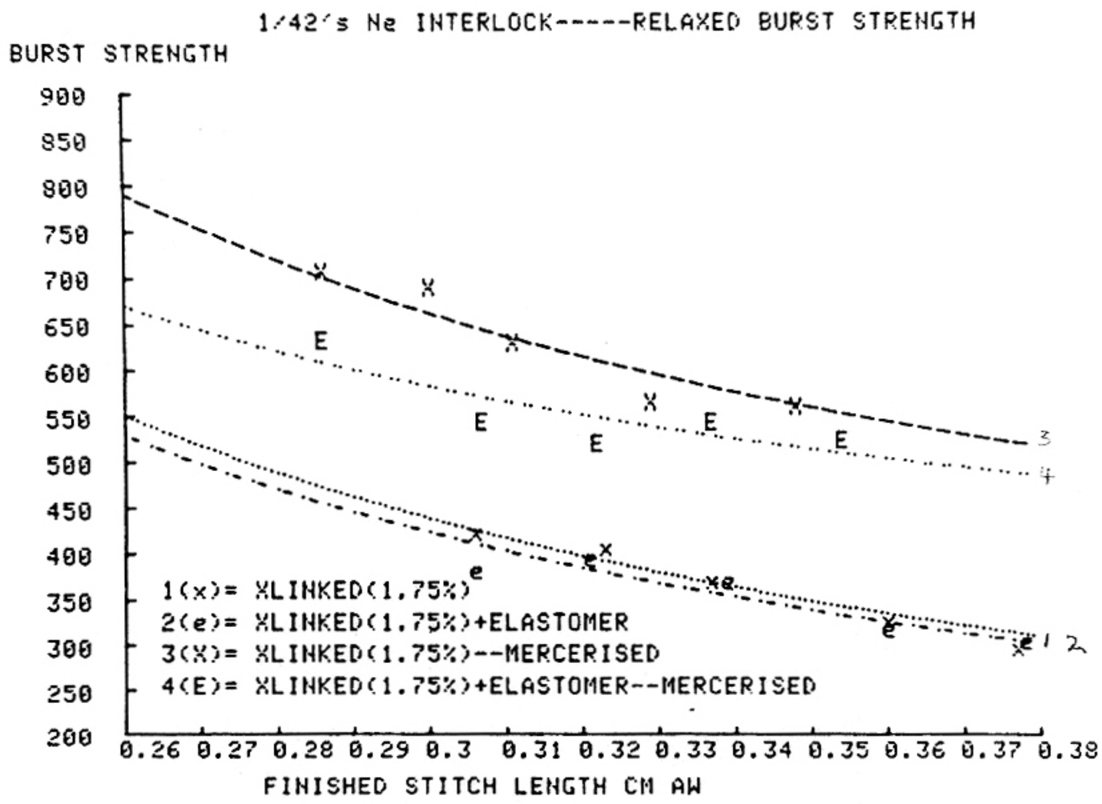

Figure 16

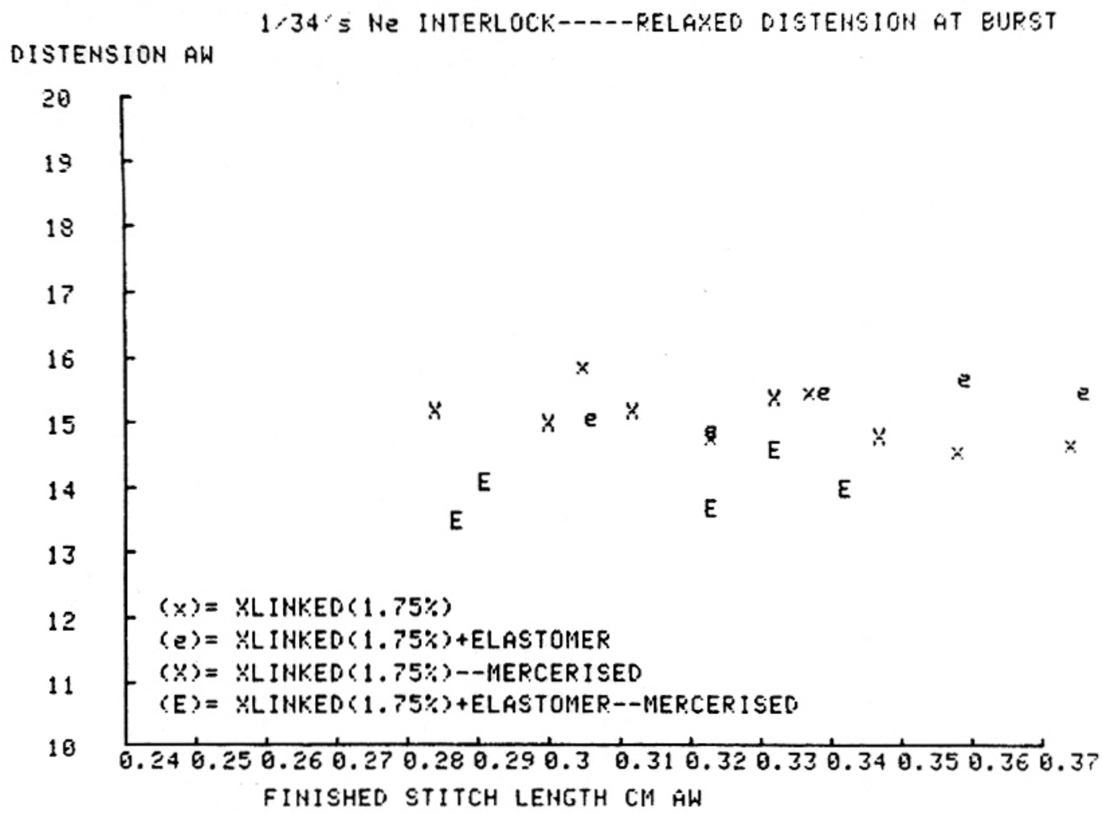

Figure 17

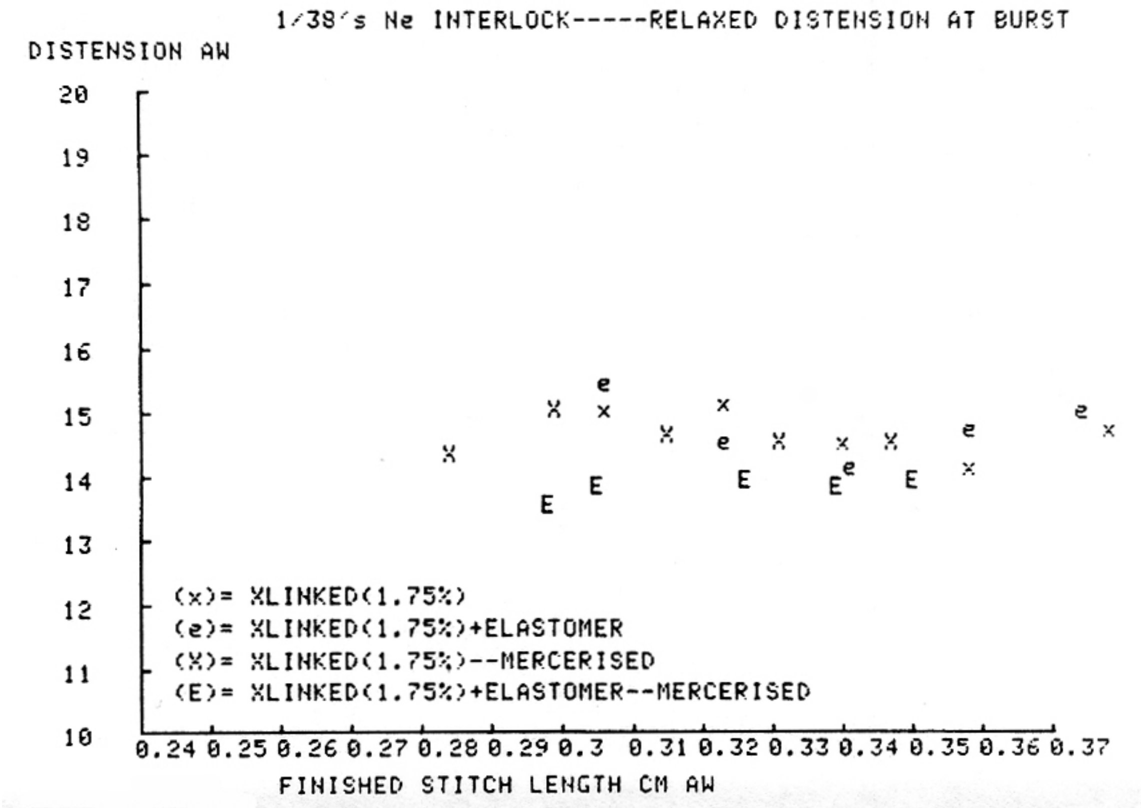

Figure 18

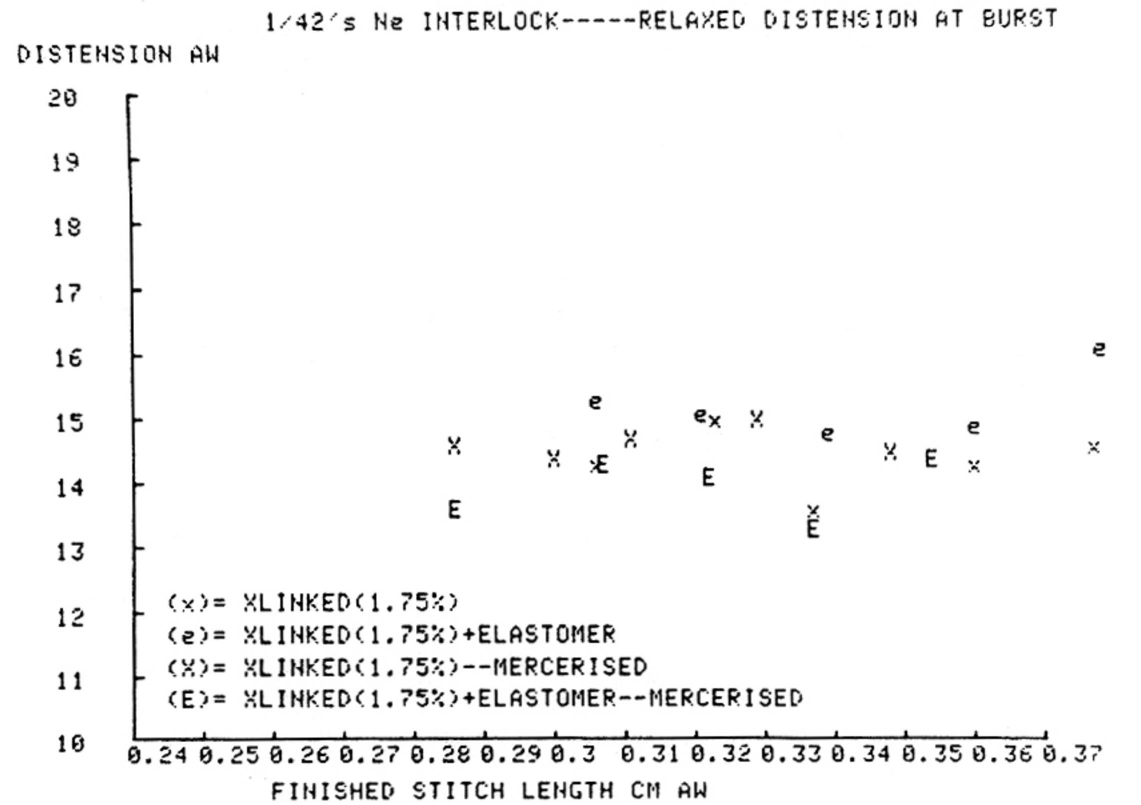

Figure 19

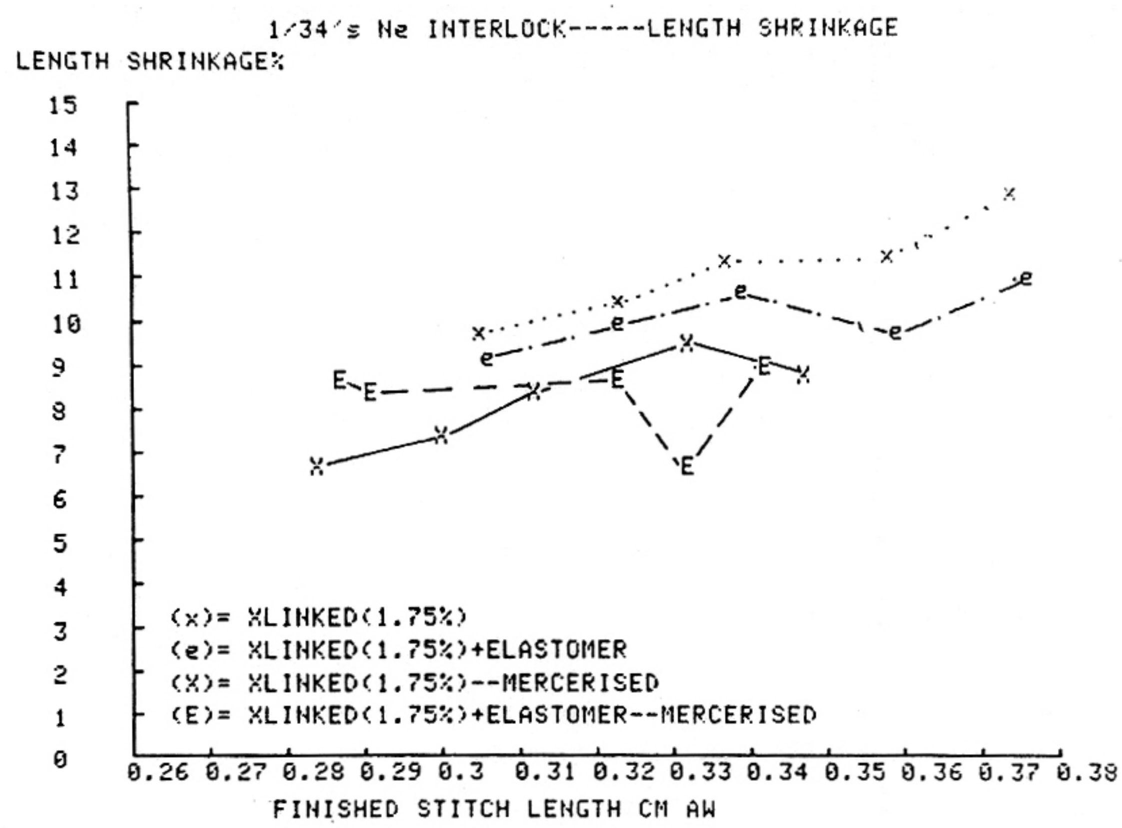

Figure 20

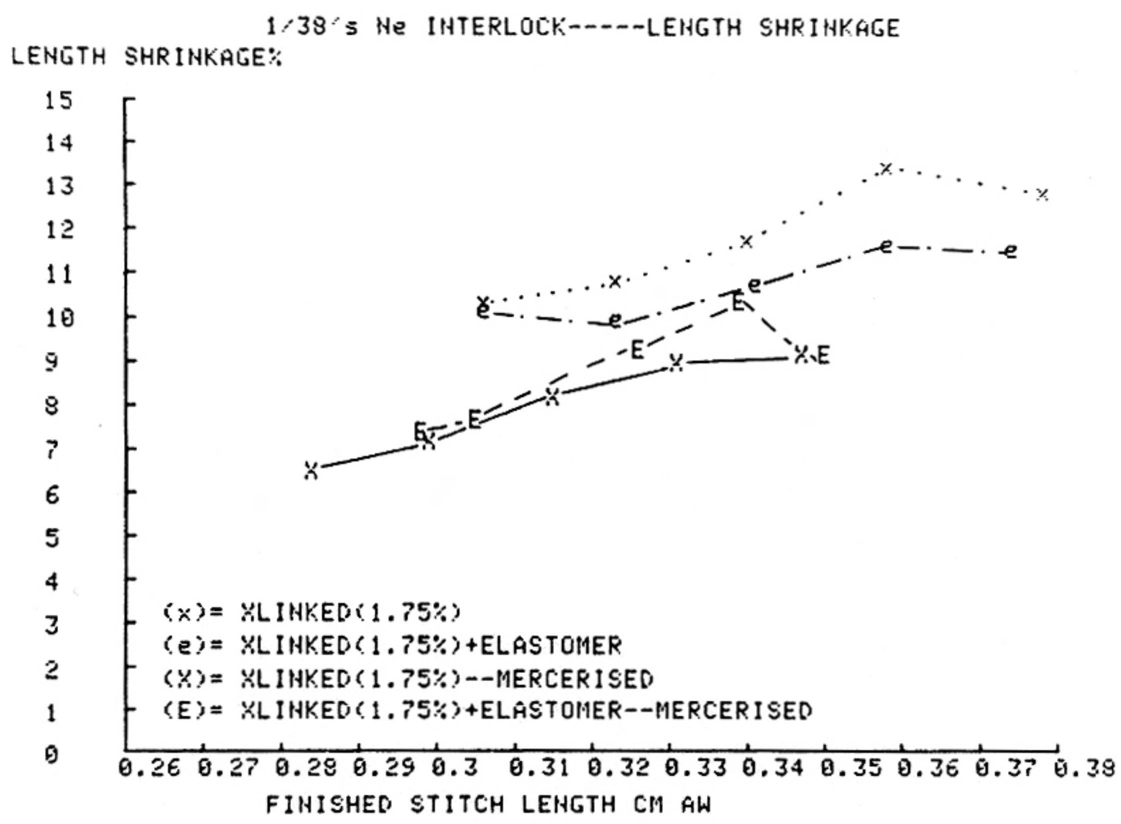

Figure 21

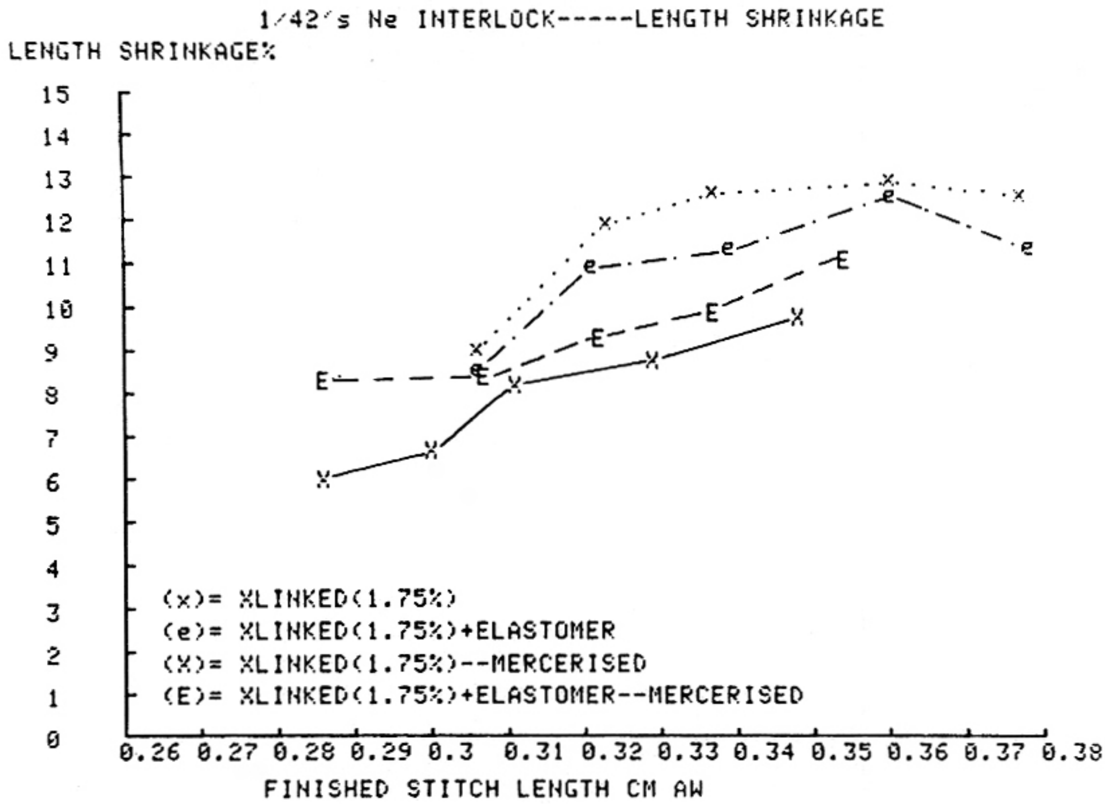

Figure 22

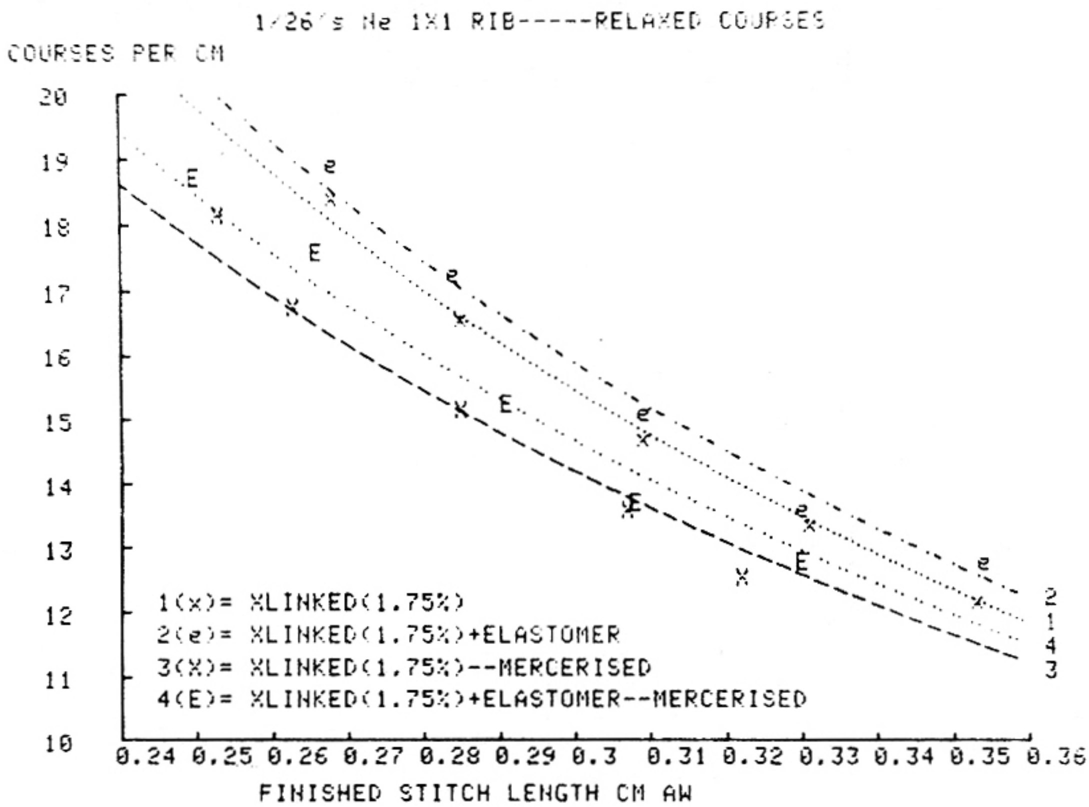

Figure 23

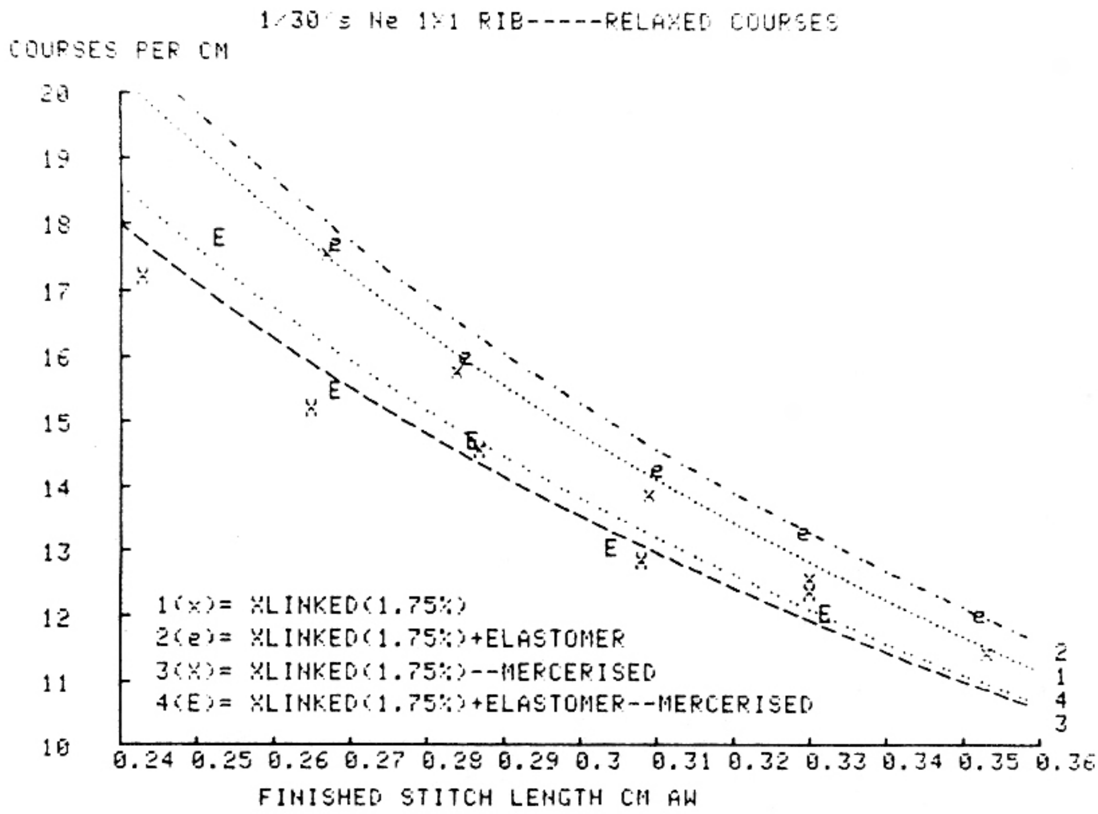

Figure 24

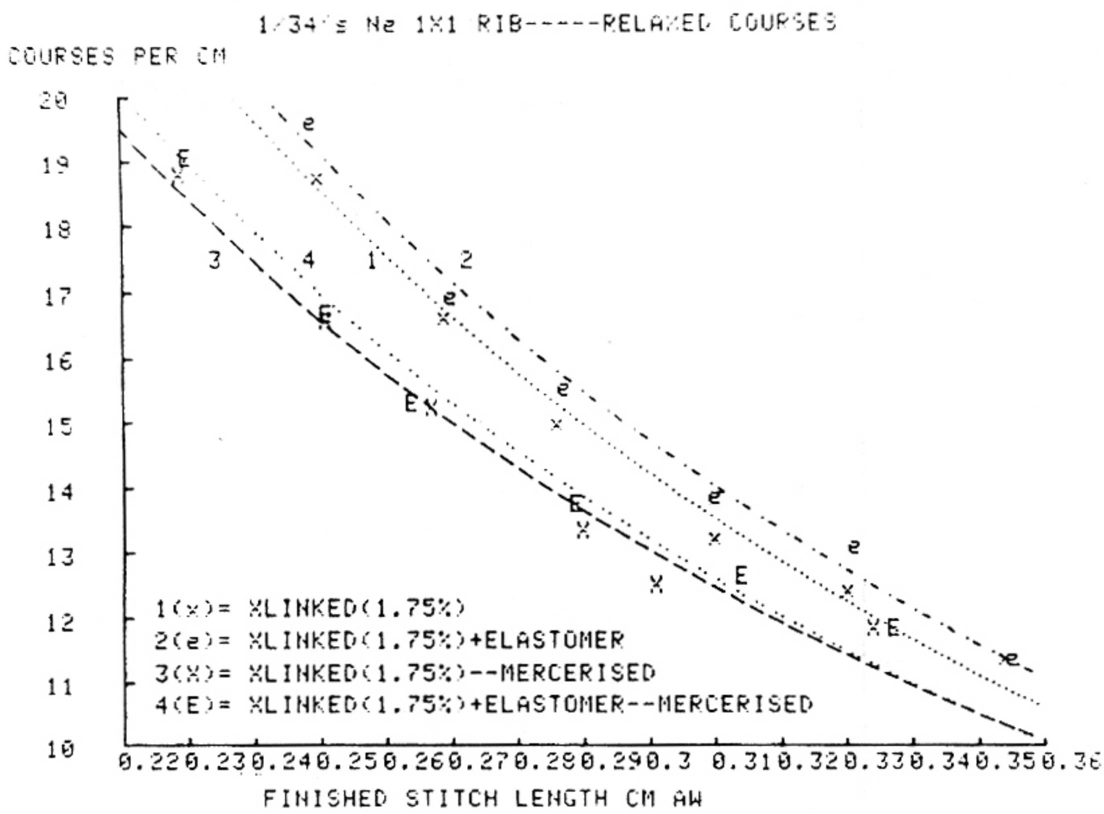

Figure 25

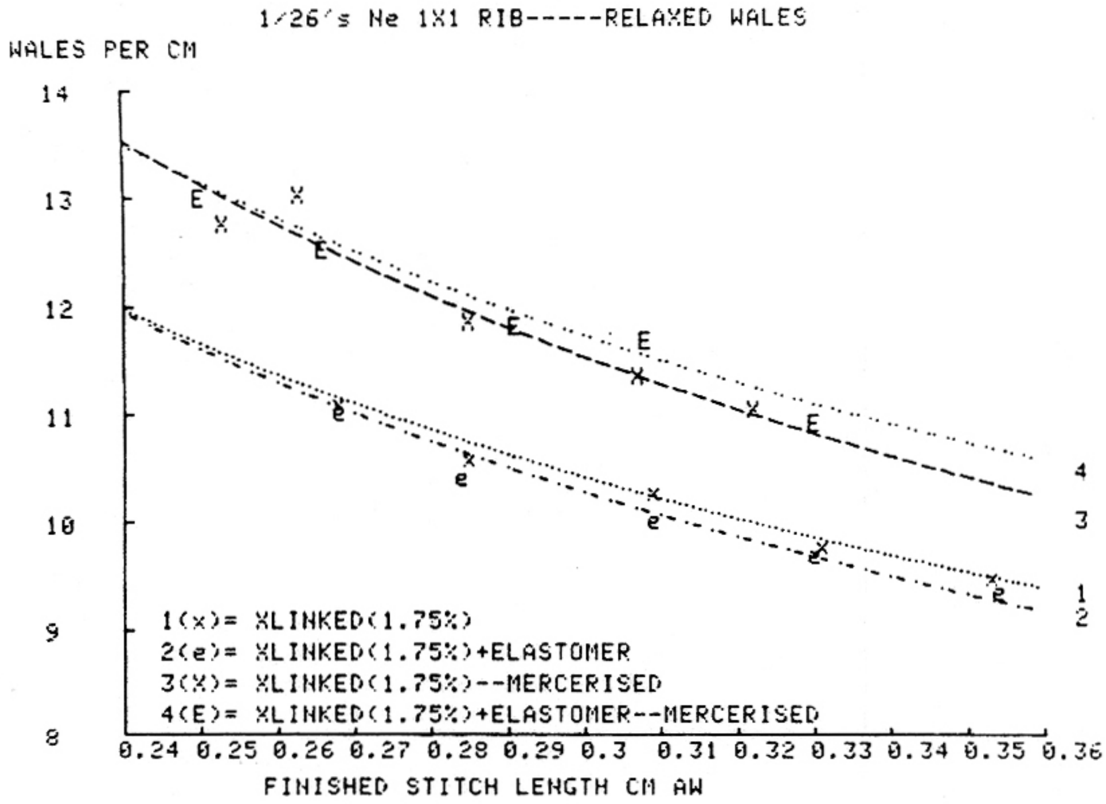

Figure 26

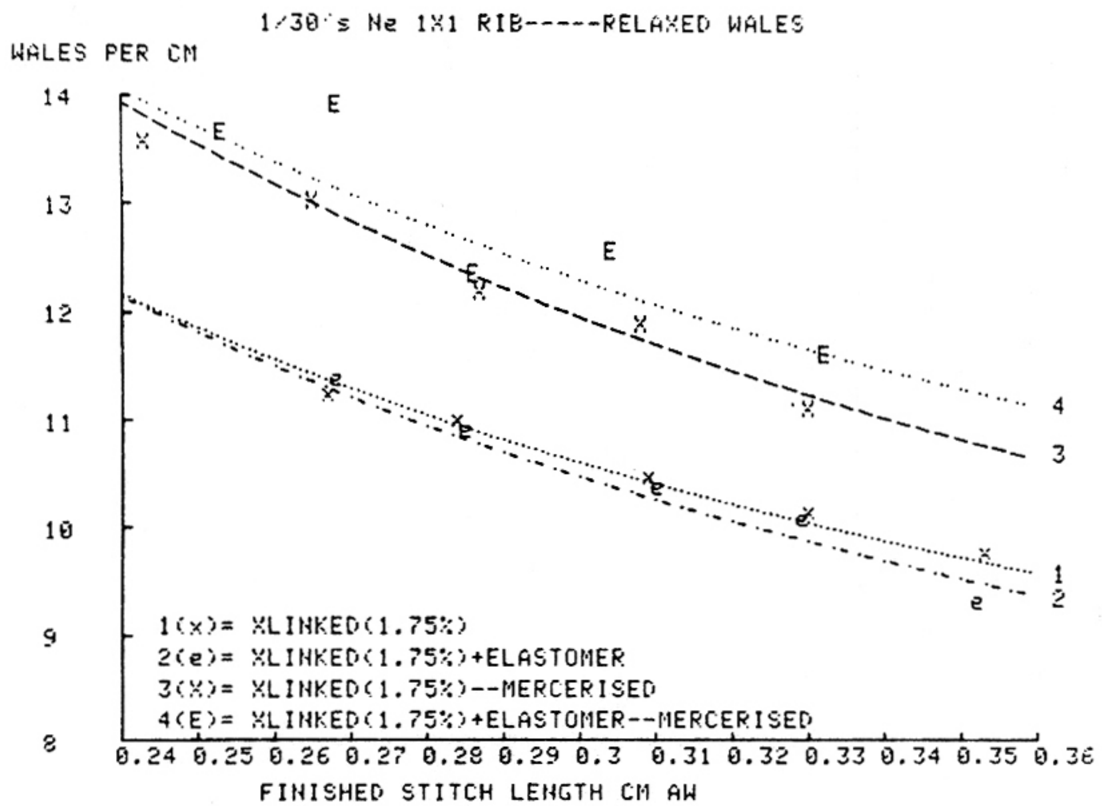

Figure 27

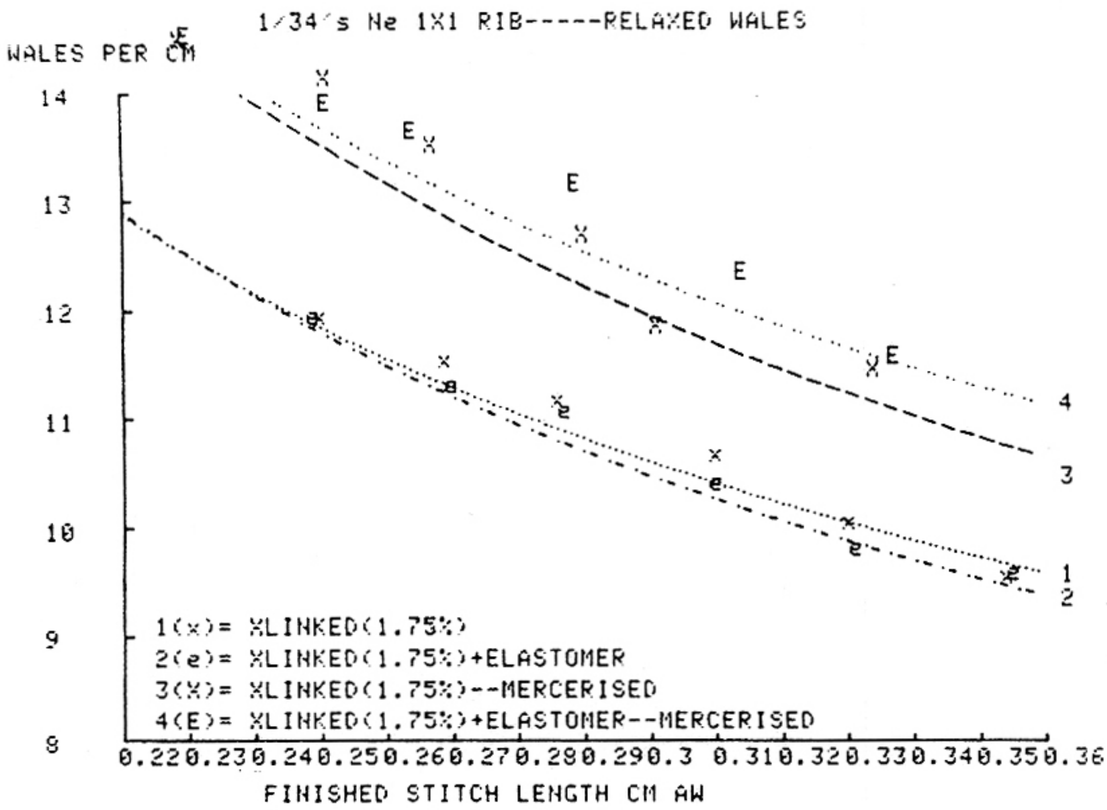

Figure 28

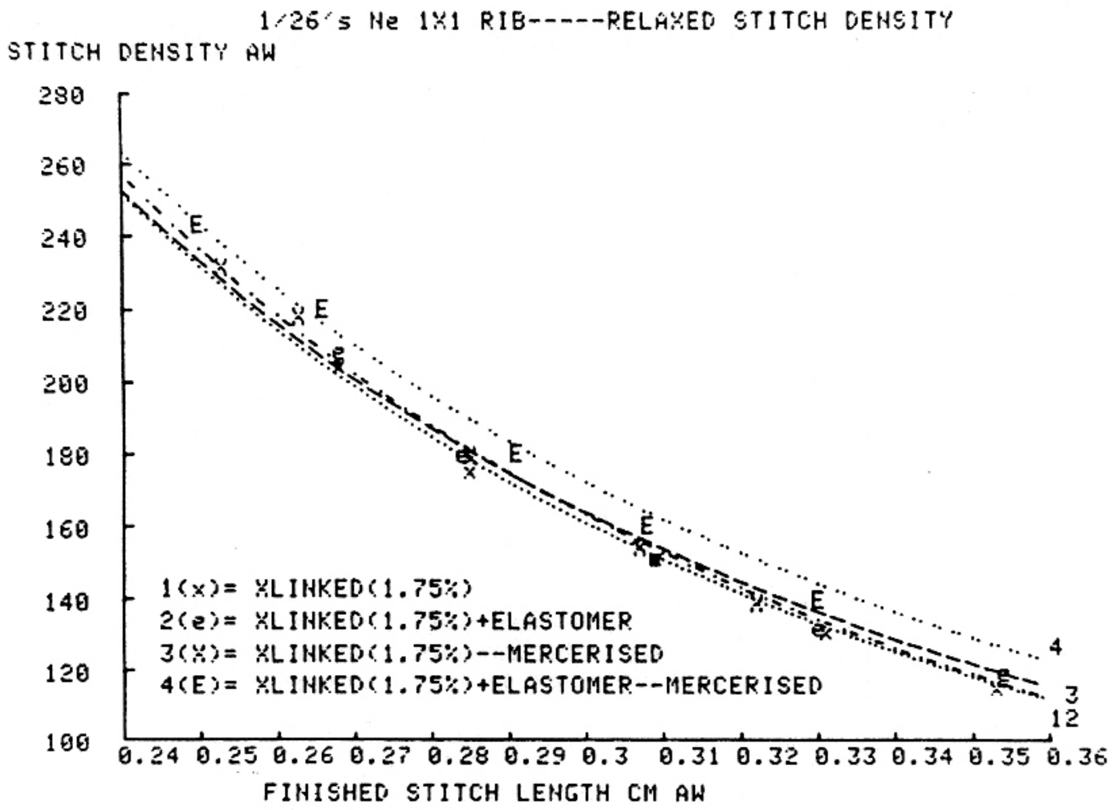

Figure 29

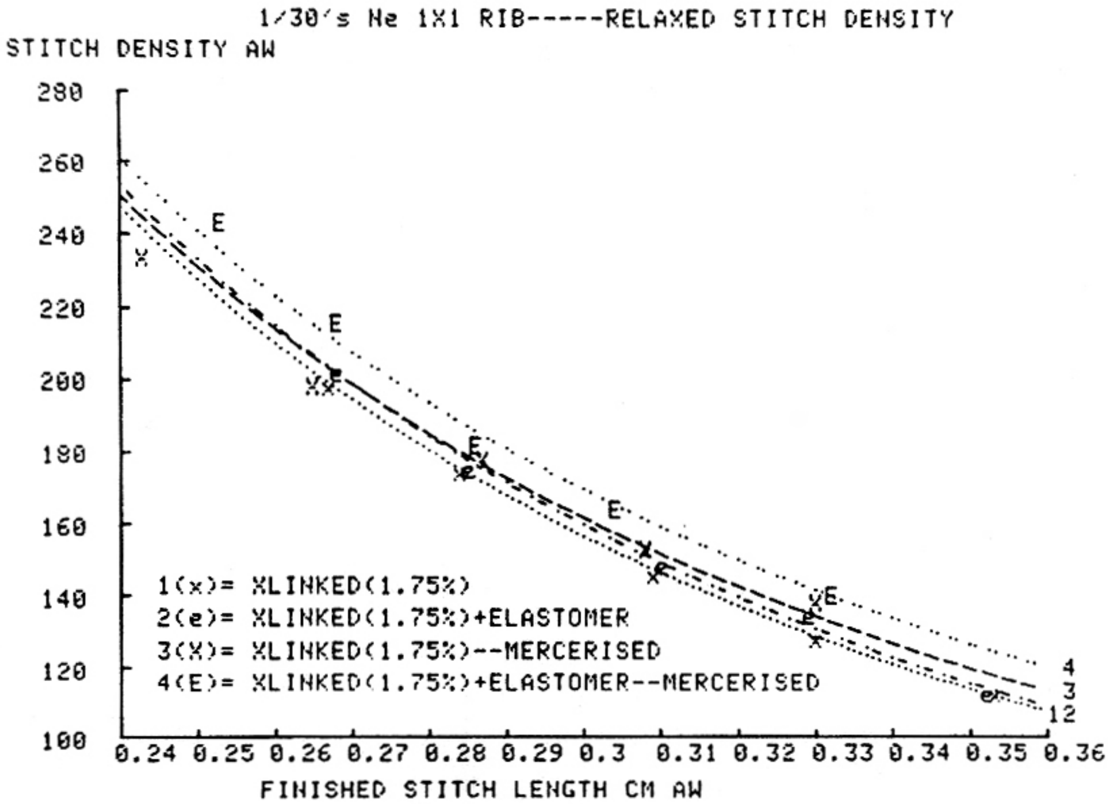

Figure 30

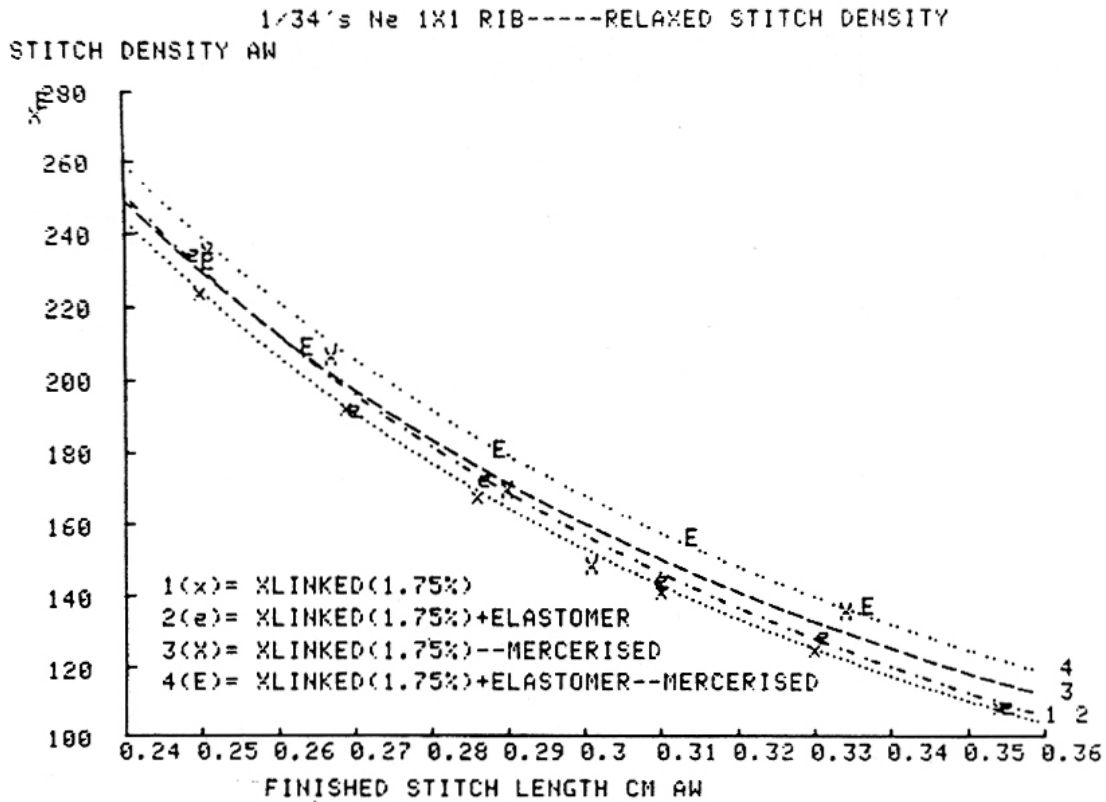

Figure 31

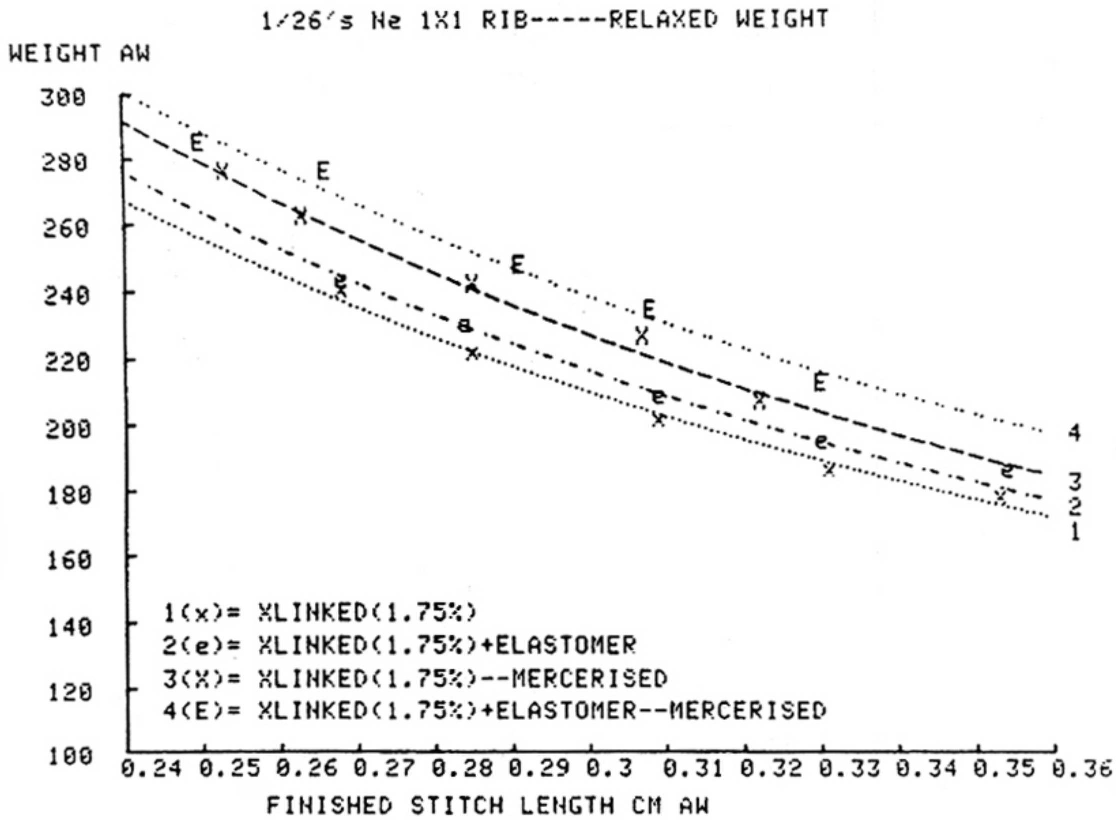

Figure 32

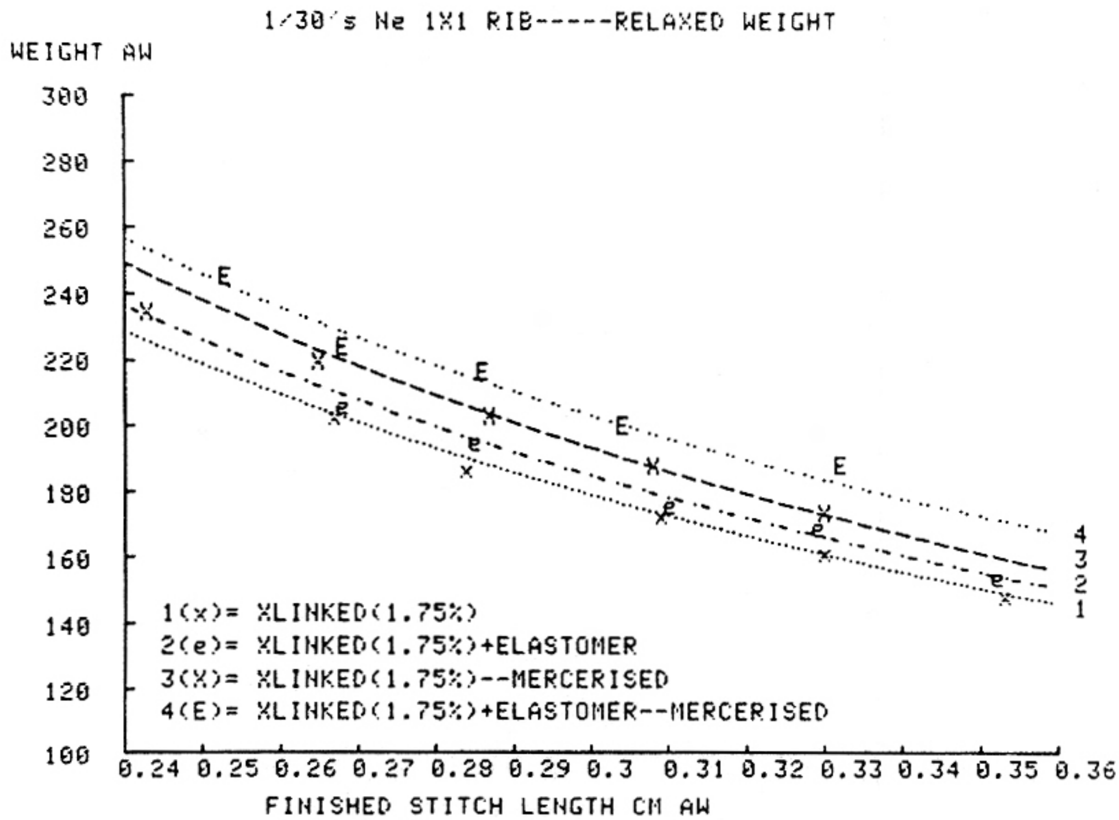

Figure 33

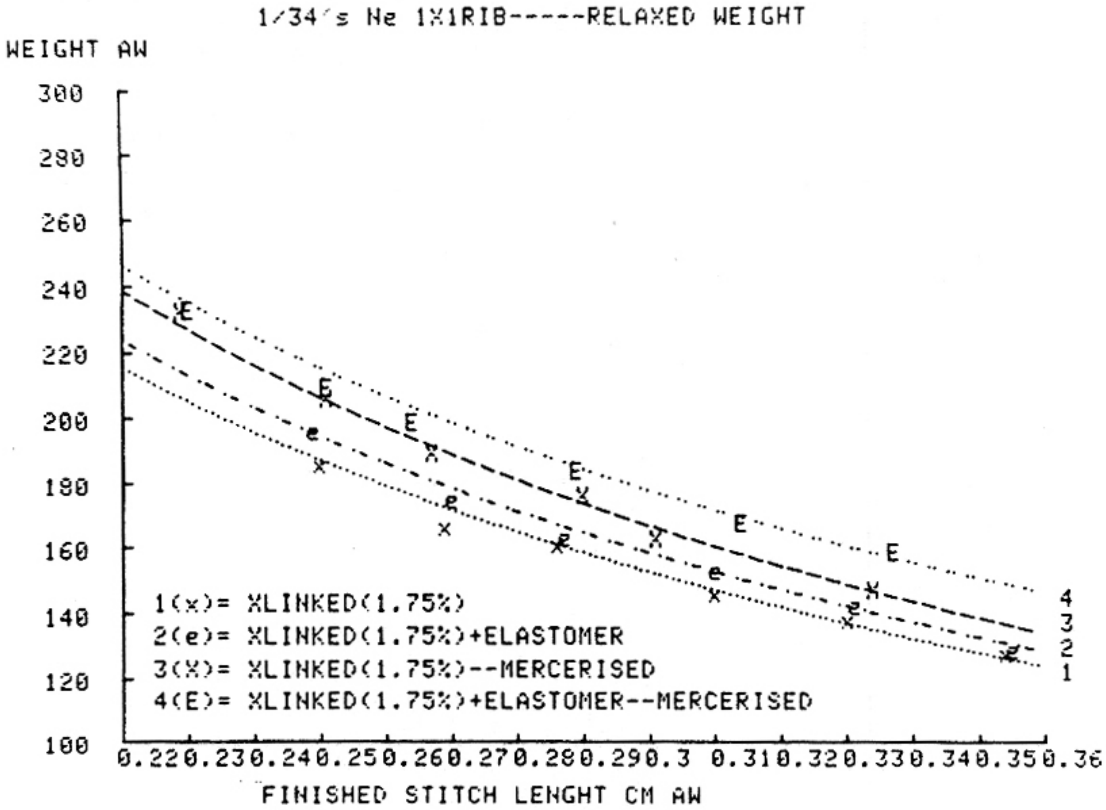

Figure 34

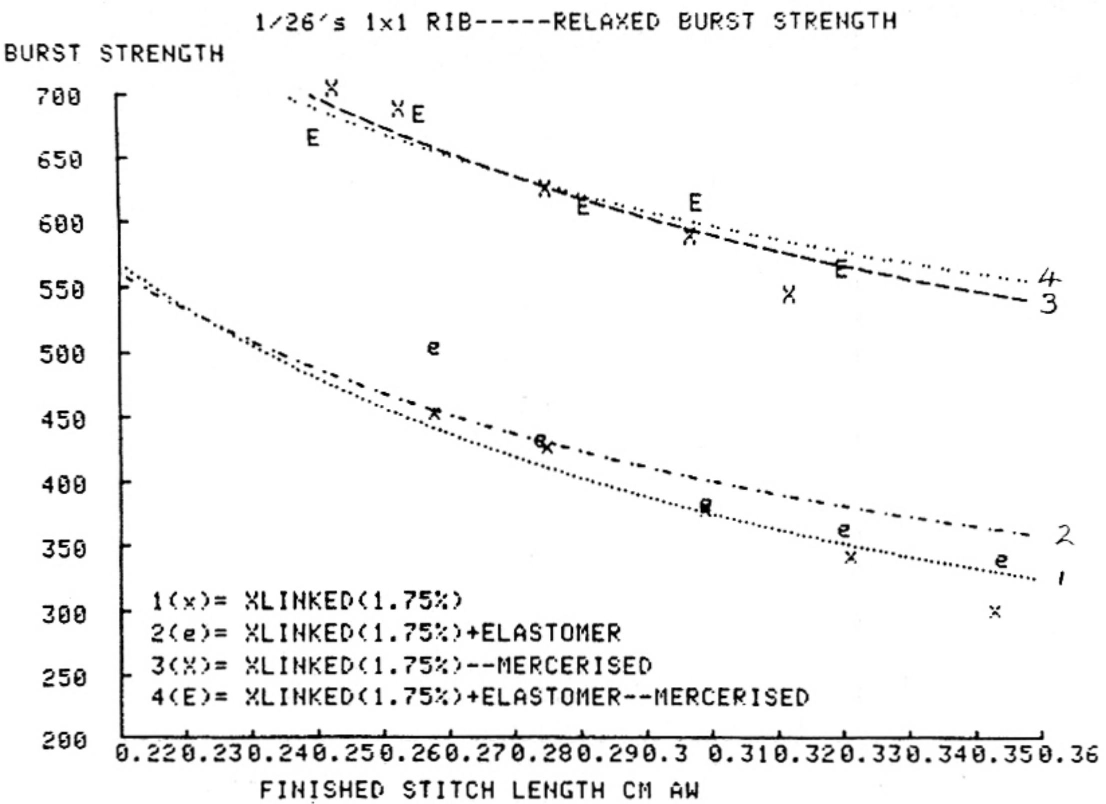

Figure 35

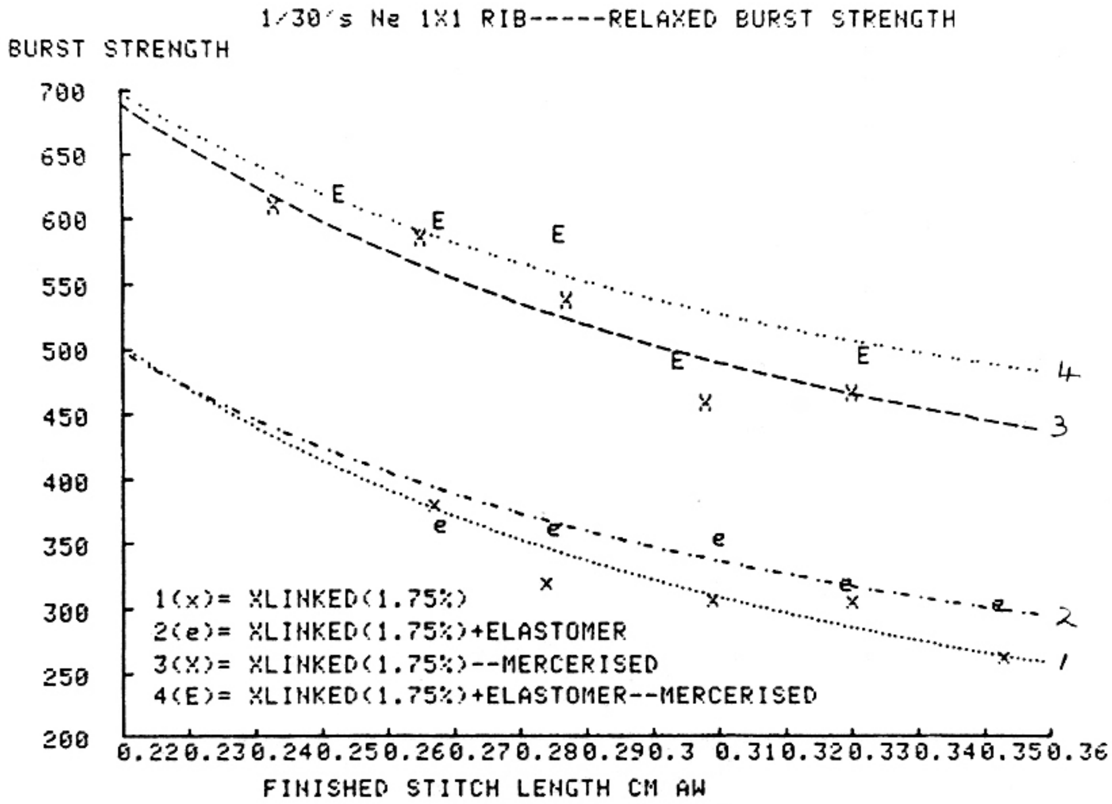

Figure 36

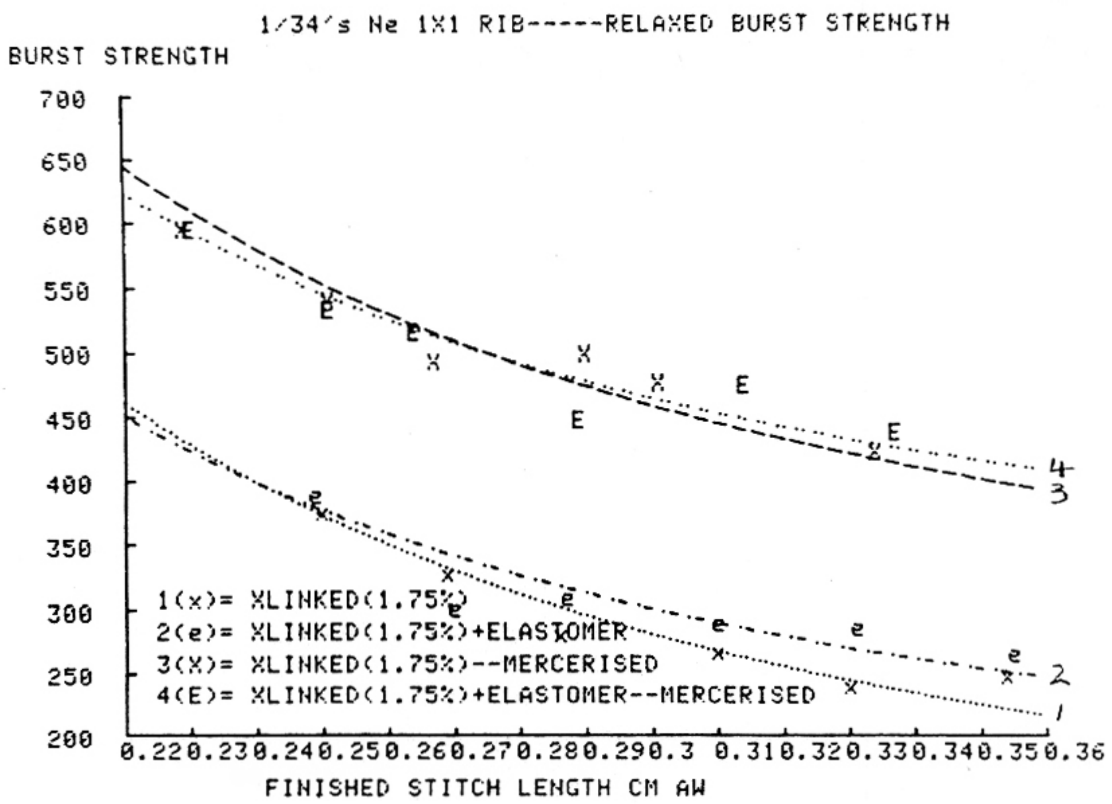

Figure 37

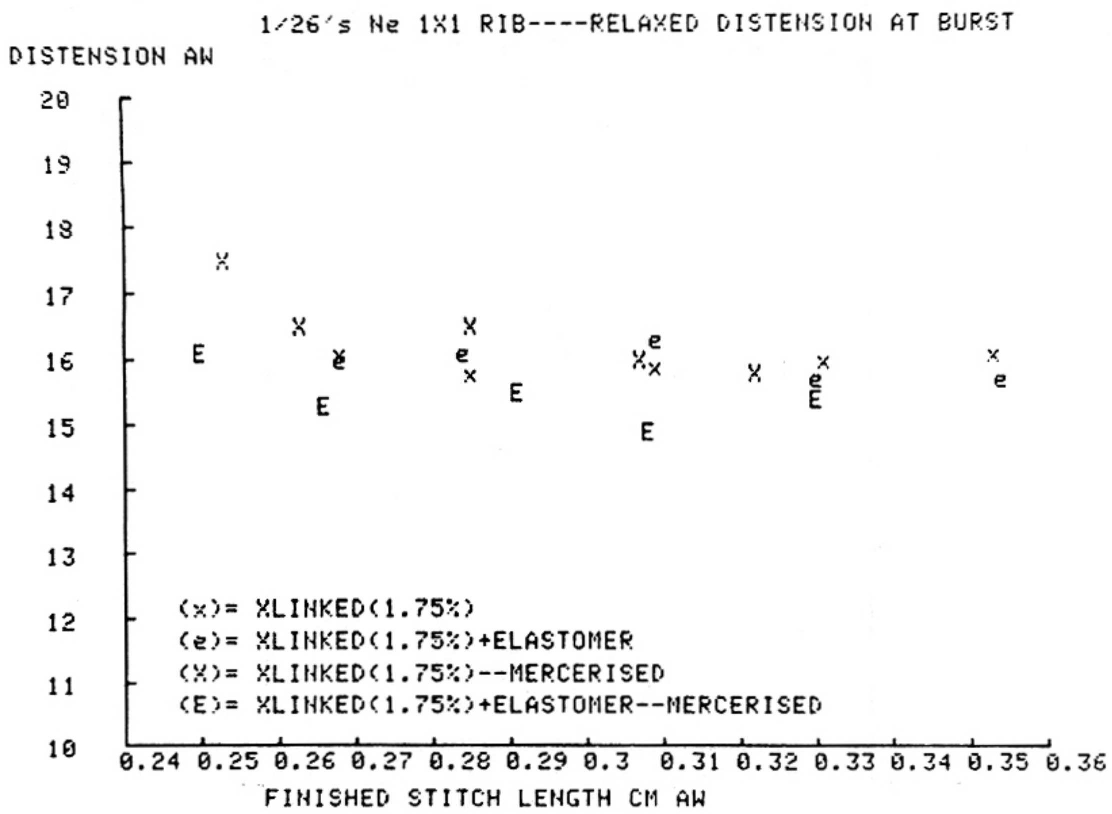

Figure 38

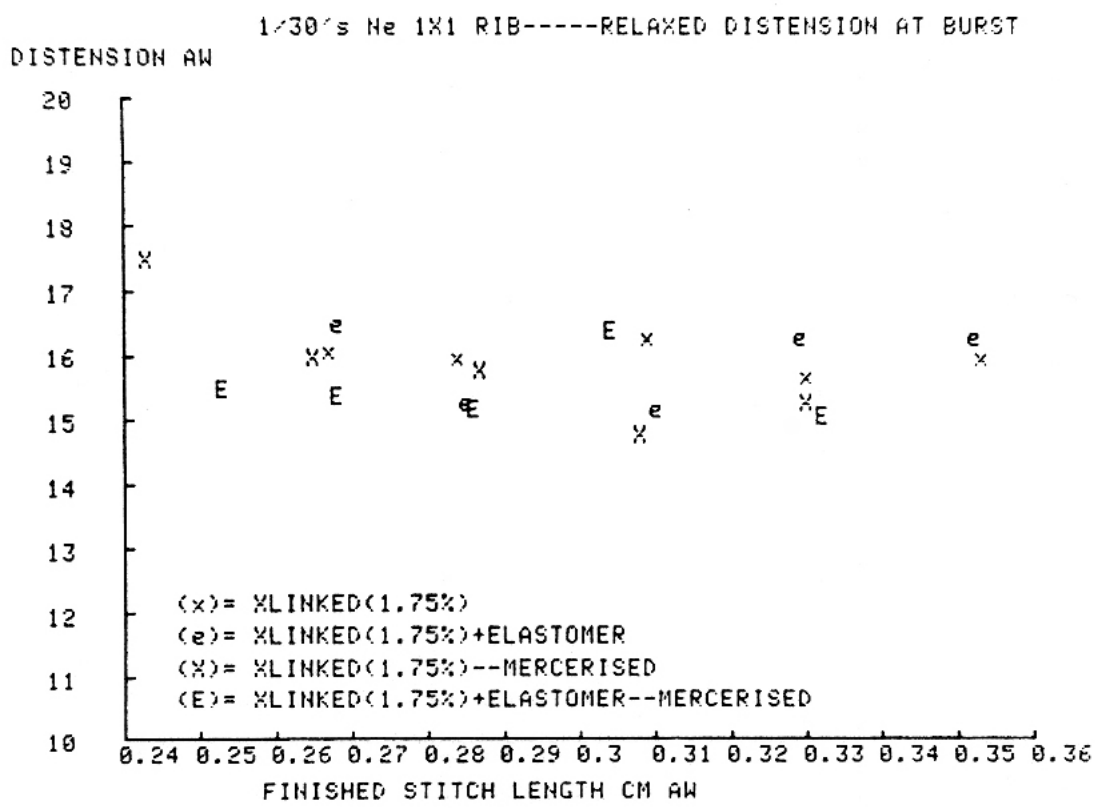

Figure 39

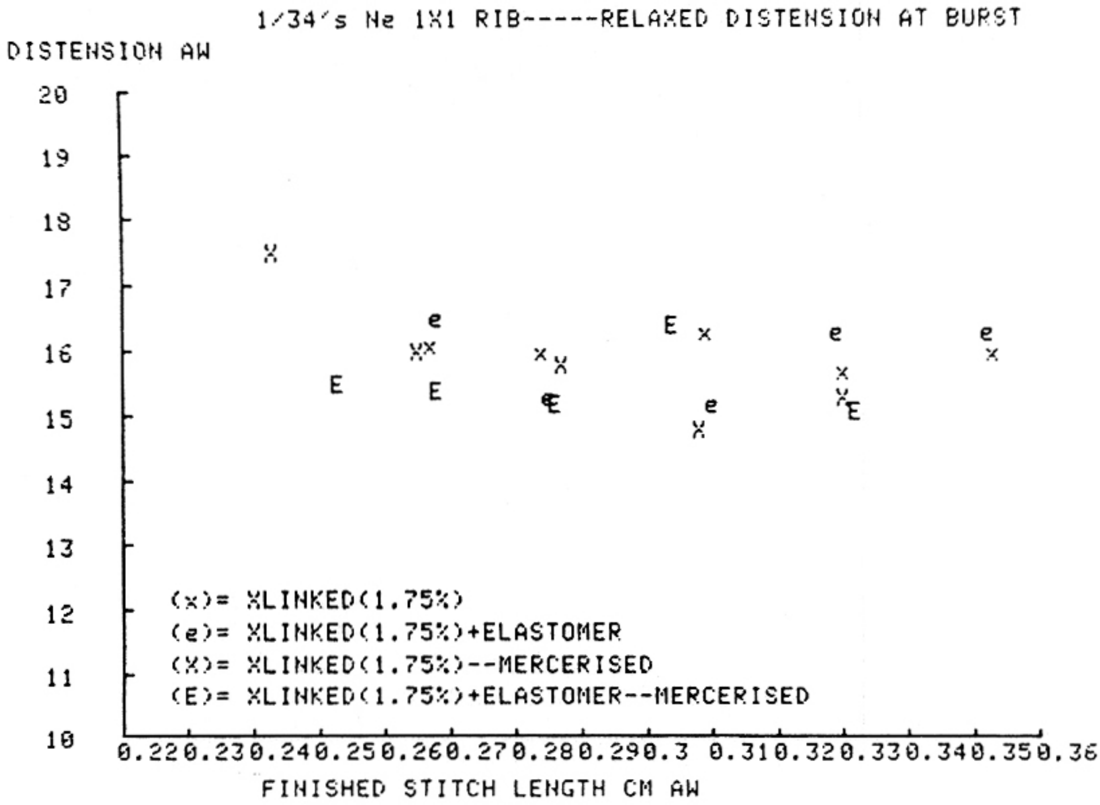

Figure 40

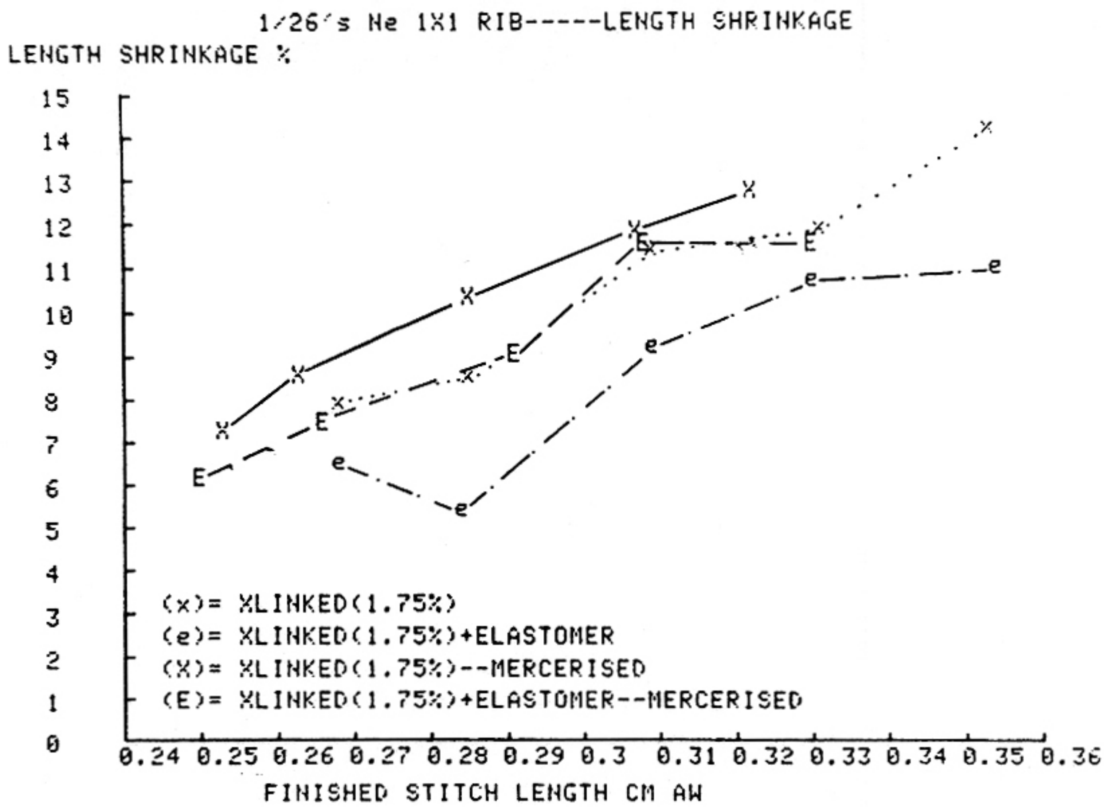

Figure 41

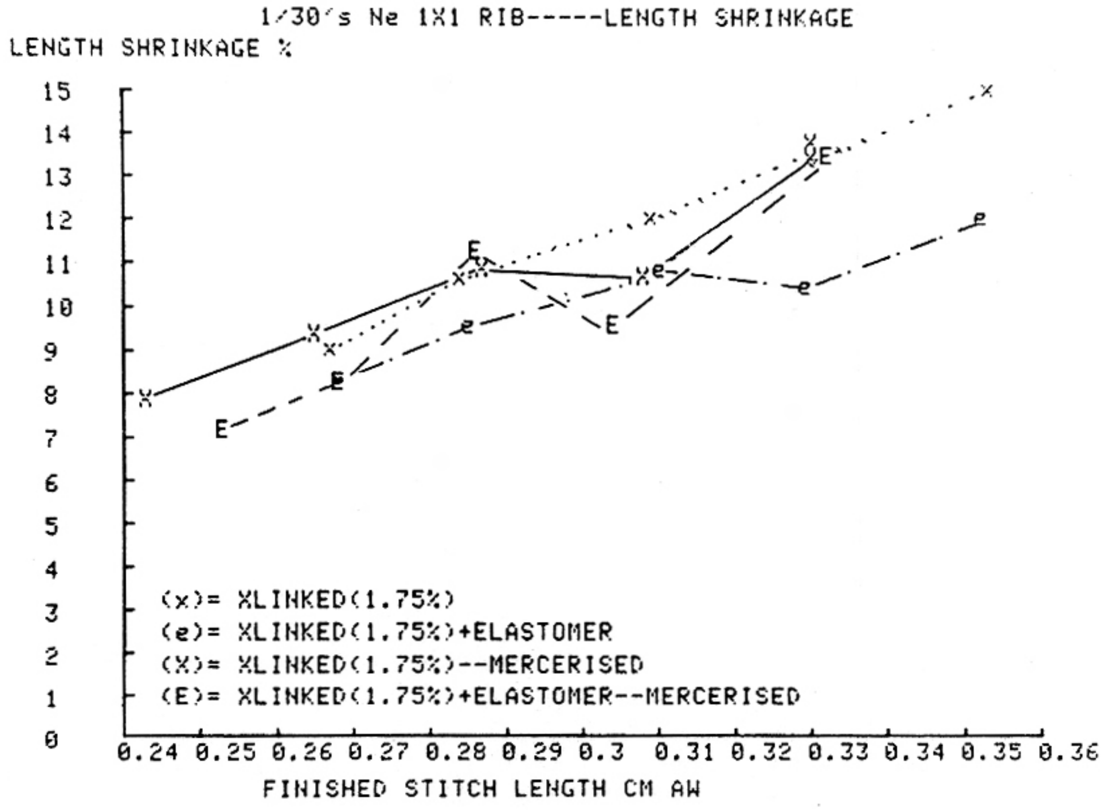

Figure 42