Research Record No: 145

International Institute For Cotton

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CP78 Interlock & Rib Fabrics
Effect Of Finishing Route Upon Dimensional Properties

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(NB: for “fully relaxed” please read “Starfish Reference State”

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1. Introduction

In *Research Record No. 129*, a mathematical analysis of the CP78 (K3) data was described and the regression equations and coefficients, which had been developed, were reported. As the report states, the analysis undertaken was only one way of approaching the topic and had a strictly limited objective, namely the discovery of a set of equations which would predict the fully relaxed dimensions of the 20 gauge interlock and 14 gauge 1x1 rib fabrics produced in the project. In this respect, the analysis was reasonably successful and it has enabled the dimensional properties of these fabrics to be predicted with a good degree of precision. In other respects, however, the analysis was "fairly unsophisticated" in so much as it was based on an assumption of the validity of two fundamental relationships, i.e.

1. for grey fabrics: that equations of the form $y = a + b/l + c\sqrt{Tex}$ would be adequate for predicting the dimensional properties of grey relaxed fabrics,
2. for finished fabrics: that the equations would retain the same form but, in addition to any changes brought about in *Tex* and *l*, the coefficients would be significantly shifted to different extents by the different finishing (wet processing) routes.

The potential limitations of the approach were not, however, overlooked and, although for most practical purposes the analysis was adequate, it has not removed the need for a more critical approach and more thorough investigation in at least certain areas. This is especially true if (as eventually we would like to be able to do) extrapolations and predictions are to be made about fabrics outside of our existing data base.

For example, as pointed out in *Research Record No. 129*, no attempt had at that time been made to either test the significance of the differences between the equations representing different fabrics and finishing routes or investigate whether another factor (or factors) needed to, or could be introduced to explain the changes in dimensional properties which cannot be accounted for by changes in *Tex* and *l* alone.

Note for the Digital Version

> *The basic equation was later modified as a result of a more detailed analysis of a broader database. It turned out that the first term, a, could be dropped if the last term were modified to* $c.Tex^d$*, where the value of c depends on the type of wet process (and probably also the yarn properties) but d is more-or-less constant and is negative in sign.*

However, before a comprehensive second stage analysis is carried out, it is useful to try and identify, from a more general point of view, those areas where closer statistical scrutiny of the results is of primary importance.

As a first step therefore this report assesses from a purely visual representation of the results, whether separate equations for each finishing route are justified or whether certain routes can be combined thus allowing an overall better average estimate of the dimensional changes which take place during finishing to be made.

2. Results

It has previously been shown that the fully relaxed dimensions of fabrics that have been chemically modified during finishing, e.g. by mercerising or cross-linking are, in the main, substantially different from their unmodified equivalents, and it has also been implied that a fabric which has received any form of finishing treatment will have different relaxed

dimensions than in its grey relaxed state. Therefore, the validity of using separate equations in these cases to predict relaxed dimensions needs no further justification.

However, to re-confirm these points, the first group of figures (*Figures 1-60*) is included as illustration.

Key to Figures 1 - 60

Comparison	Interlock	1x1 Rib
JDH *vs*. G	1 - 9	28 - 33
JDH *vs*. JDX2	10 - 15	34 - 42
JDH *vs*. MJDH	16 - 21	43 - 48
MJDH *vs*. MJDX2	22 - 27	49 - 60

For other finishing routes the picture is not always as clear cut and the following rationale was adopted as the basis for the assessment.

For both interlock and rib two major finishing routes were selected to act as controls against which every other finishing route could be compared. These were jet dyed, Hunt & Moscrop compacted (JDH) and tubular mercerised, jet dyed, Hunt & Moscrop compacted (MJDH).

This allows the non-mercerised fabrics to be compared with a non-mercerised control and the mercerised fabrics with a mercerised control. In all cases, the comparison is based on an examination of the three main dimensional properties, courses/cm, wales/cm, and weight g/m^2, plotted against stitch length in cm; all data being measured in the fully-relaxed state (IIC definition: 1 wash and tumble dry, followed by four rinse and tumble dry cycles).

The figures are grouped in sets, courses, wales, and weight, by fabric and finish and, where the data are not clearly defined on the composite figures, separate figures comparing individual yarn counts are included.

As it is difficult to generalise, each finish/parameter is examined separately. Where minor routes are compared with the controls both the compacted and non-compacted data are included on the same figure. In addition, the minor routes are also compared one with another, as it is not always possible to assess differences between them adequately on the basis of their relationship with the major route alone.

3. Discussion

3.1. Interlock

JDH vs. JD Figures 61-69

Courses Figures 61-64

There does not appear to be any systematic difference between the routes.

Wales Figures 65-68

Although perhaps it could be argued that a combined regression would be adequate, the tendency is for there to be fewer wales through JD than JDH for each yarn count. Therefore,

on balance, the impression is that there is probably a difference between the routes.

Weight Figure 69

No systematic difference.

JDH vs. WD/WDH Figures 70-78

Courses Figures 70-73

There appears to be a systematic difference between winch-processed fabrics and jet-dyed fabrics but not between WD and WDH.

Wales Figures 74-77

There is no apparent difference between JDH and WD, but there are consistently more wales/cm through WDH. Therefore, there does appear to be a difference between JDH and WDH and between WD and WDH.

Weight Figure 78

Although on balance one can argue no difference between the three routes, it is by no means clear on this evidence alone.

JDH vs. WB/WBT Figures 79-87

Courses Figures 79-82

On balance there is a difference between jet-dyed and winch-bleached fabrics but probably not between WB and WBT.

Wales Figures 83-86

There is probably no difference between the routes but there is an indication for Ne 38's and 42's that the WB route has a tendency to more wales than JDH or WBT.

Weight Figure 87

There is no difference between JDH and WB but there is a difference between JDH and WBT and between WB and WBT.

JDH vs. CB/CBT Figures 88-96

Courses Figures 88-91

There is a systematic difference between jet-dyed and continuous-bleached fabrics; there are always fewer courses after continuous bleaching. However, there does not appear to be a difference between CB and CBT.

Wales Figures 92-95

No difference between JDH and CBT. However, although the differences are not large between JDH and CB there are consistently more wales recorded in the CB fabrics. Therefore, there is probably a difference between JDH and CB and, consequently, between CB and CBT.

Weight Figure 96

There does appear to be a difference between jet dyeing and continuous bleaching and also

between CB and CBT.

WD/WDH vs. WB/WBT Figures 97-107

Courses Figures 97-99

On balance, there is probably no difference between winch dyeing and winch bleaching.

Wales Figures 100-103

The possibility of a difference between all four routes can not be dismissed on this evidence alone.

Weight Figures 104-107

The situation is again unclear but possibly WBT is different from the rest.

WD/WDH vs. CB/CBT Figures 108-118

Courses Figures 108-111

There does not appear to be any systematic difference.

Wales Figures 112-114

There are probably no differences overall, although there are always more wales through CB than CBT.

Weight Figures 115-118

Probably no difference between WD, WDH and CB, but the CBT fabrics are always lighter in weight than the others.

WB/WBT vs. CB/CBT Figures 119-129

Courses Figures 119-121

Probably no difference between winch and continuous bleaching.

Wales Figures 122-125

There appears to be a difference between compacted and not compacted fabrics rather than between winch and continuous bleached.

Weight Figures 126-129

Again, the situation is not clear but there probably is a difference between routes.

MJDH vs. M Figures 130-138

Courses Figures 130-133

There is a clear difference between M and MJDH.

Wales Figures 134-137

There does not appear to be any difference in the wales between M and MJDH.

Weight Figure 138

On balance, there is a tendency for the mercerised-only fabrics to be heavier than the mercerised dyed and compacted. Therefore, there is probably a difference.

MJDH vs. MJD Figures 139-147

Courses Figures 139-142

No systematic difference

Wales Figures 143-146

No systematic difference

Weight Figure 147

No systematic difference

3.2. 1x1 Rib

JDH vs. JD Figures 148-156

Courses Figures 148-151

No systematic difference

Wales Figures 152-155

No systematic difference

Weight Figure 156

No systematic difference

JDH vs. WD/WDH Figures 157-165

Courses Figures 157-160

There does not appear to be any difference between JDH and WD. However, the recorded courses for WDH are always lower. Therefore, although the differences are not large, they are consistent and consequently, on this evidence alone, a difference must be recorded between JDH and WDH and between WD and WDH.

Wales Figures 161-164

Similarly to the courses, there is no apparent difference between JDH and WD but there is a consistent and probably significant difference between WDH and WD/JDH.

Weight Figure 165

There is perhaps a difference between WD and WDH, but between winch-processed and jet-processed it is not clear. Perhaps on balance WD may be different.

JDH vs. WB/WBT Figures 166-174

Courses Figures 166-169

No systematic difference

Wales Figures 170-173

No systematic difference

Weight Figure 174

No difference between WB and WBT but probably a difference between jet-dyed and winch-bleached.

WD/WDH vs. WB/WBT Figures 175-186

Courses Figures 175-178

There does not appear to be a difference between WD, WB and WBT, but the WDH fabrics tend to have fewer courses on average. Therefore, there is a possible difference.

Wales Figures 179-182

Similarly, there does not appear to be a difference between WD, WB and WBT but there are significantly more wales recorded in the WDH fabrics.

Weight Figures 183-186

There does not appear to be a systematic difference between the non-compacted fabrics but the compacted fabrics do tend to be different. The WDH are on average heavier and the WBT lighter.

MJDH vs. M Figures 187-195

Courses Figures 187-190

No systematic difference

Wales Figures 191-194

No systematic difference

Weight Figure 195

No systematic difference

MJDH vs. MJD Figures 196-204

Courses Figures 196-199

No systematic difference

Wales Figures 200-203

No systematic difference

Weight Figure 204

No systematic difference

MJDH vs. MWB/MWBT Figures 205-213

Courses Figures 205-208

There is no difference between MWB and MWBT, but probably between winch-bleached and jet-dyed as the bleached fabrics always tend to have fewer courses than the jet-dyed.

Wales Figures 209-212

There does not appear to be any difference between the routes.

Weight Figure 213

There is a definite difference between the bleached and the dyed fabrics; the bleached fabrics always being lighter, and there is also probably a difference between the bleached and the bleached compacted routes, although this is less clear.

3. Summary Table 2

The results basically fall into three groups which can be summarised as follows.

1. Those finishing routes where all three properties assessed show a systematic difference between the routes and, therefore, separate regressions are both justified and necessary.
2. Those finishing routes where no systematic differences can be seen between the routes for the properties assessed and therefore combined regressions can be justified.
3. Those finishing routes where the picture is not clear or not consistent over the three properties. In this group, certain properties could be combined but not all. Therefore, without further analysis to clarify the situation, it would probably be safer to keep separate regressions.

The groups are divided as follows.

Group	Interlock	1x1 Rib
1	Grey v Finished, e.g. G *vs.* JDH Not crosslinked *vs.* crosslinked, JDH *vs.* JDX2, MJDH *vs.* MJDX2 Not mercerised *vs.* mercerised, JDH *vs.* MJDH	Grey *vs.* Finished e.g. G *vs.* JDH Not crosslinked *vs.* crosslinked, JDH *vs.* JDX2, MJDH *vs.* MJDX2 Not mercerised *vs.* mercerised, JDH *vs.* MJDH
2	MJDH v MJD	JDH *vs.* JD WB *vs.* WBT, WB *vs.* WD? MJDH *vs.* M MJDH *vs.* MJD
3	JDH *vs.* JD JDH *vs.* WD, JDH *vs.* WDH, WD *vs.* WDH JDH *vs.* WB, JDH *vs.* WBT, WB *vs* WBT JDH *vs.* CB, JDH *vs.* CBT, CB *vs* CBT WD/WDH *vs.* WB/WBT WD/WDH *vs.* CB/CBT WB/WBT *vs.* CB/CBT MJDH *vs.* M	JDH *vs.* WD, JDH *vs.* WDH, WD *vs.* WDH JDH *vs.* WB, JDH *vs.* WBT WD/WDH *vs.* WB/WBT MJDH *vs.* MWB, MJDH *vs.* MWBT

5. Conclusions

From a purely visual assessment of the CP78 (K3) data, it has been possible to confirm that certain finishing routes produce obviously different relaxed dimensions and therefore justify separate regressions. It has also been possible to identify certain finishing routes where separate regressions cannot be justified. Unfortunately, in the majority of cases the picture remains unclear and it is in these areas, especially, where a more detailed analysis of the results should help to clarify the situation. However, it is also in this third group where the problem of limited data is most apparent - i.e. the minor routes - and it may not be possible to reach definite conclusions without more experimental trials.

Table 1

KEY TO PROCESSING CODES

1.	G	Grey
2.	M	Mercerised
3.	WB	Winch Bleached
4.	CB	Continuous Bleached
5.	WD	Winch Dyed
6.	JD	Jet Dyed
7.	CBT	Continuous Bleach,Tubetex Compacted
8.	WDH	Winch Dyed, H&M(Bestan) Compacted
9.	WBT	Winch Bleached, Tubetex Compacted
10.	JDH	Jet Dyed, H&M(Bestan) Compacted
11.	MWB	Mercerised, Winch Bleached
12.	MJD	Mercerised, Jet Dyed
13.	MWBT	Mercerised, Winch Bleached, Tubetex Compacted
14.	MJDH	Mercerised, Jet Dyed, H&M(Bestan) Compacted
15.	JDX2	Jet dyed, Crosslinked(2.5%)
16.	MJDX2	Mercerised, Jet dyed, Crosslinked(2.5%)

Table 2

SUMMARY

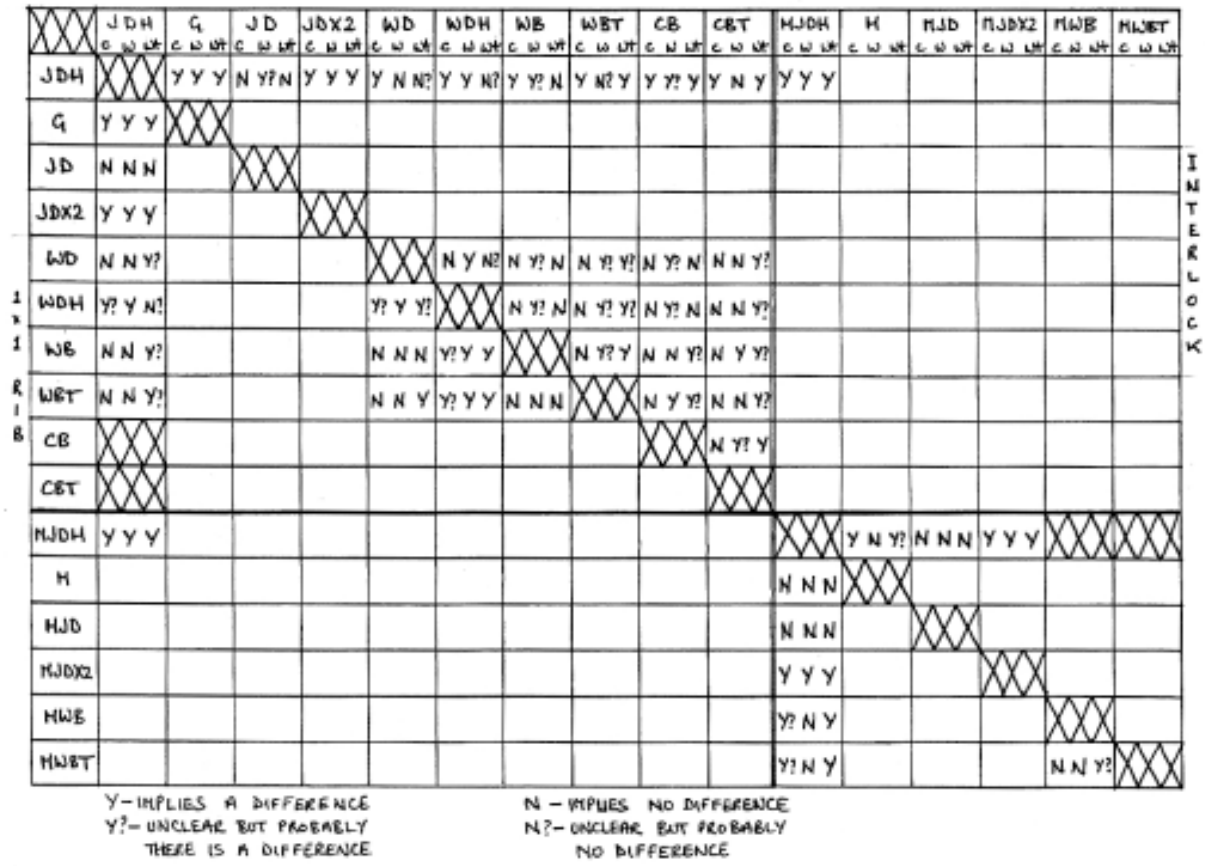
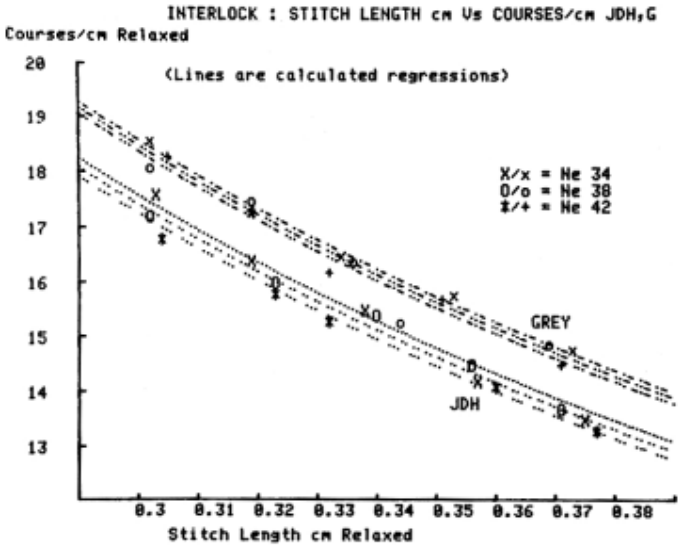


Figure 1



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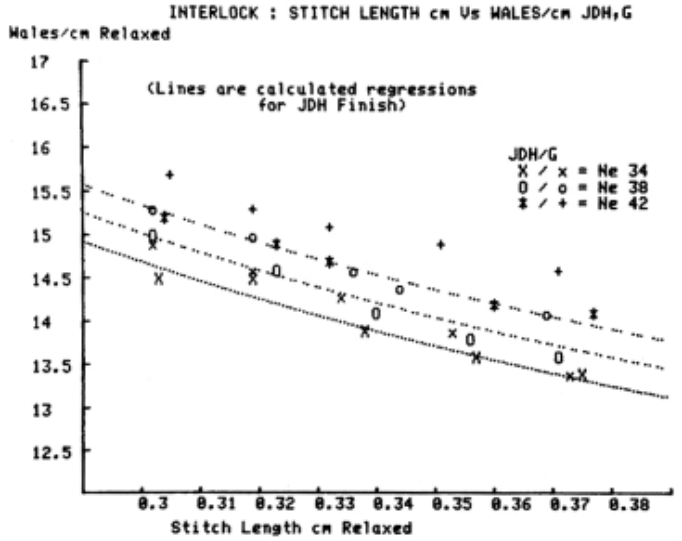

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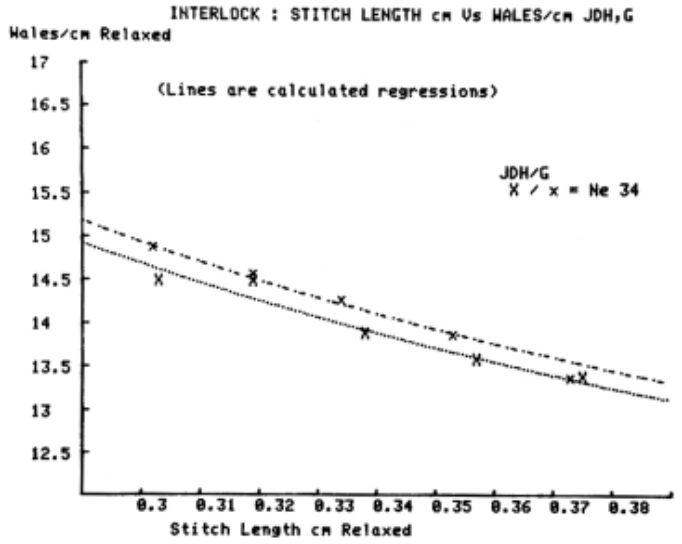

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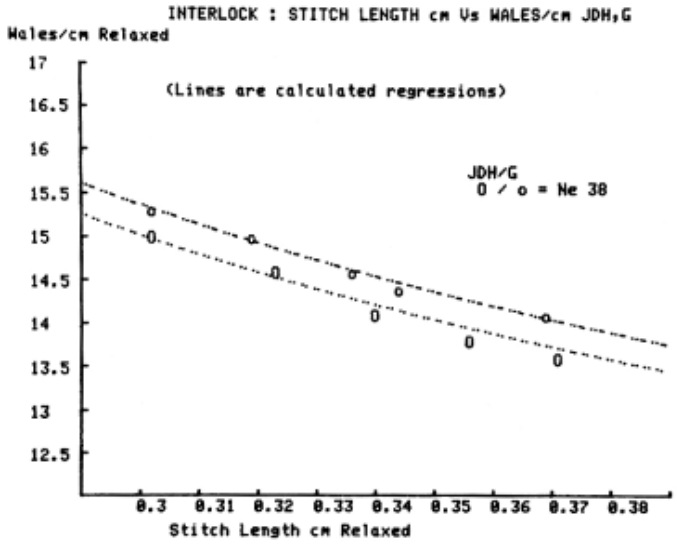

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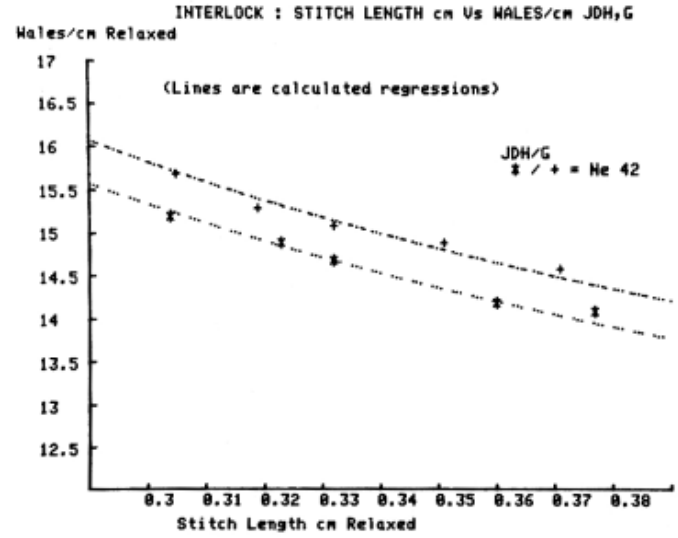

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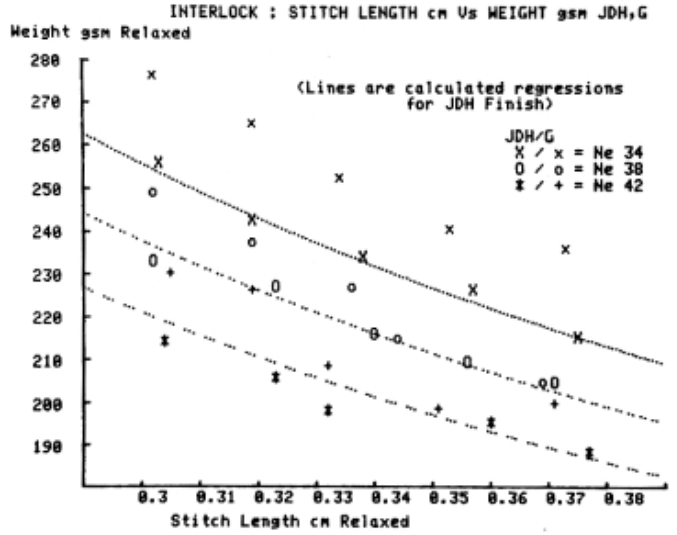

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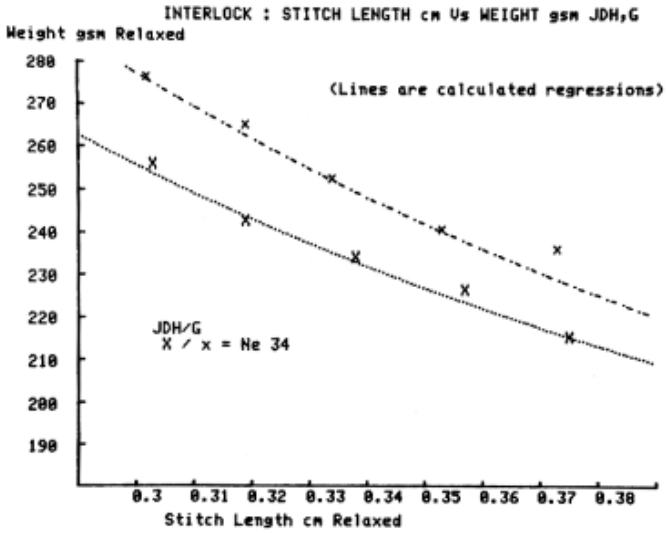

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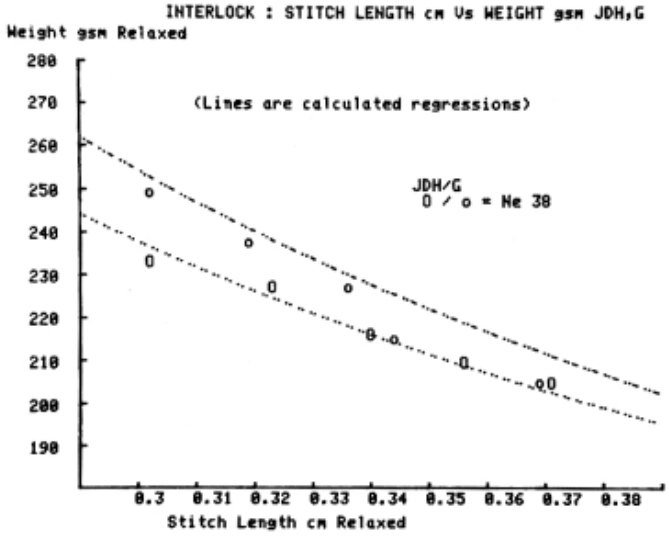

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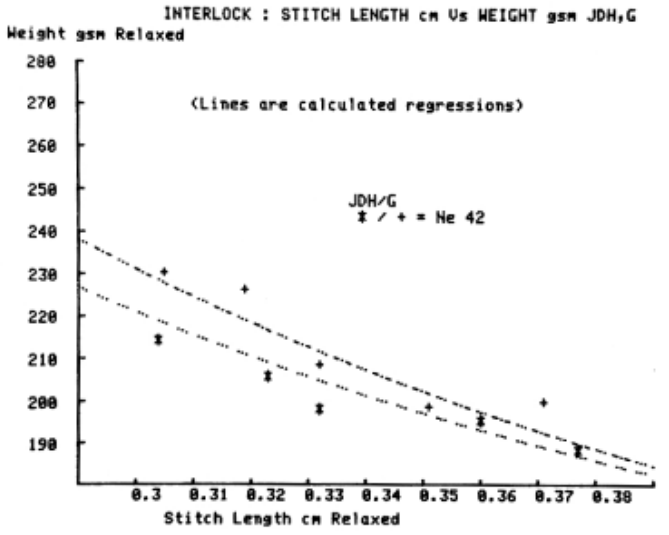

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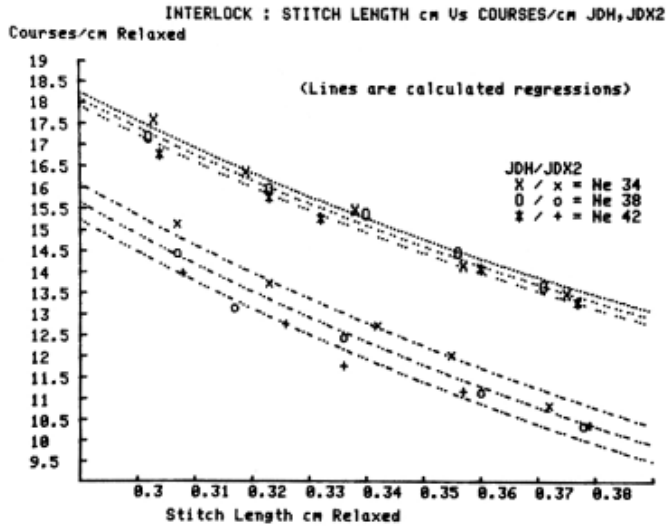

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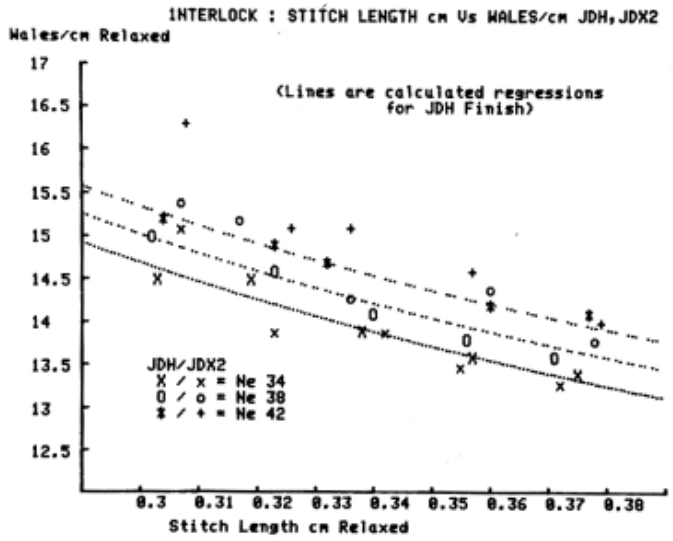

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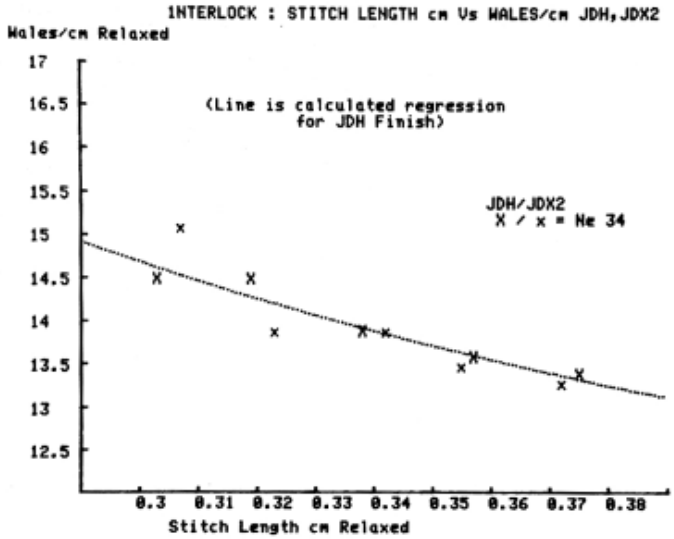

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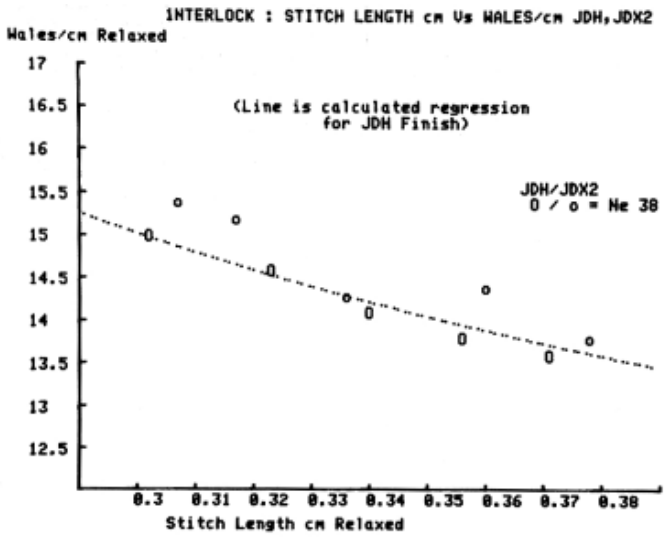

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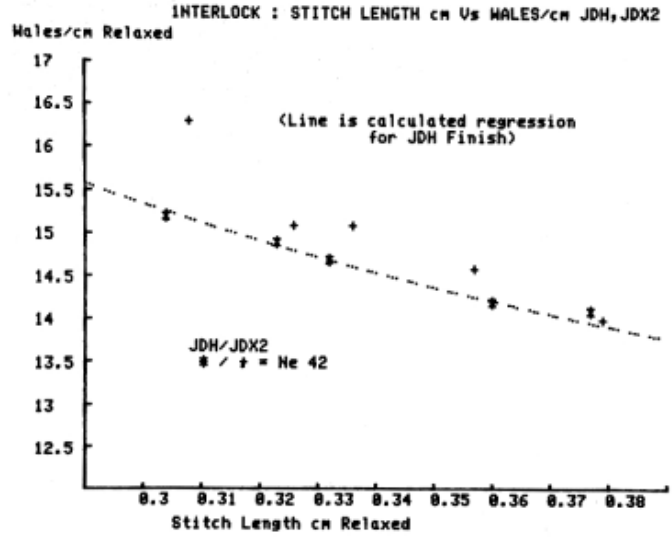

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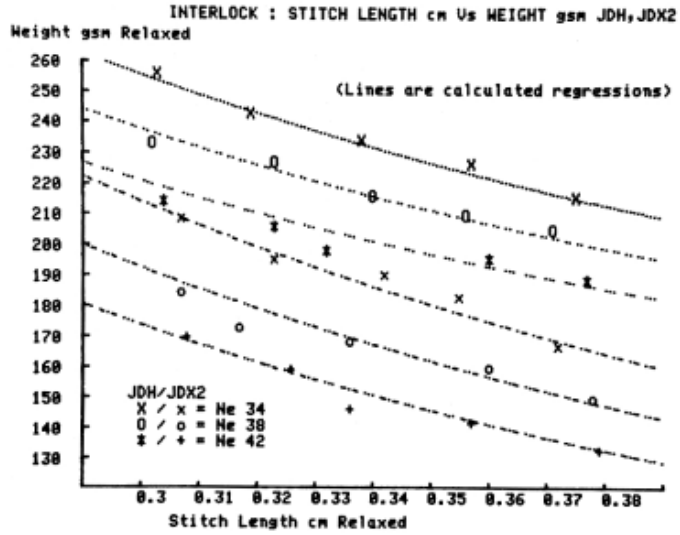

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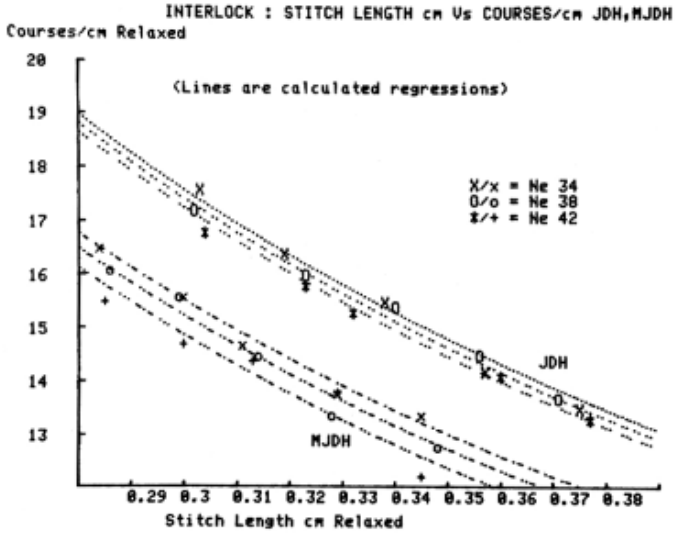

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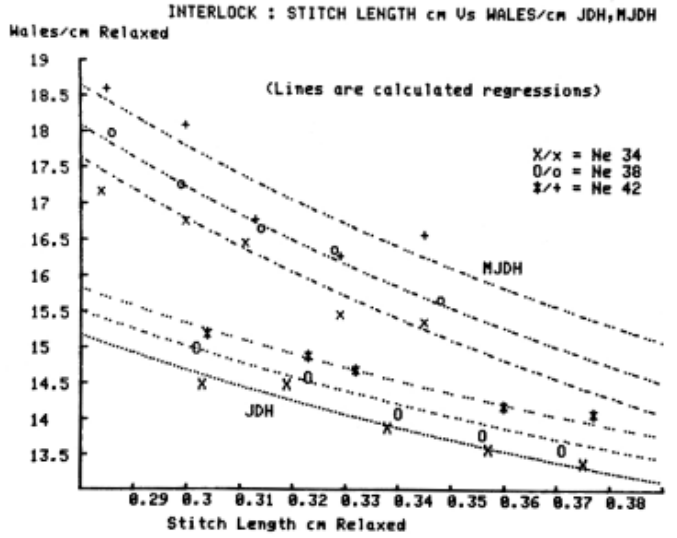

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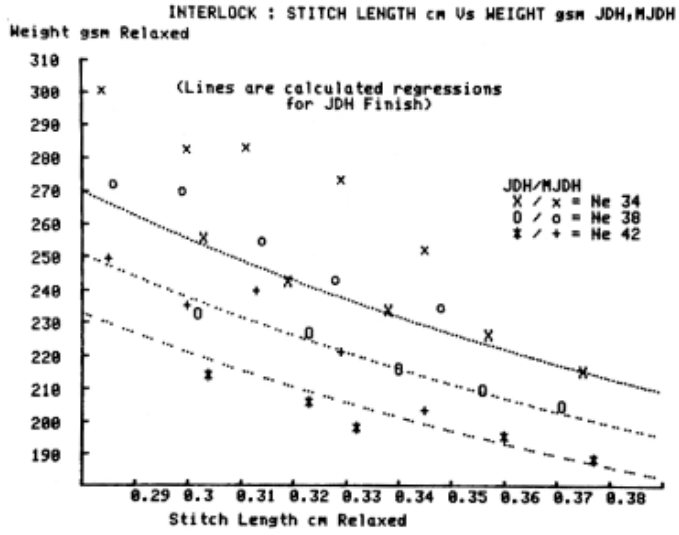

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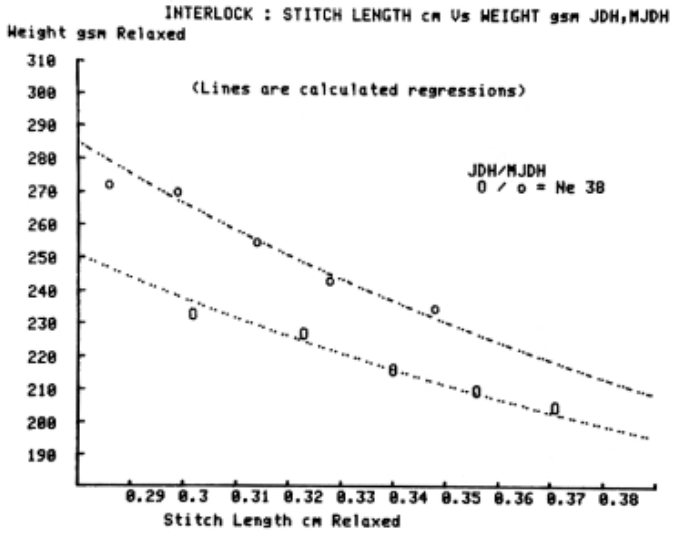

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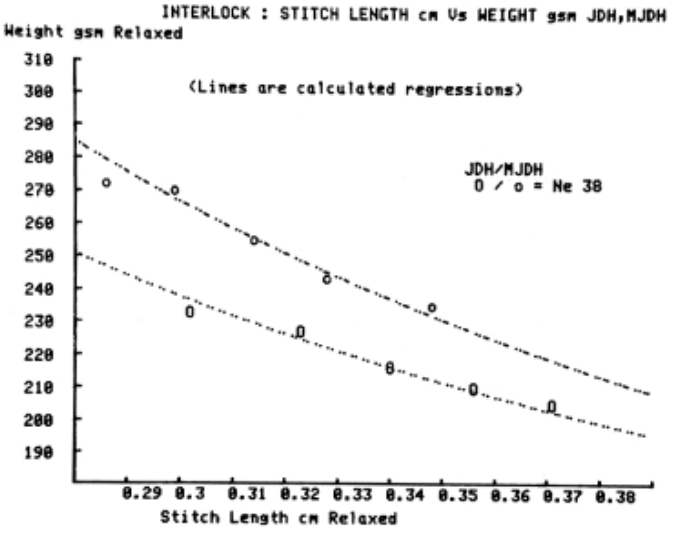

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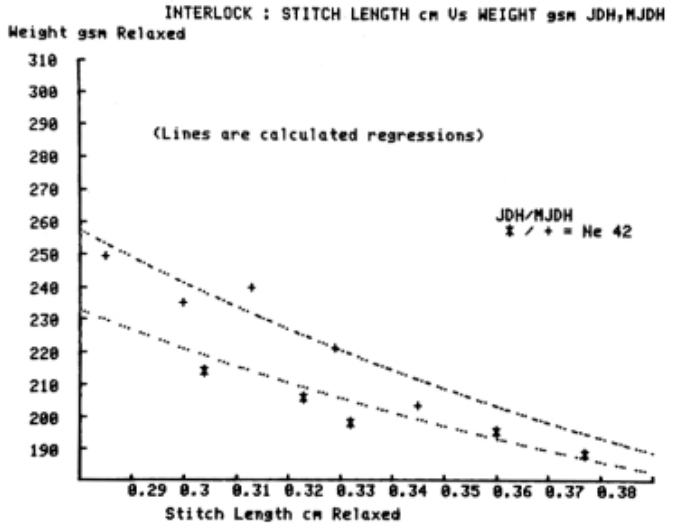

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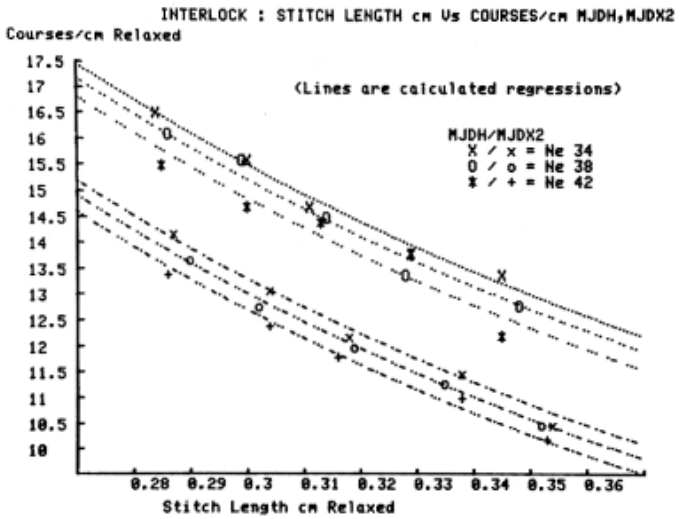

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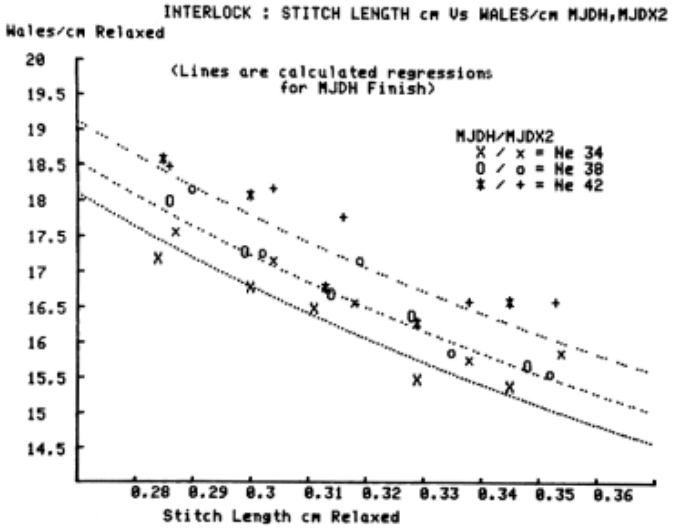

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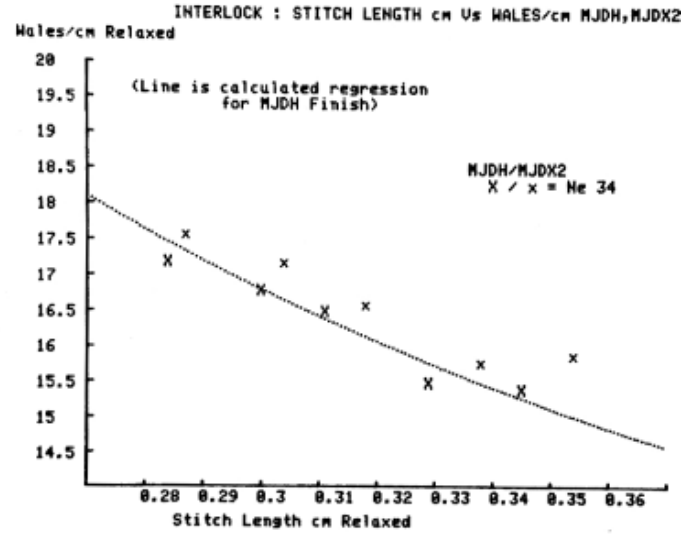

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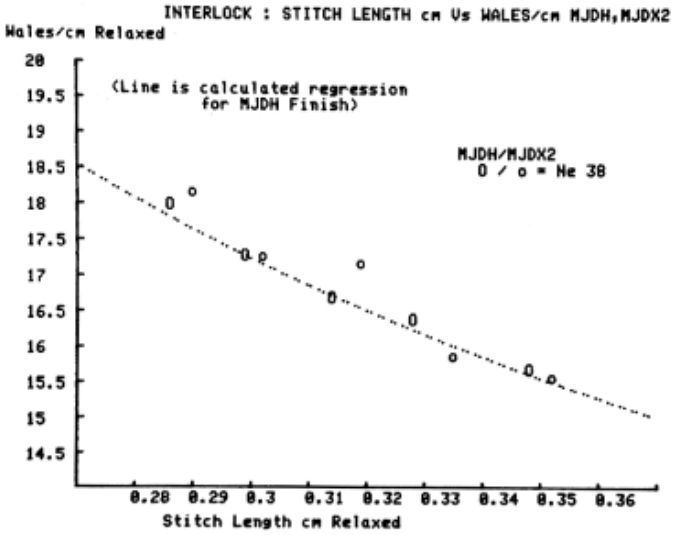

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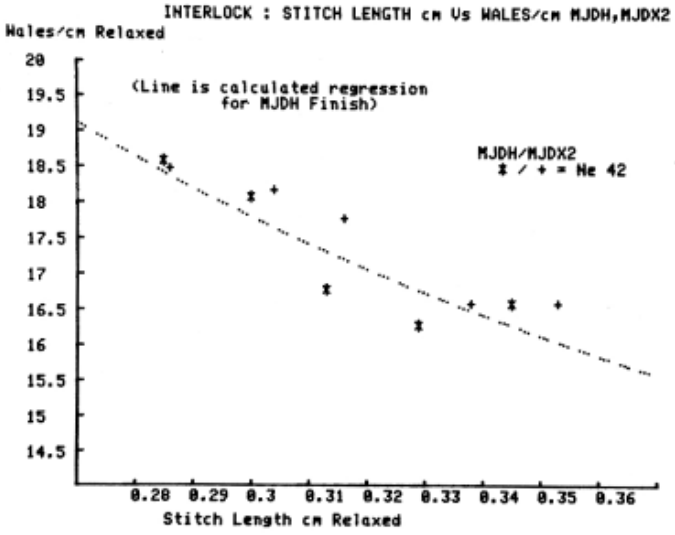

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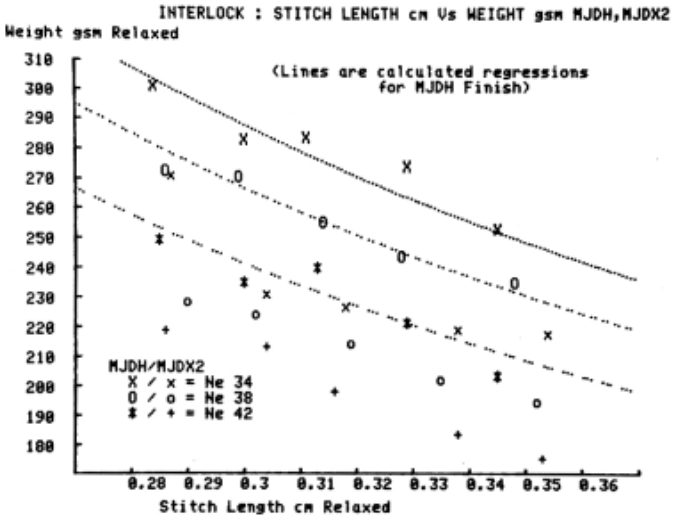
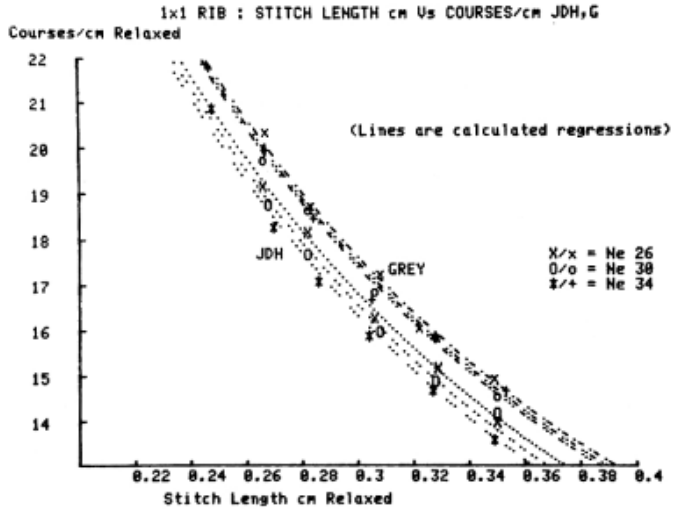


Figure 28



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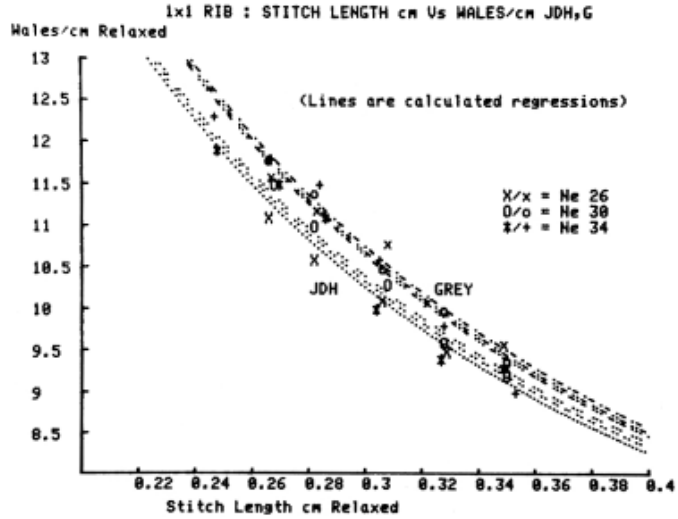

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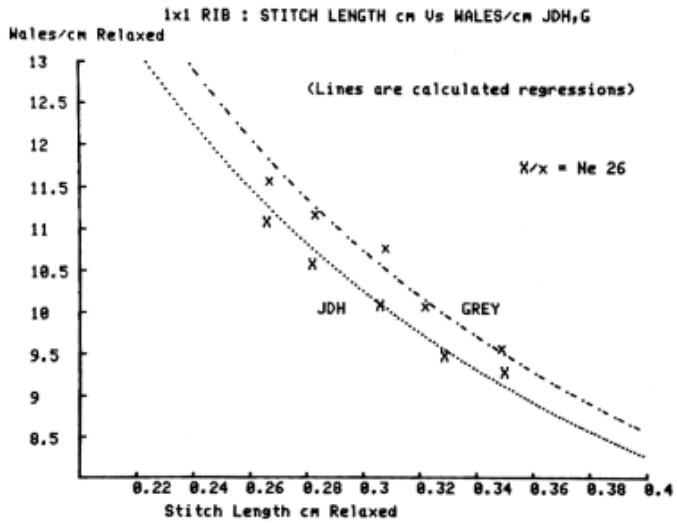

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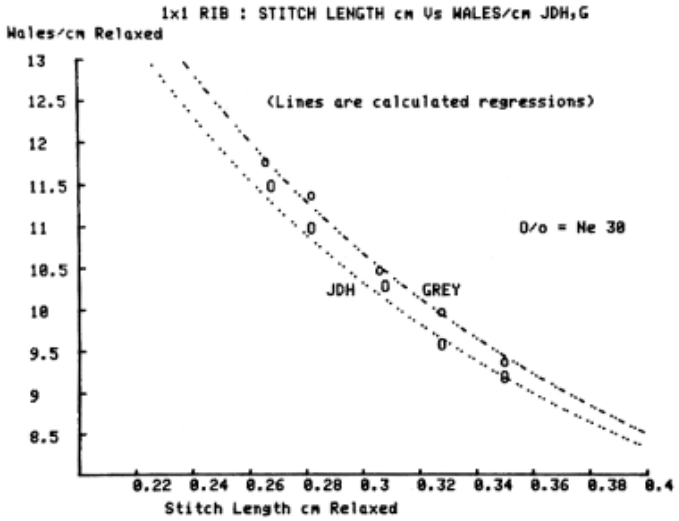

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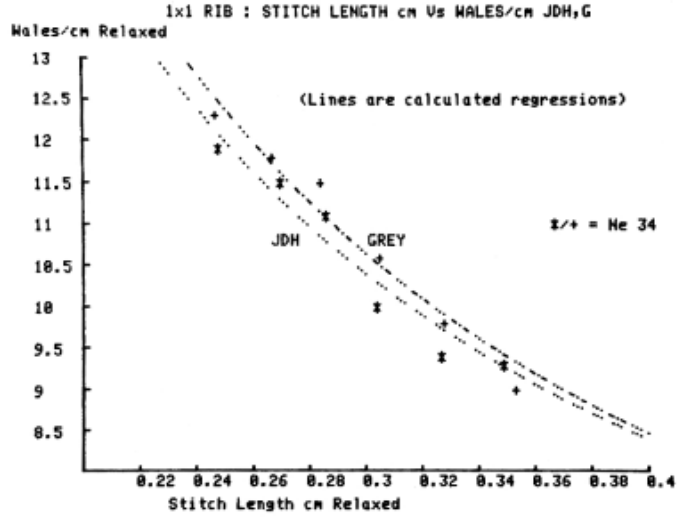

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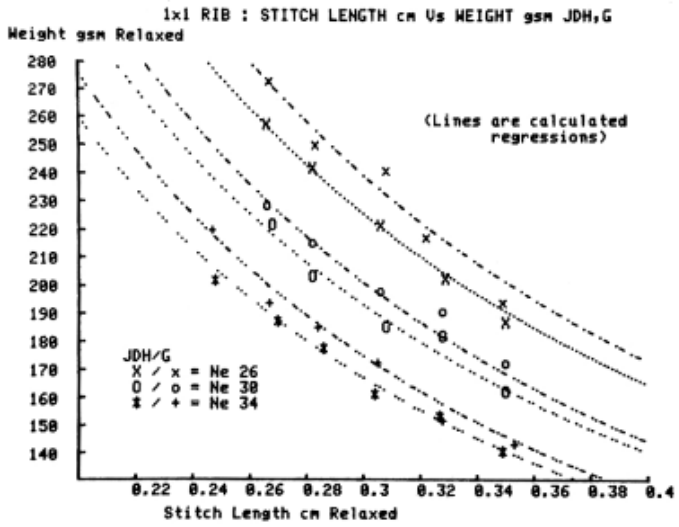

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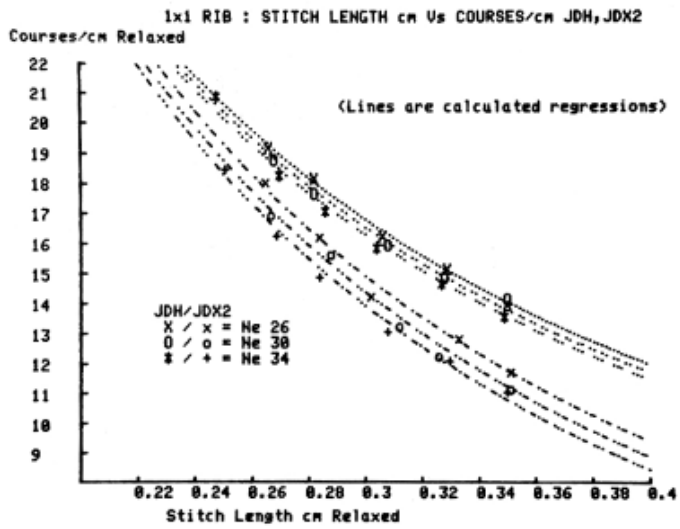

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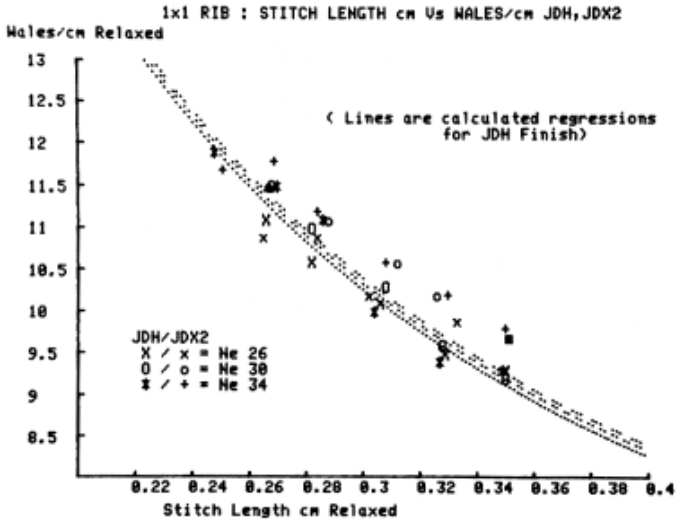

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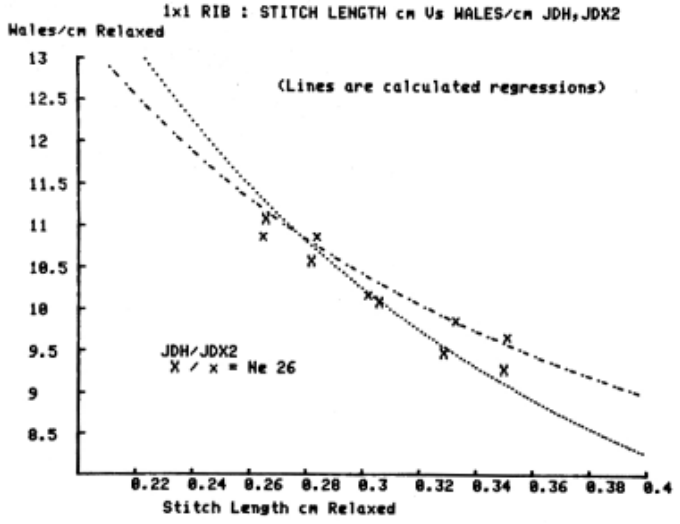

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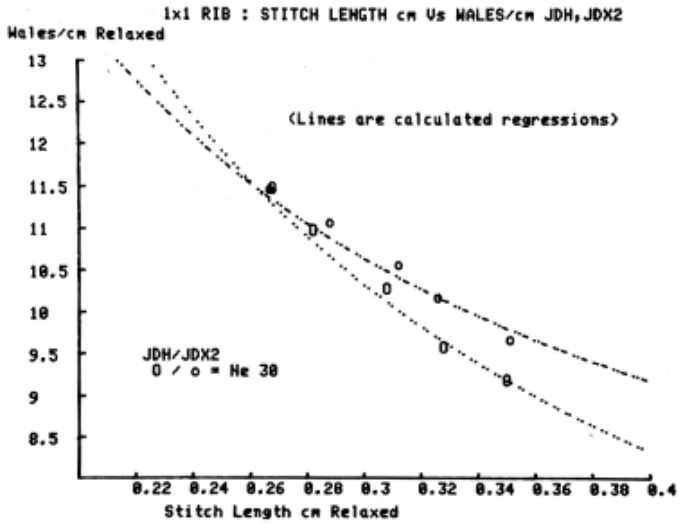

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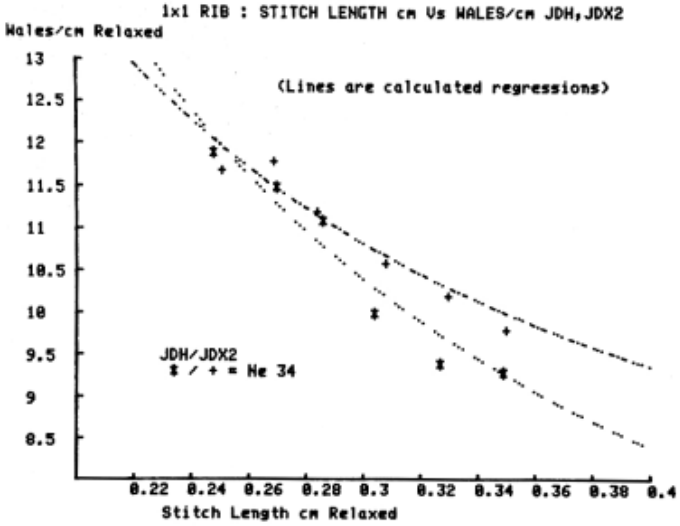

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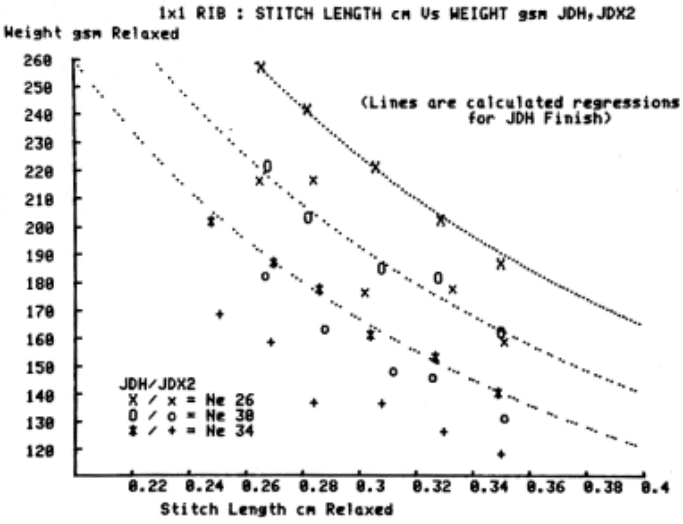

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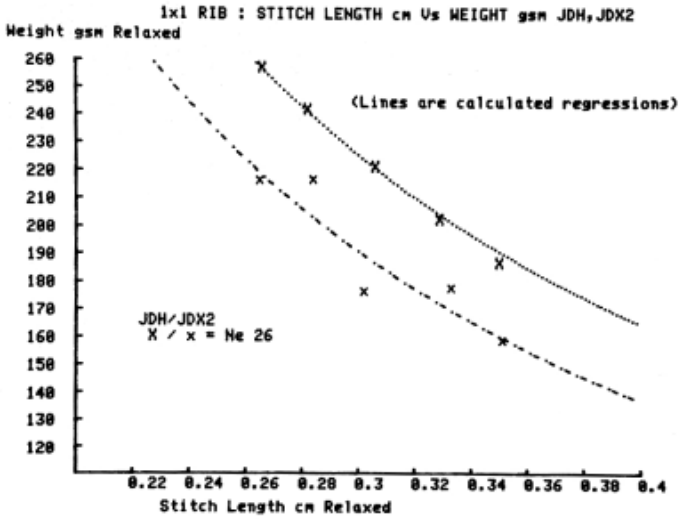

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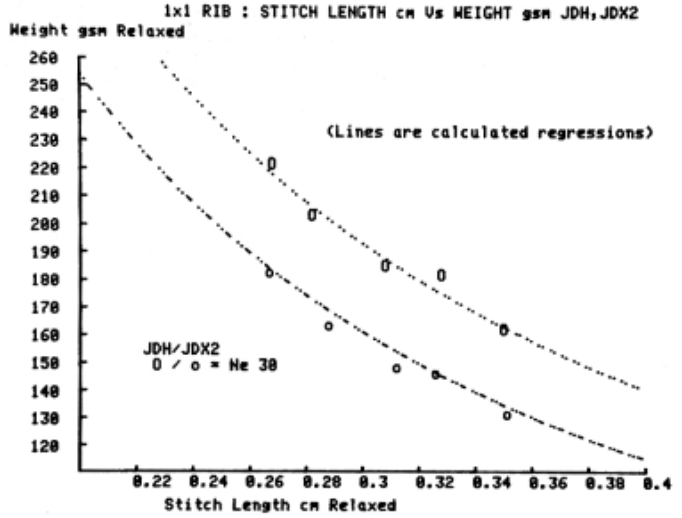

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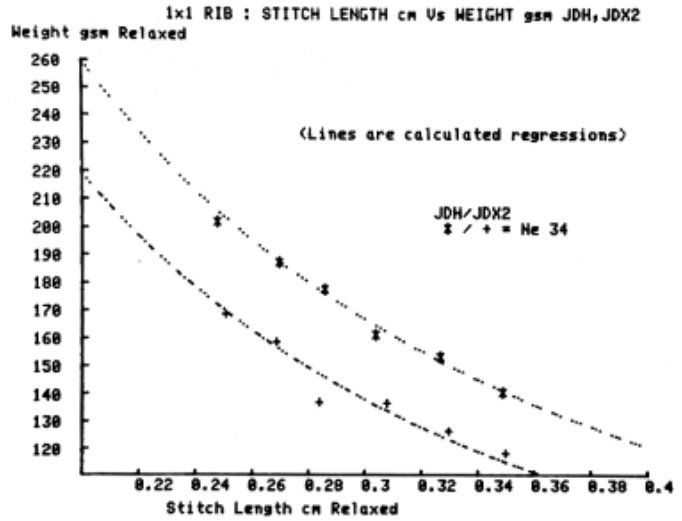

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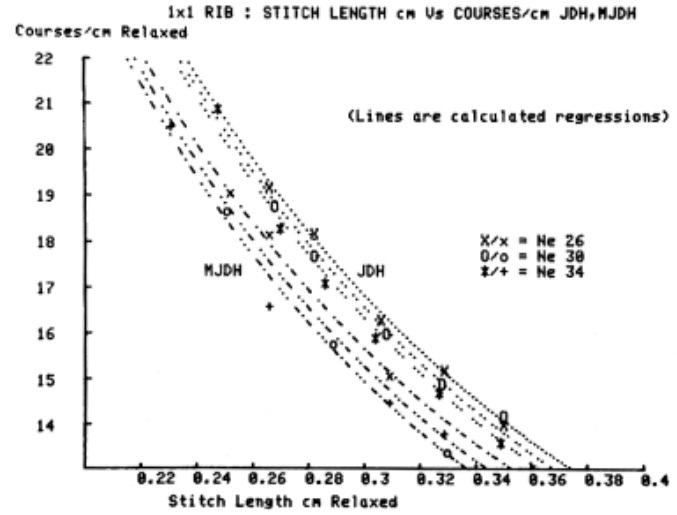

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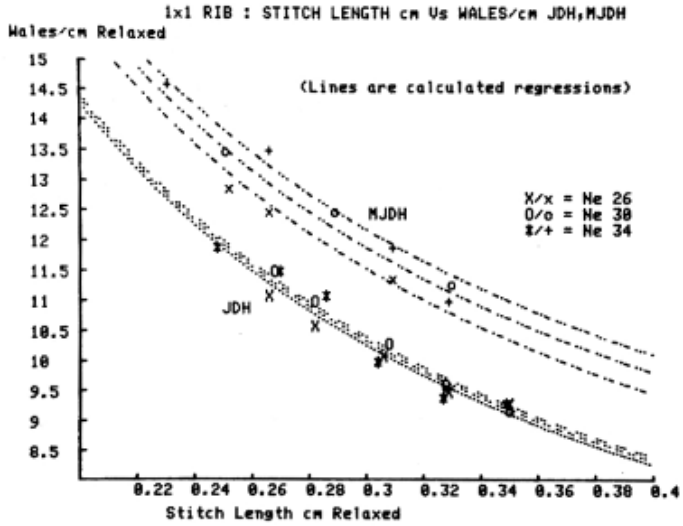

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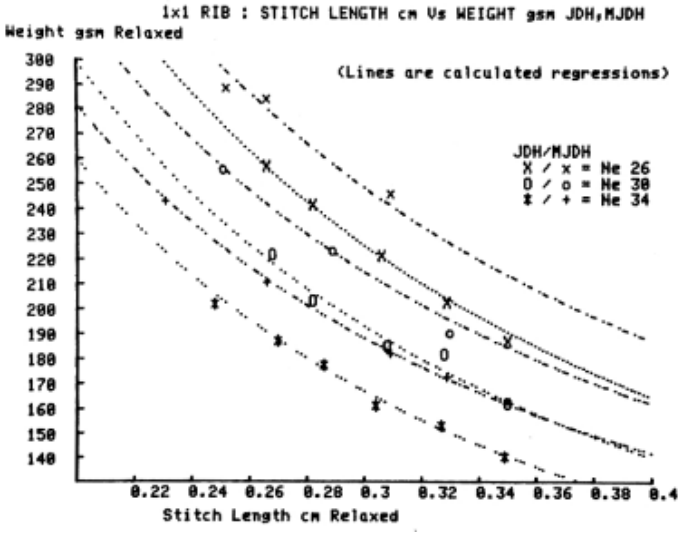

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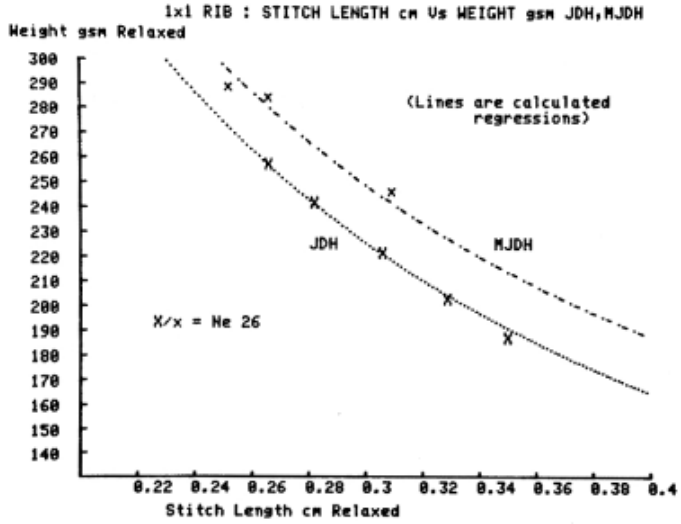

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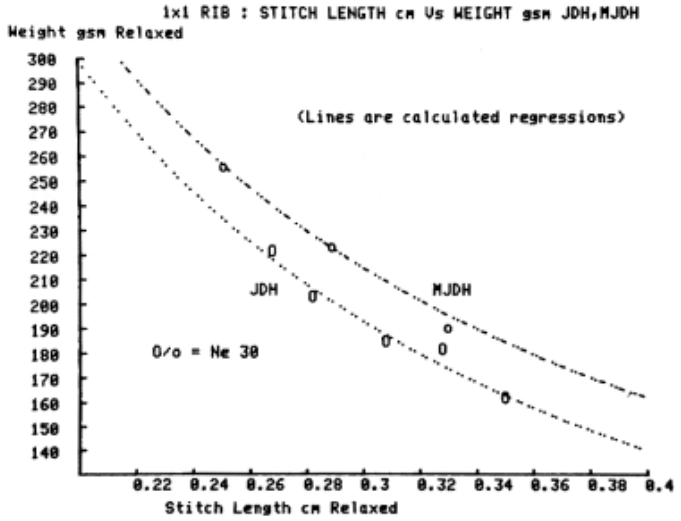

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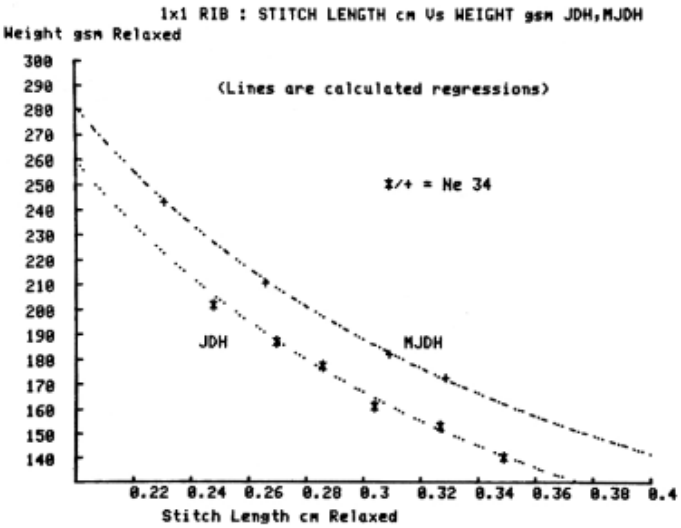

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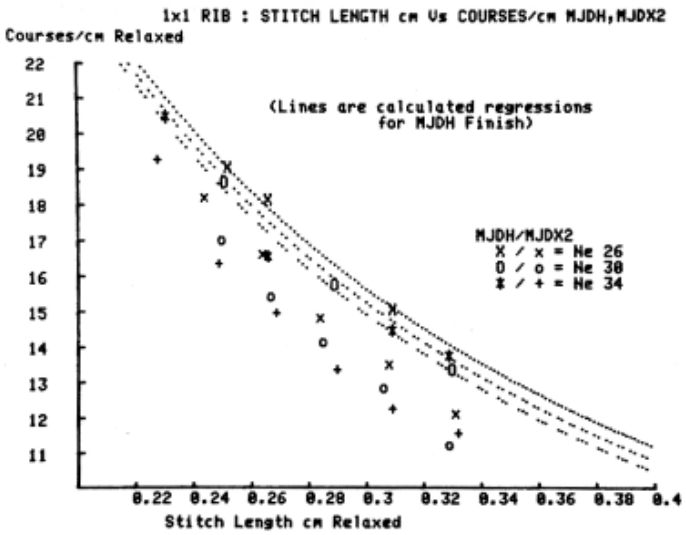

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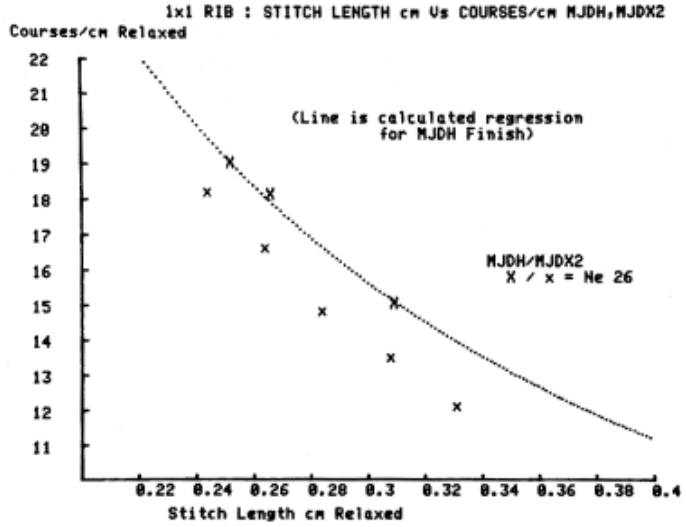

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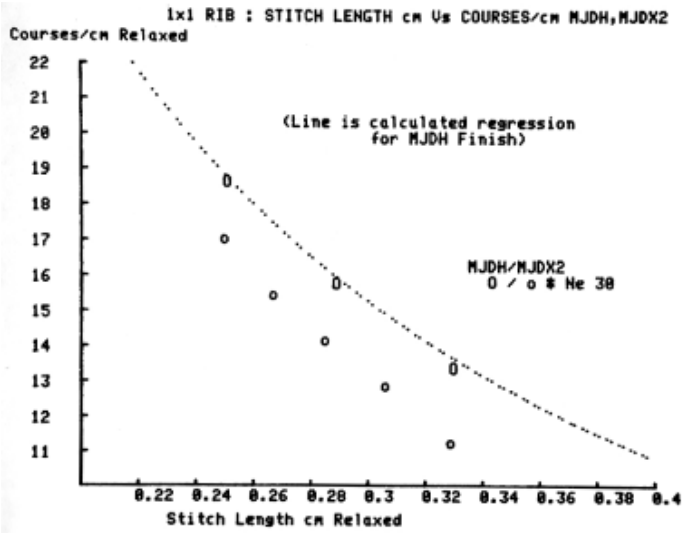

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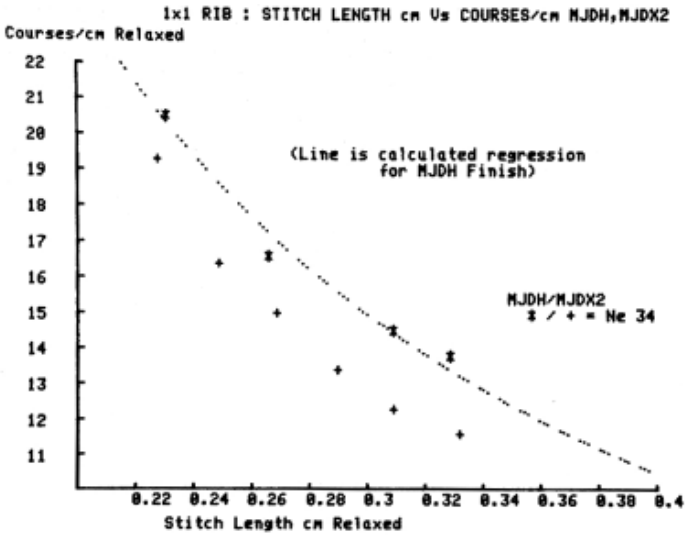

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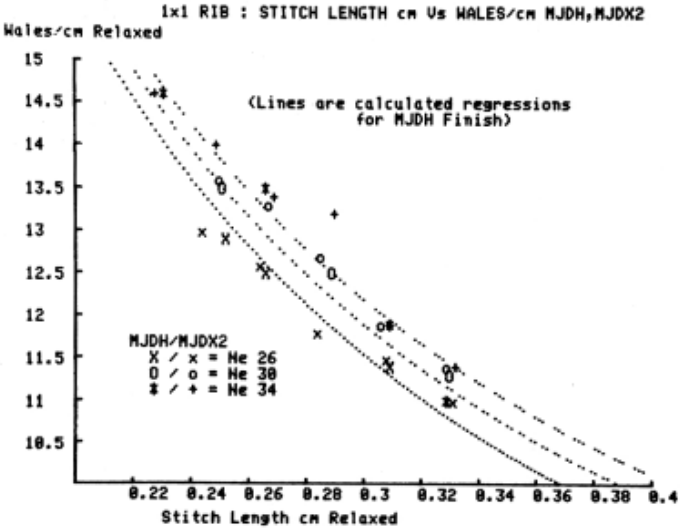

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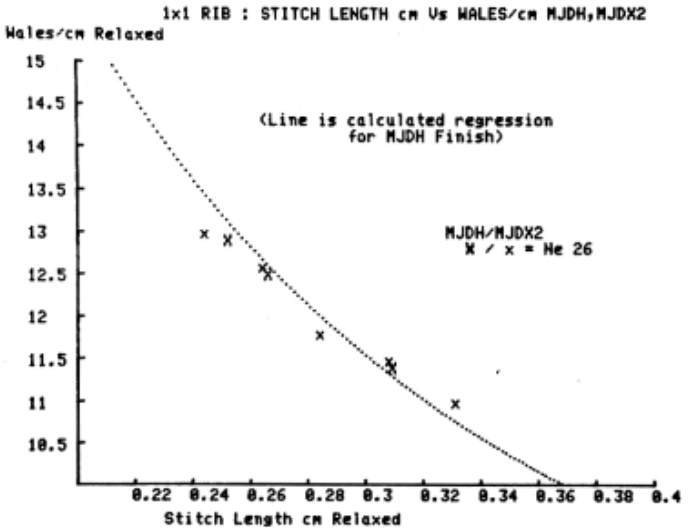

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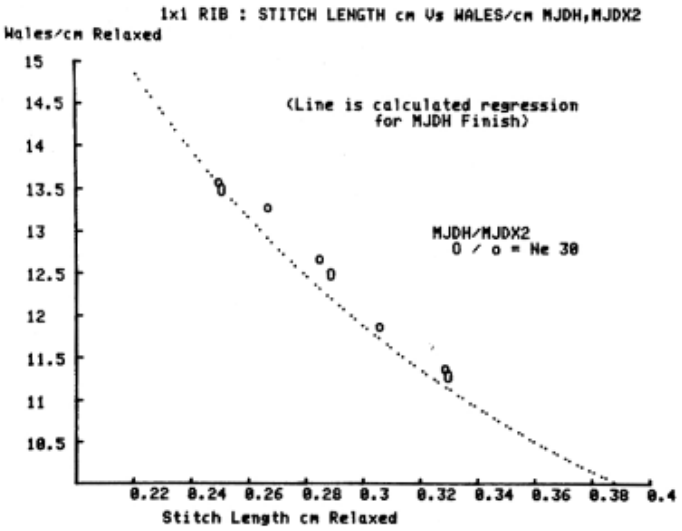

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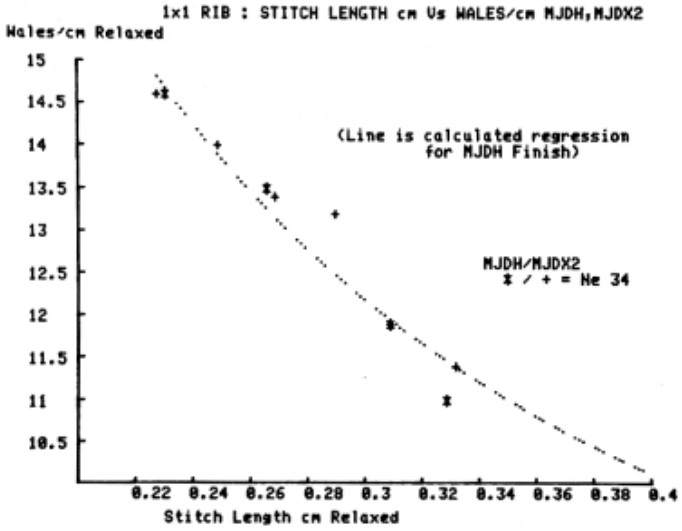

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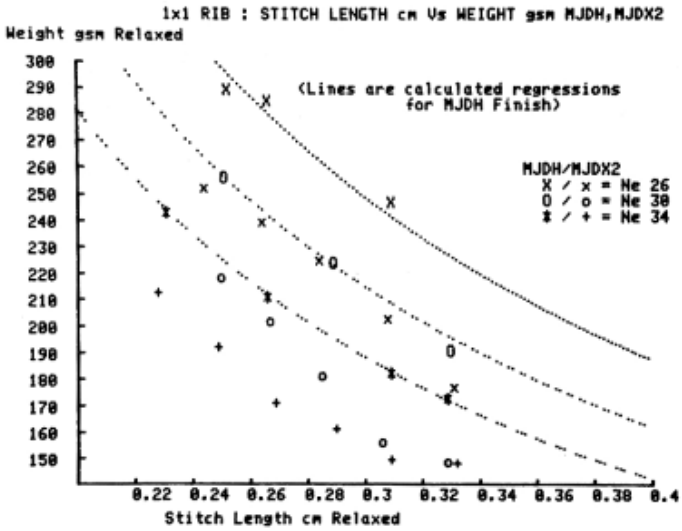

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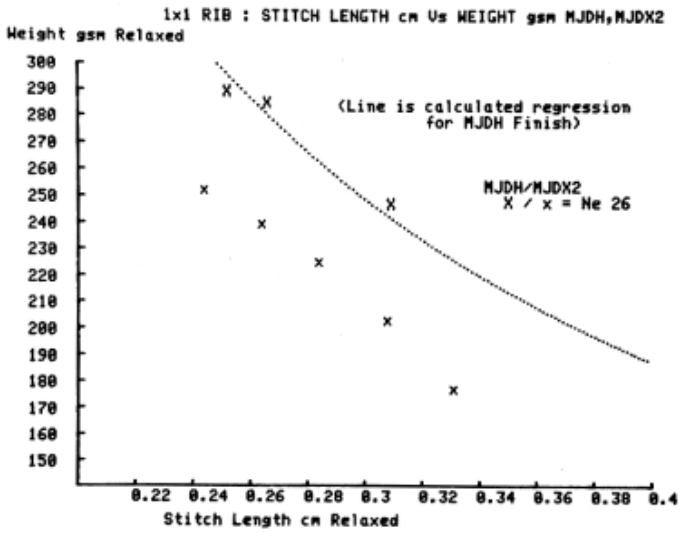

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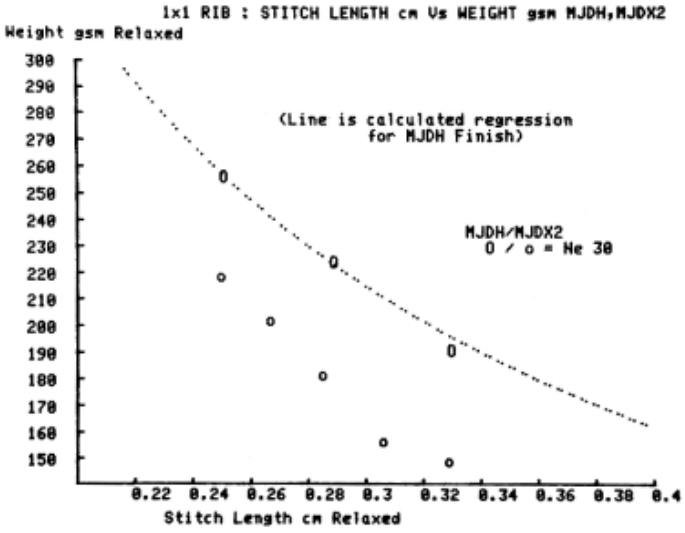

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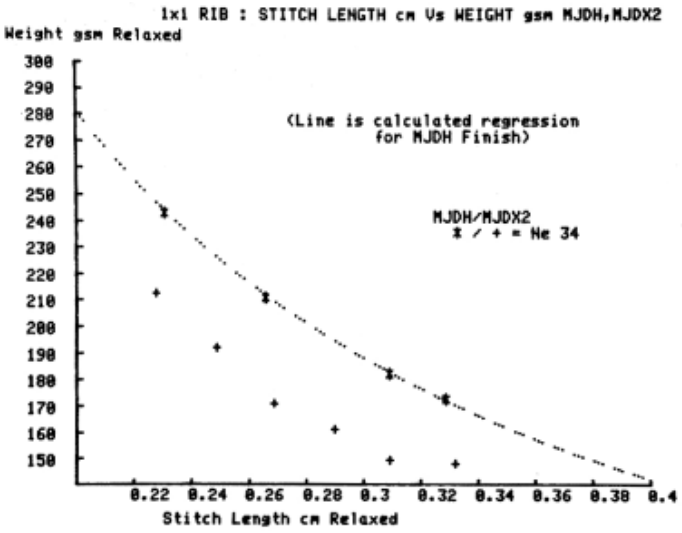

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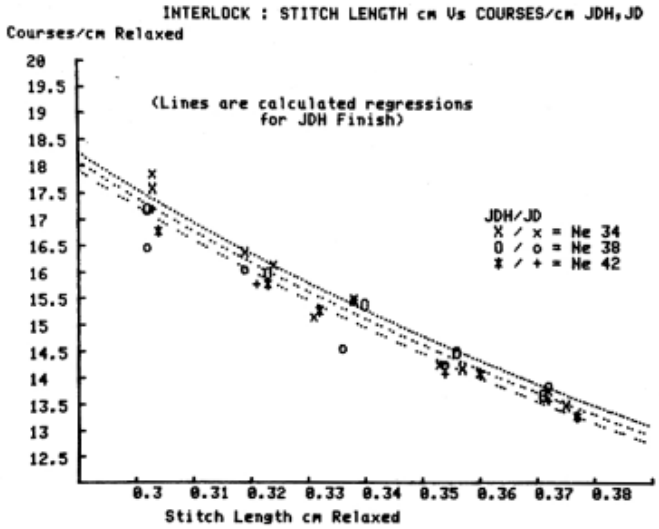

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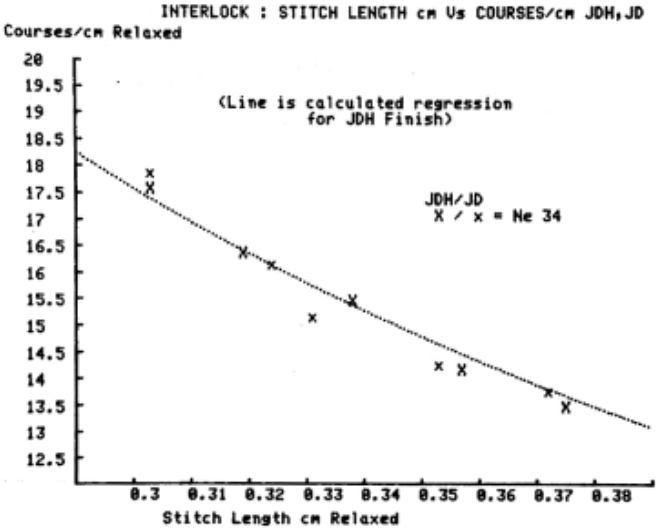

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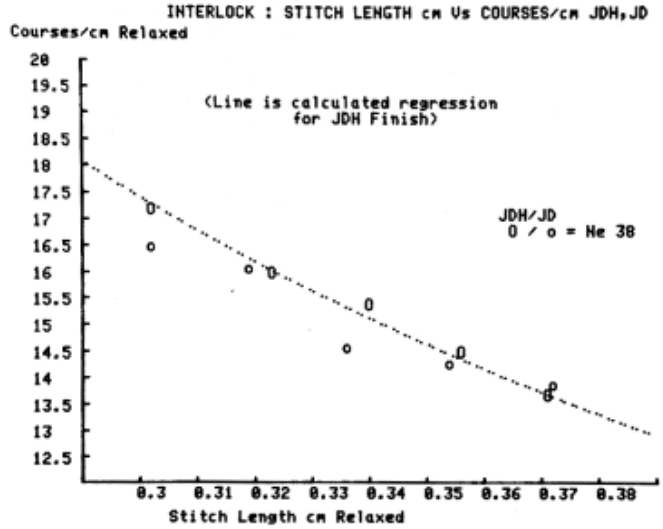

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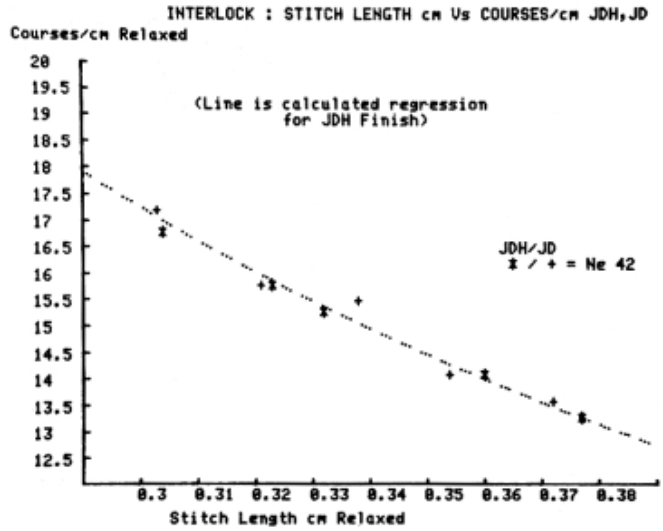

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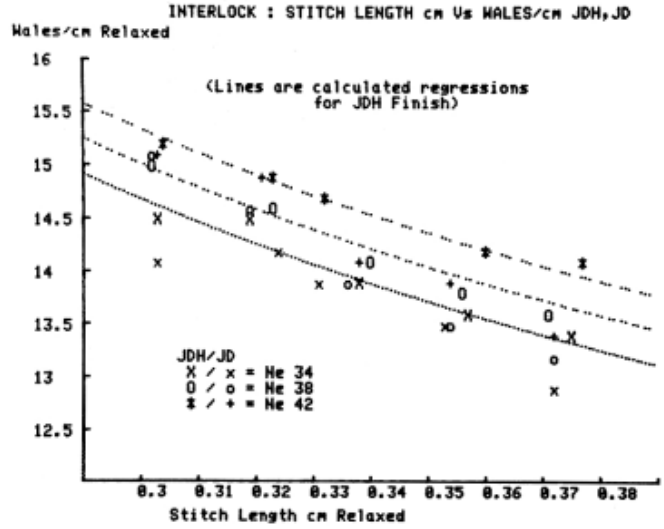

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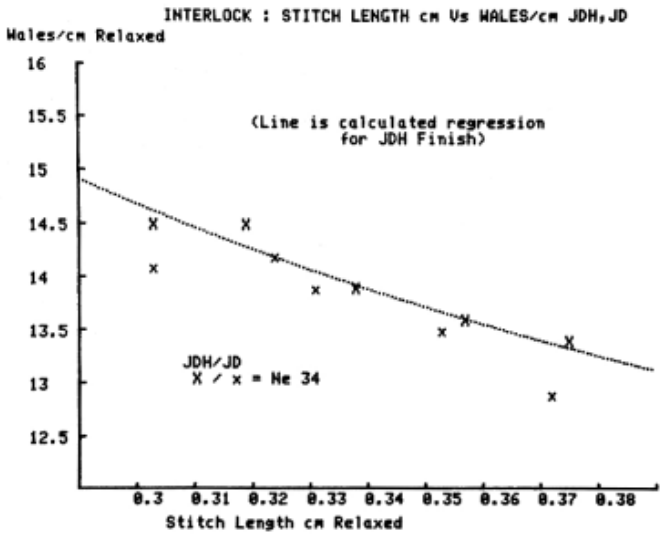

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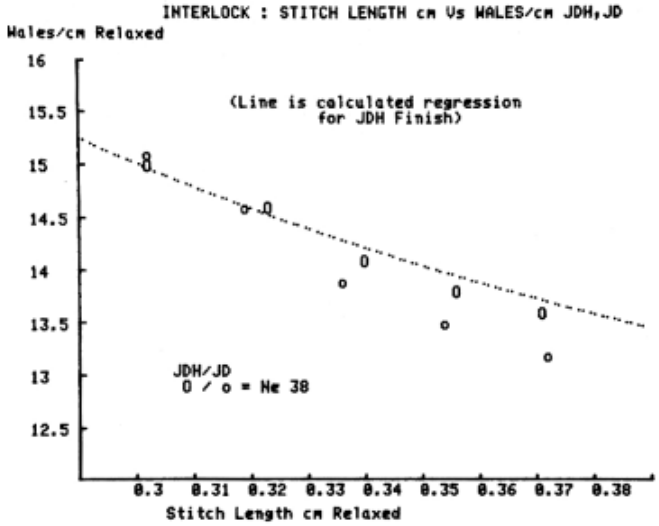

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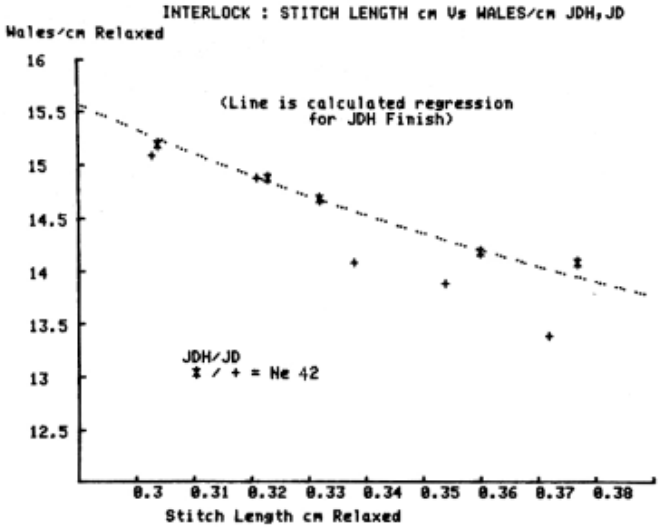

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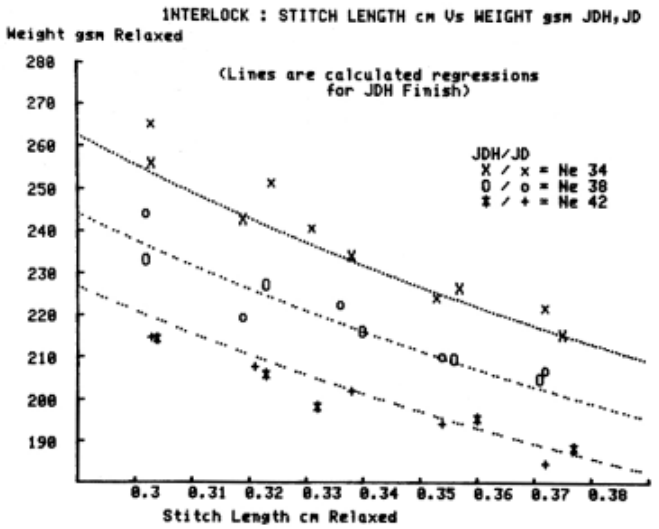

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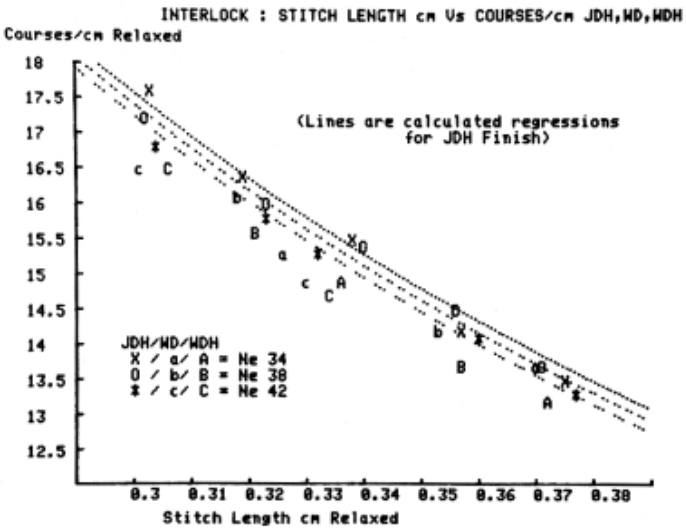

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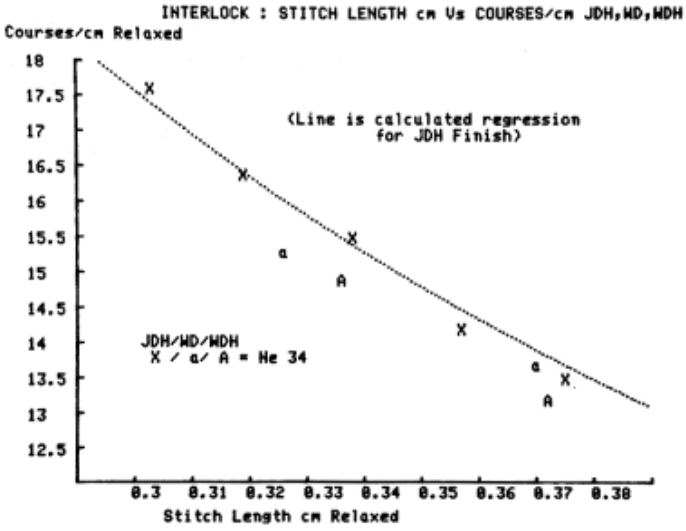

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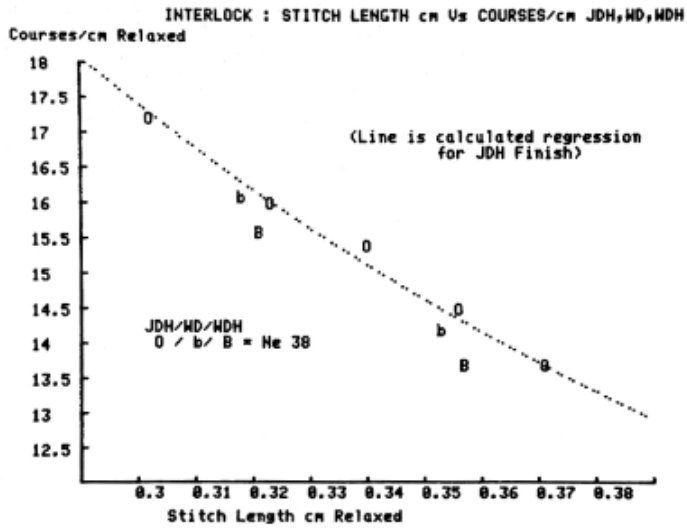

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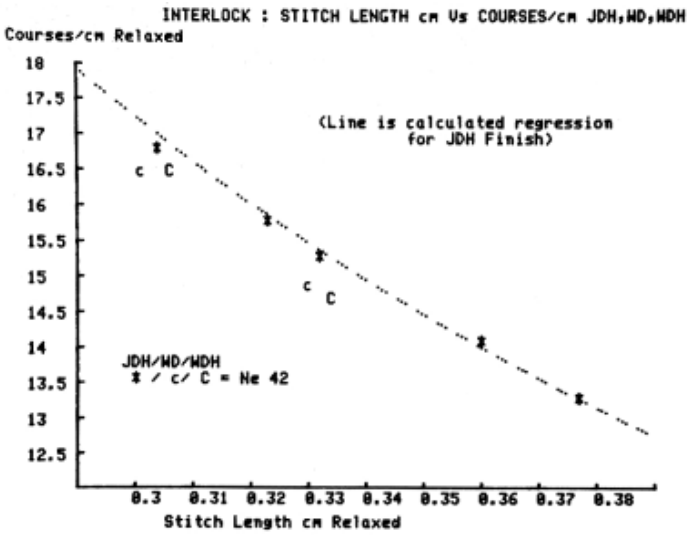

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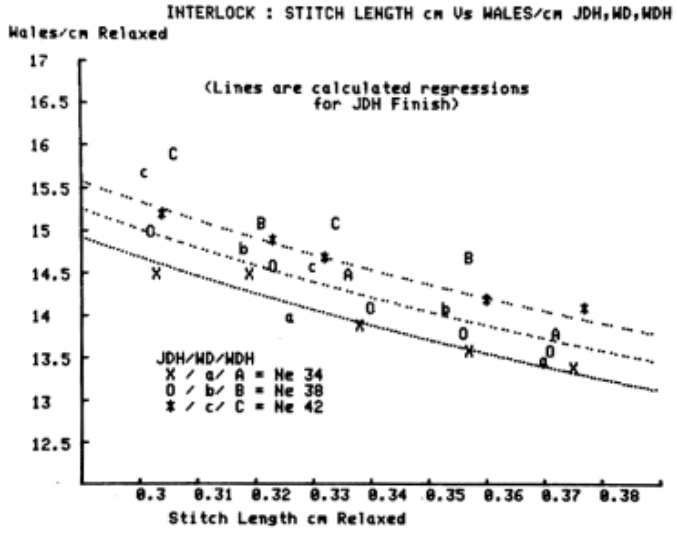

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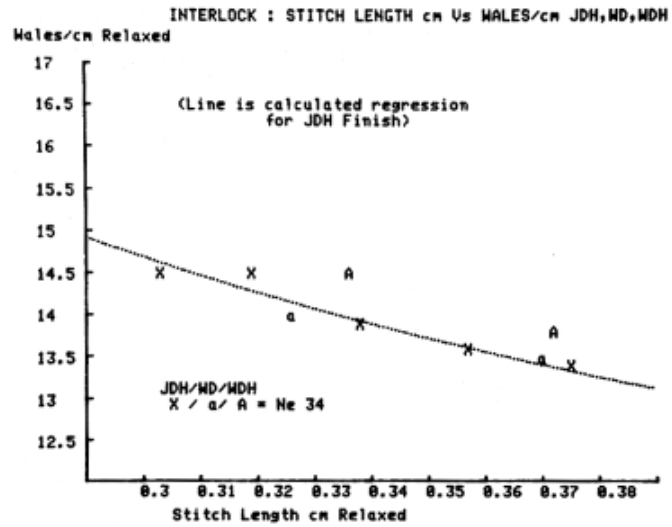

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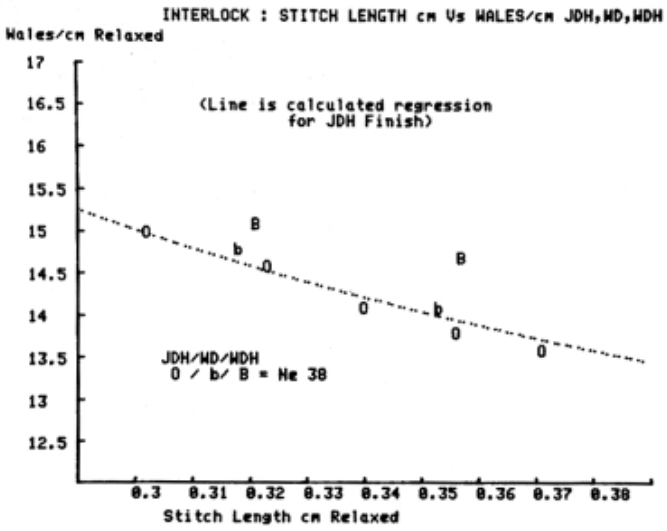

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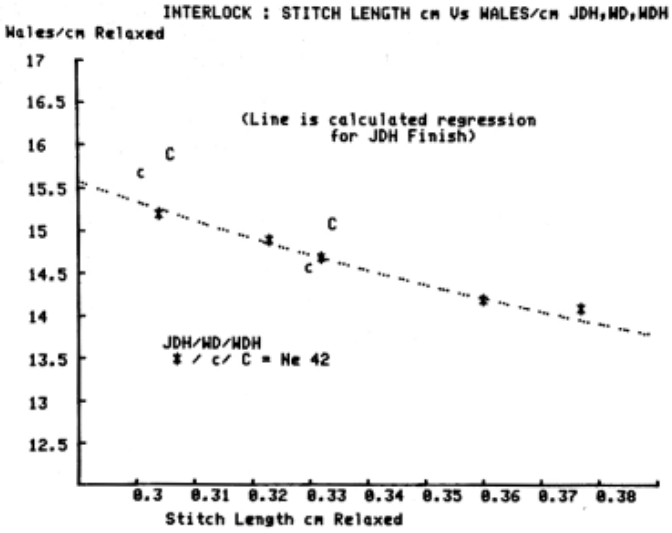

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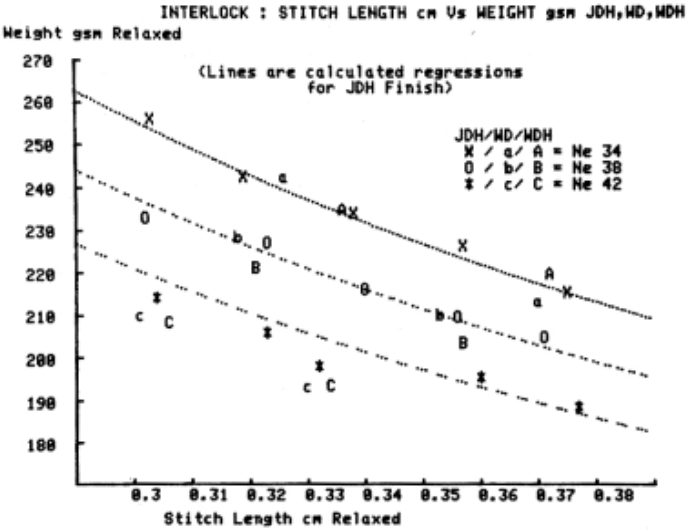

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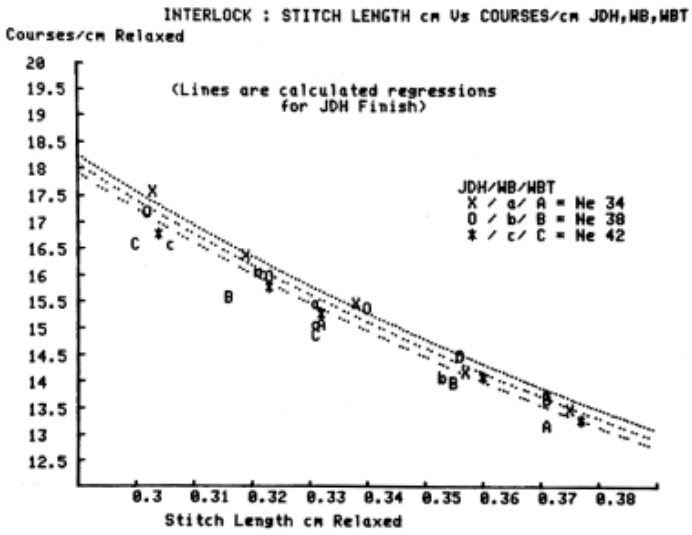

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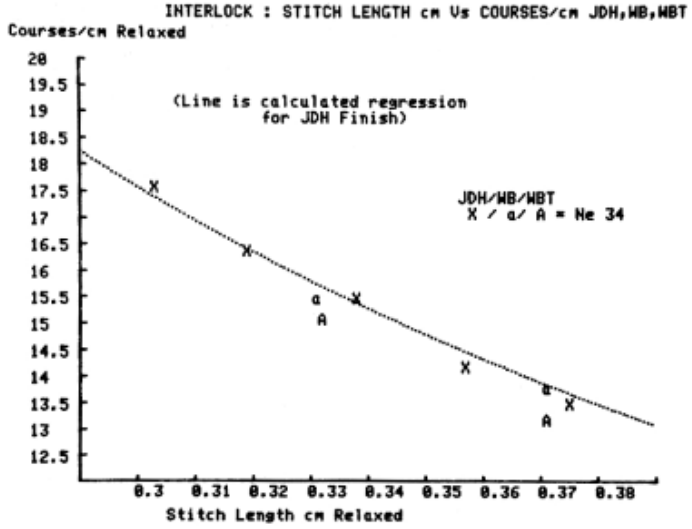

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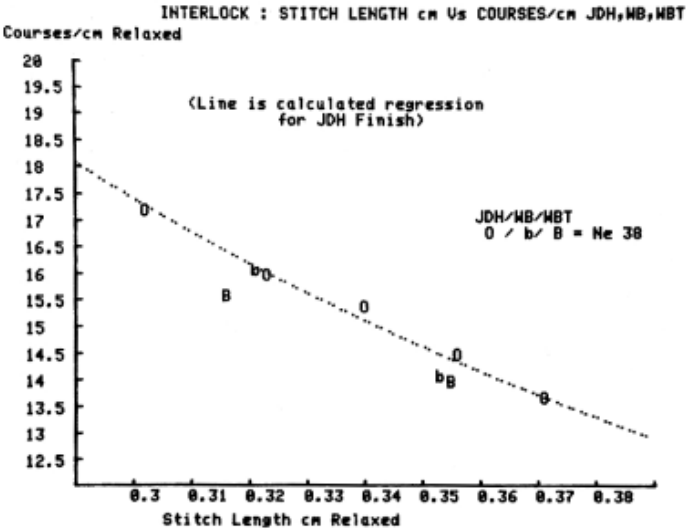

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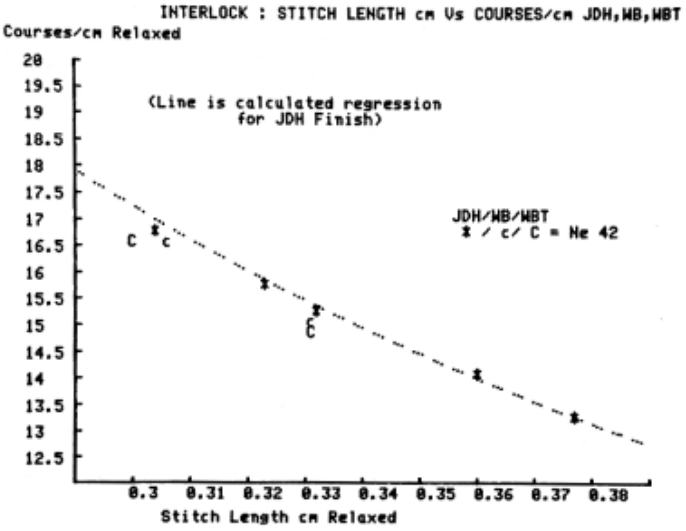

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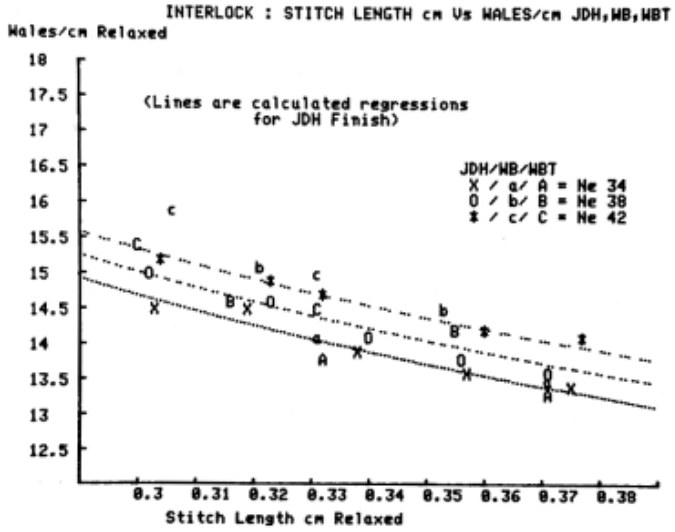

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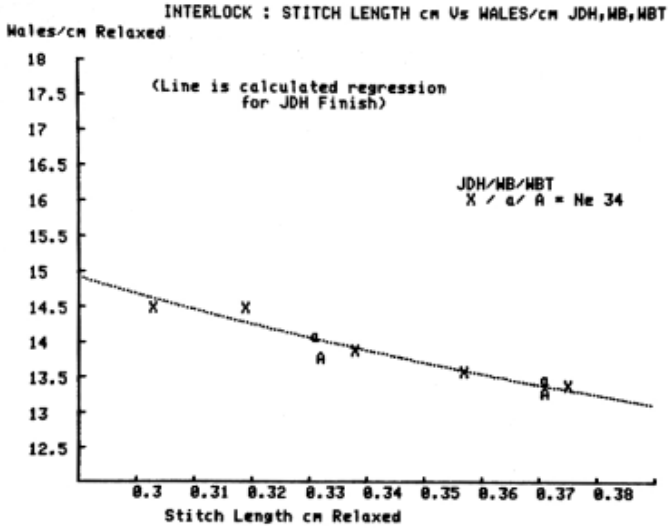

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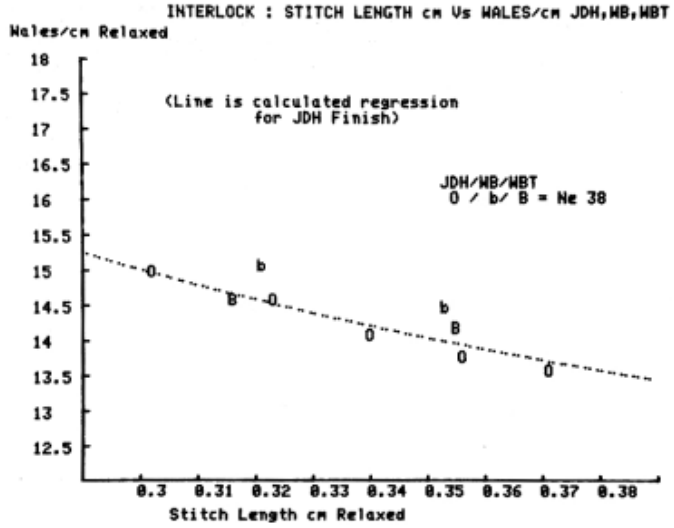

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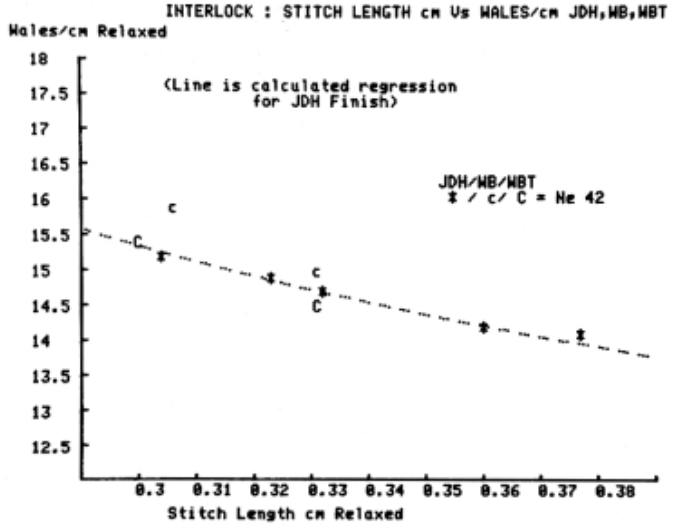

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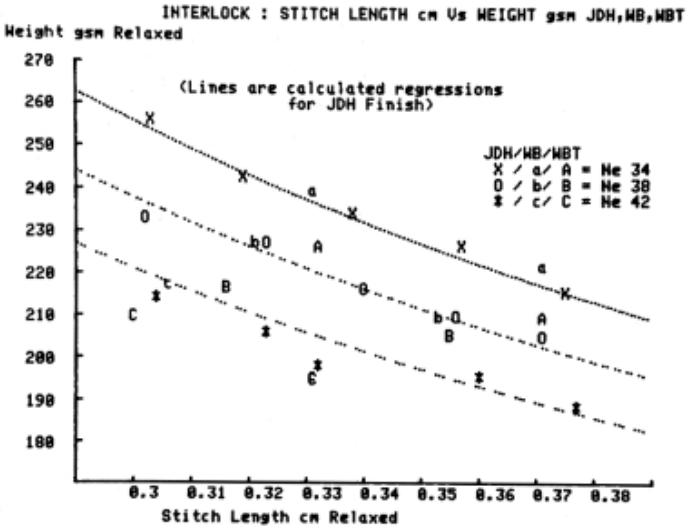

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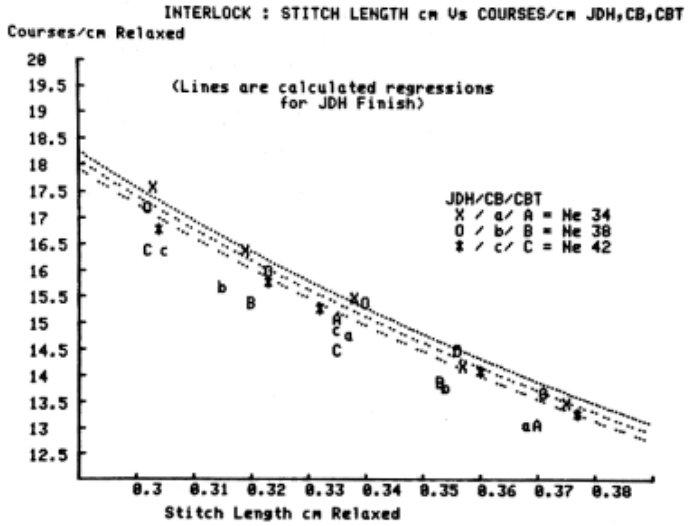

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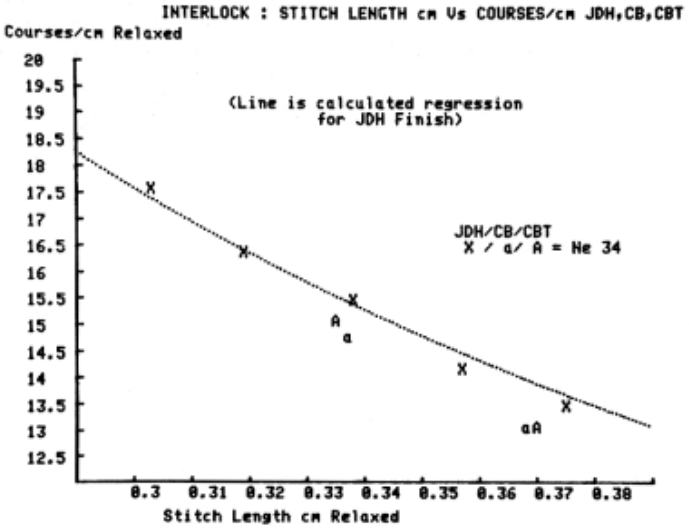

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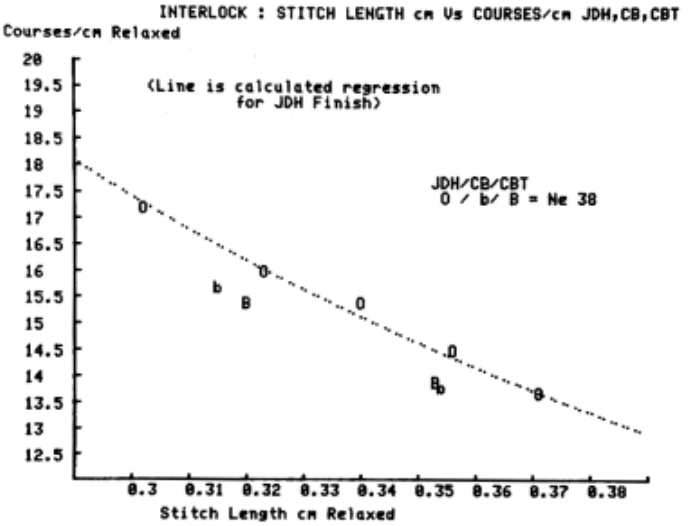

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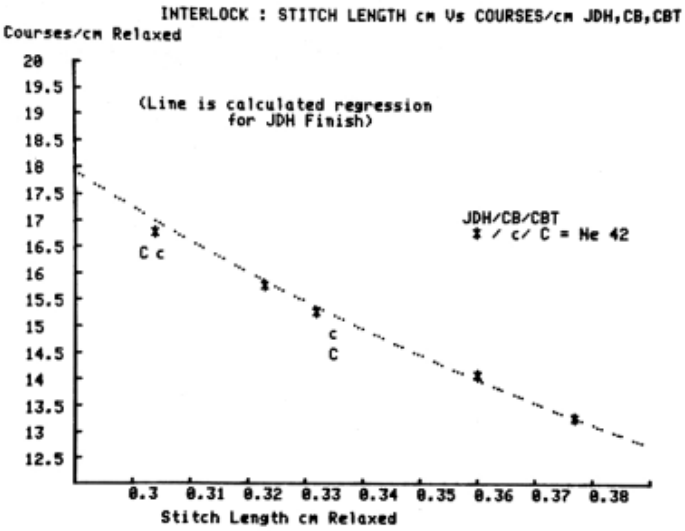

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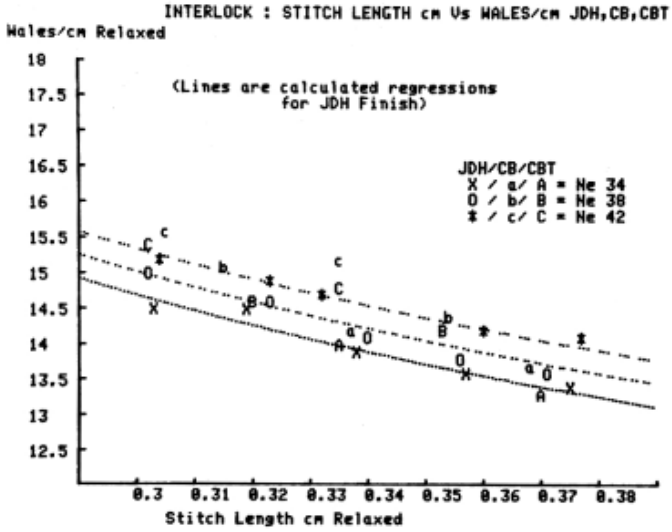

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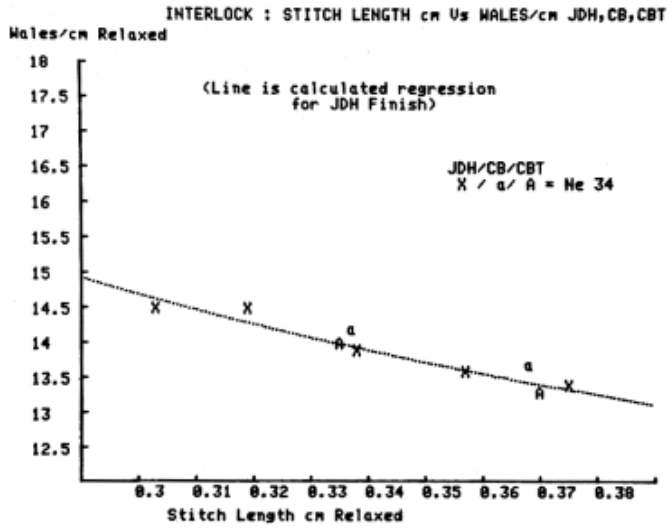

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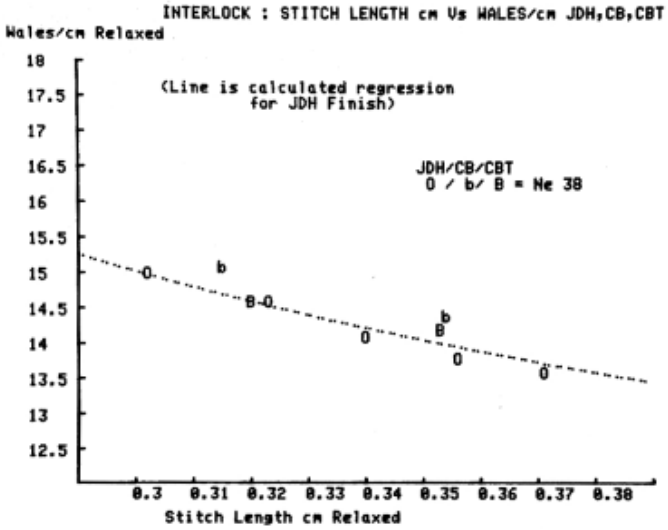

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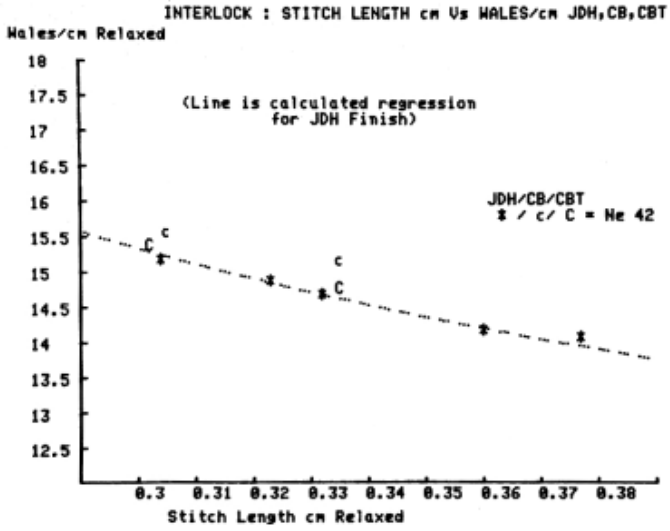

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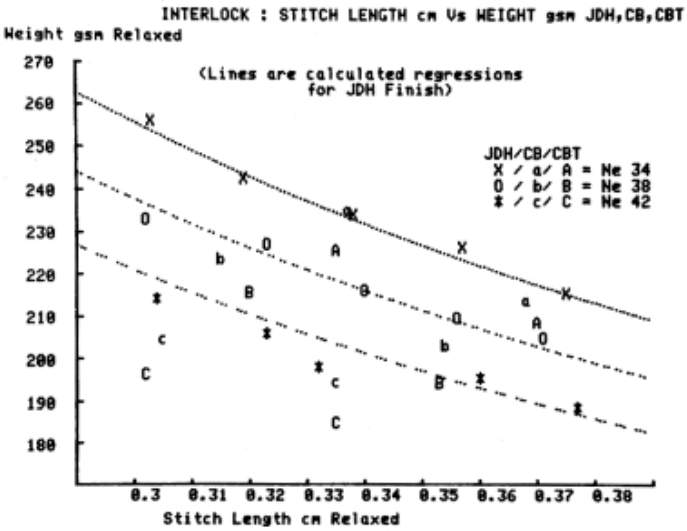

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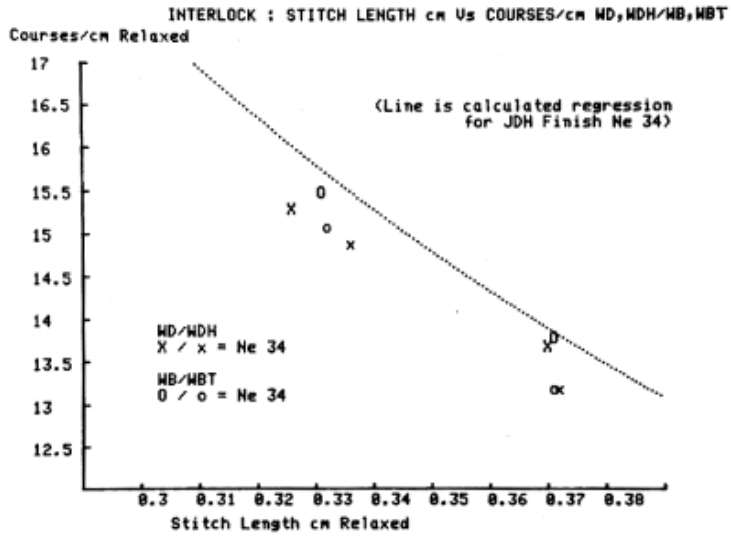

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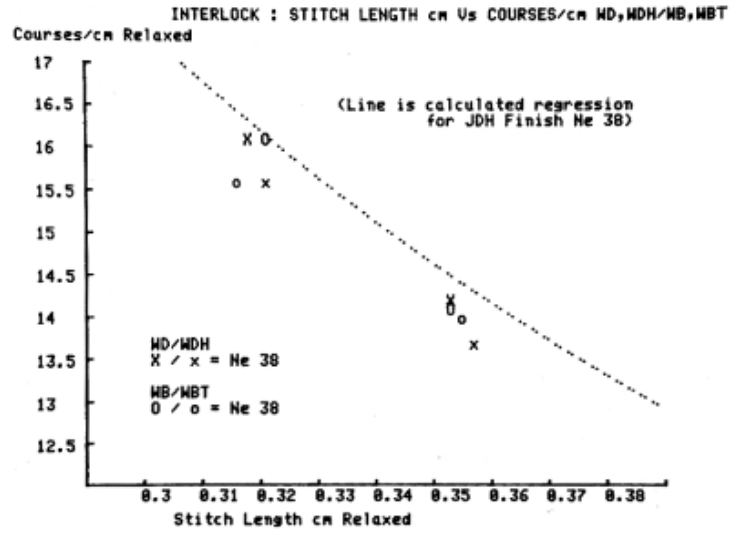

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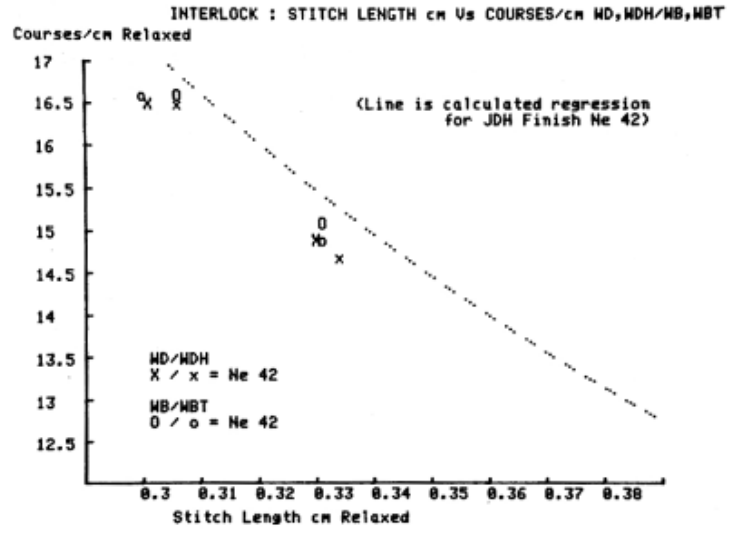

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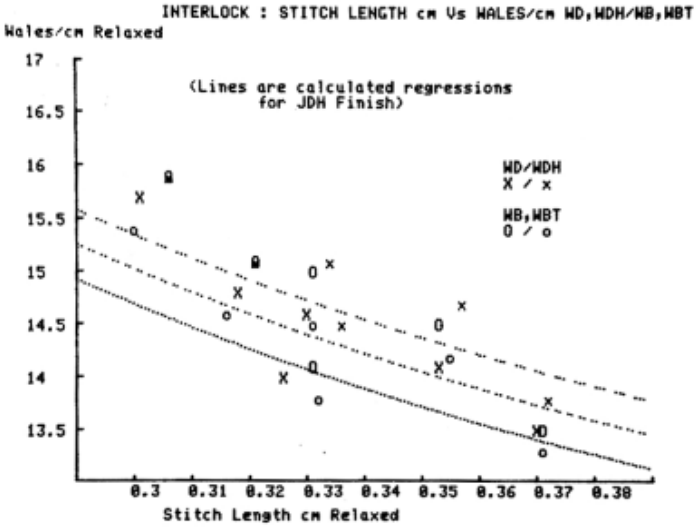

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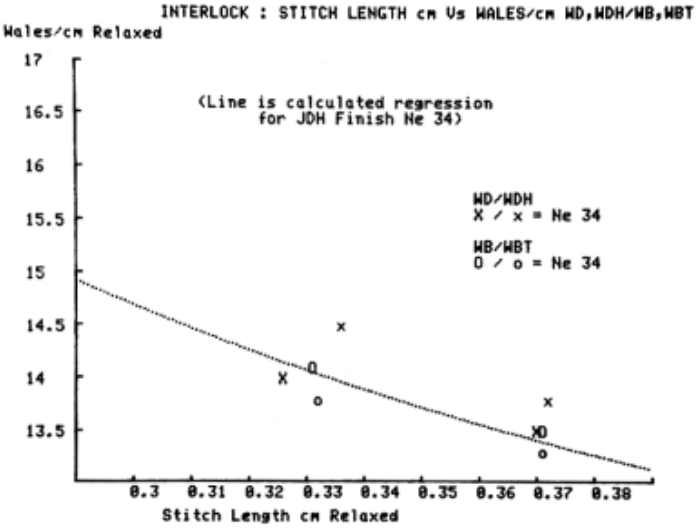

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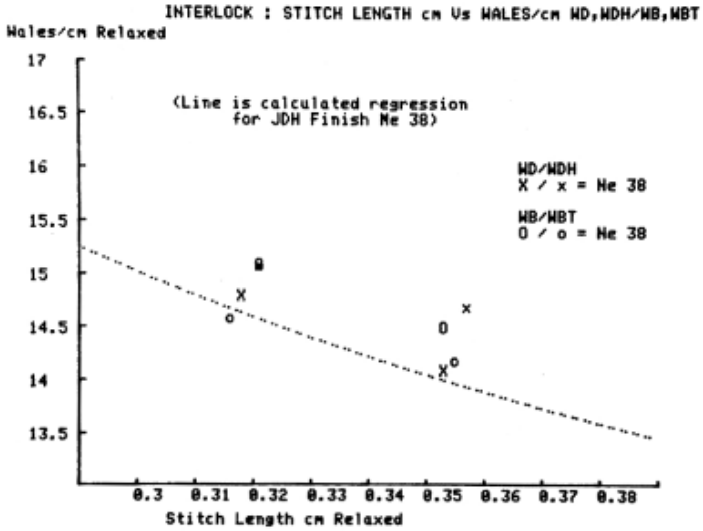

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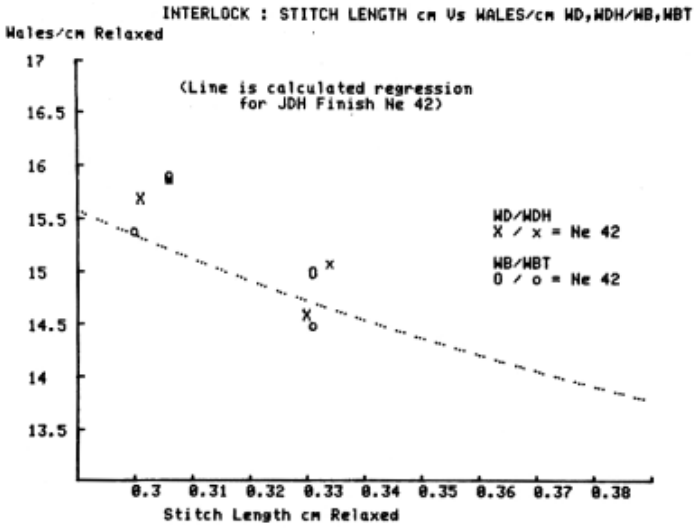

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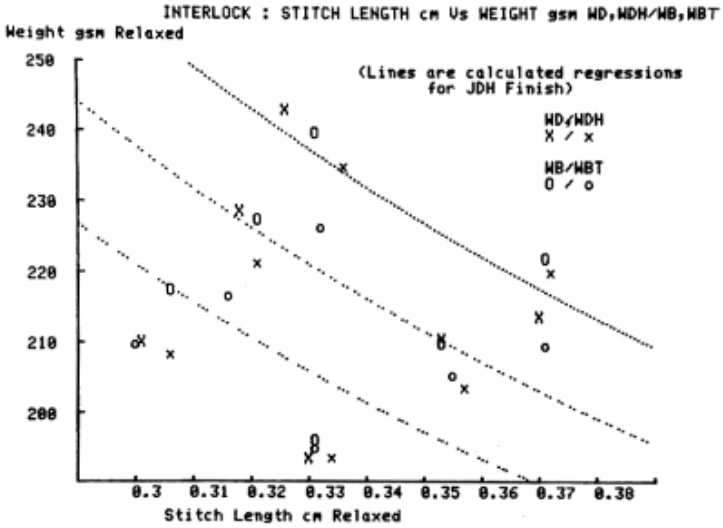

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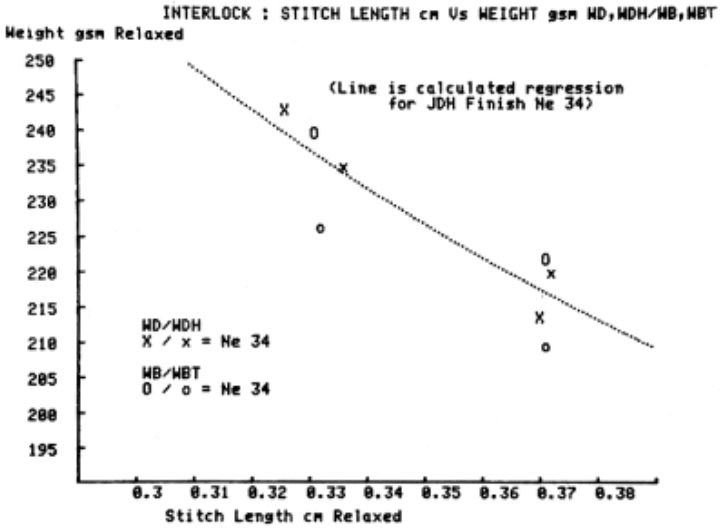

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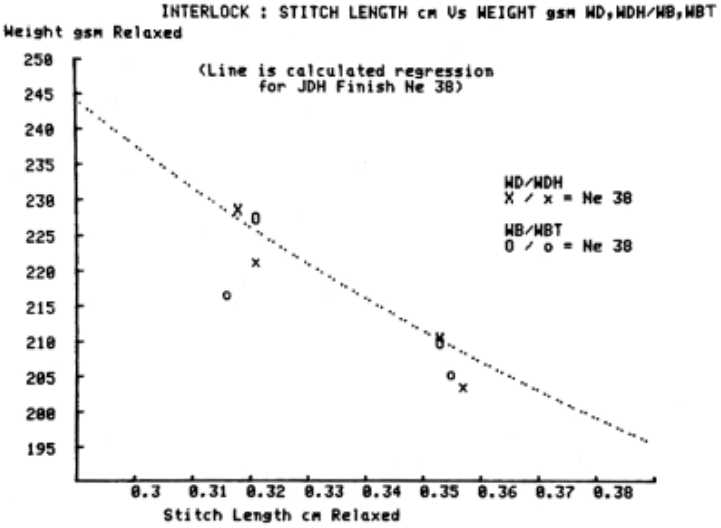

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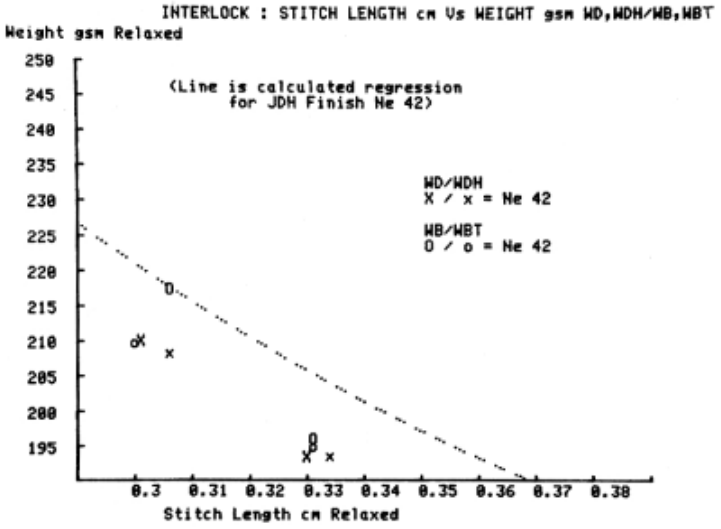

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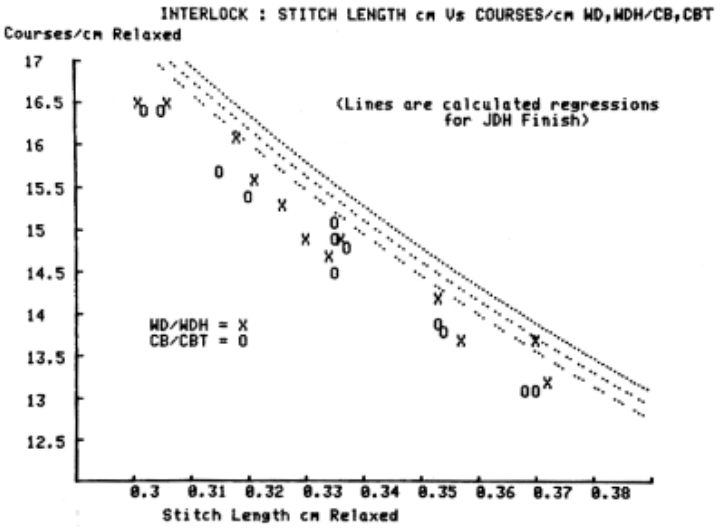

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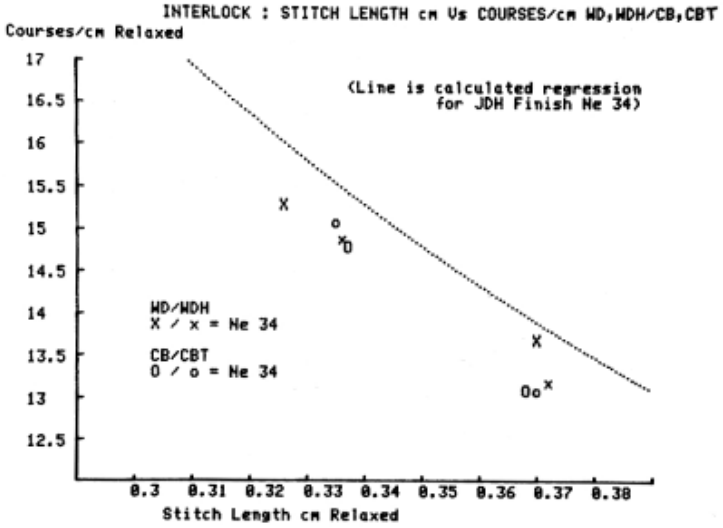

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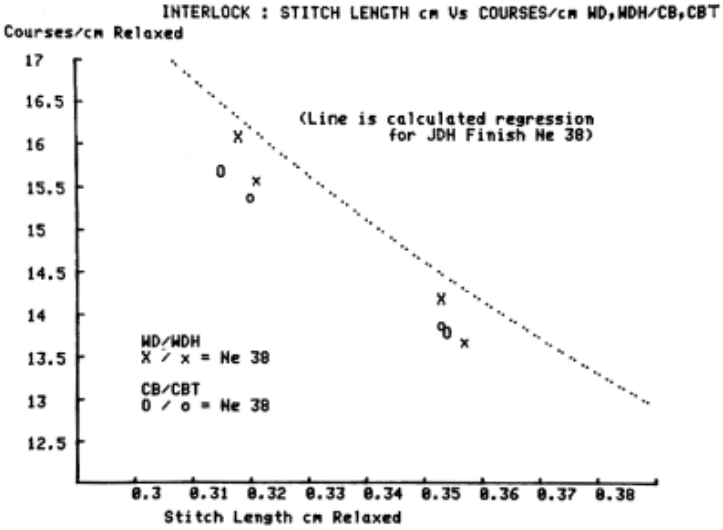

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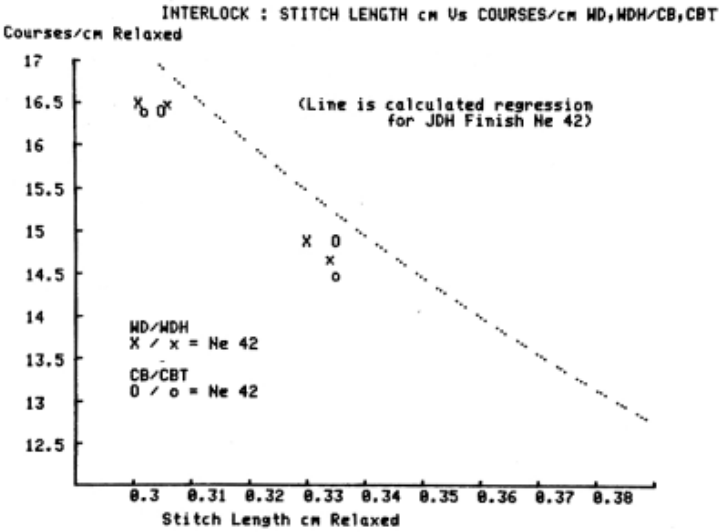

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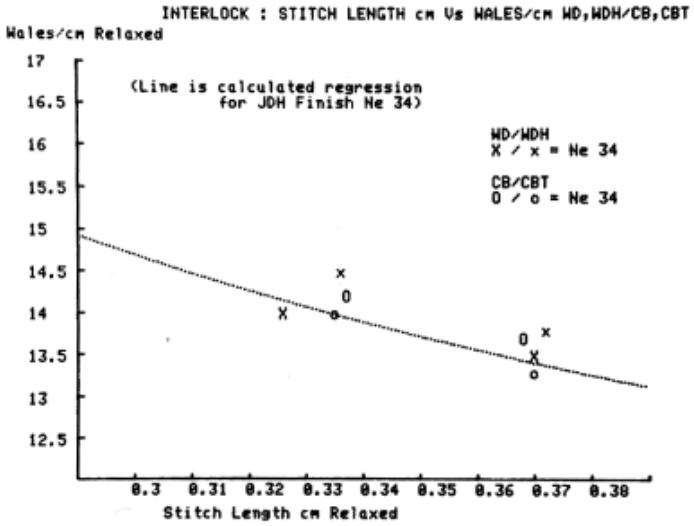

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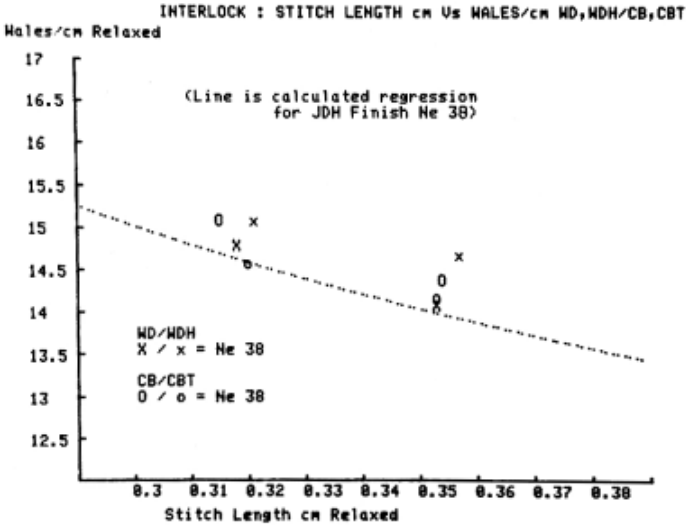

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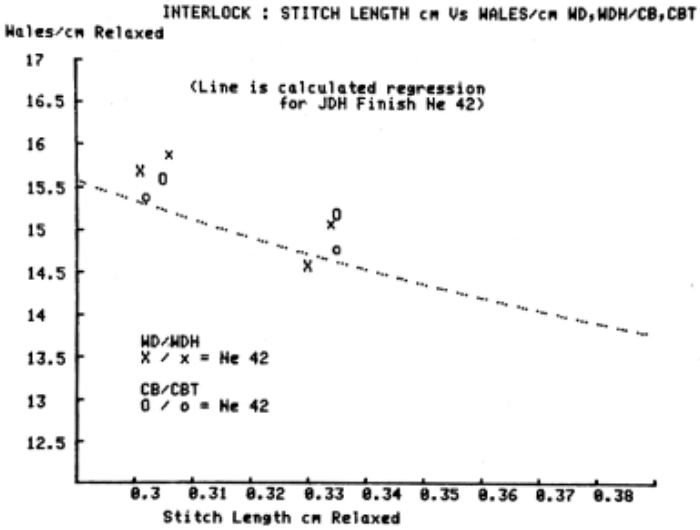

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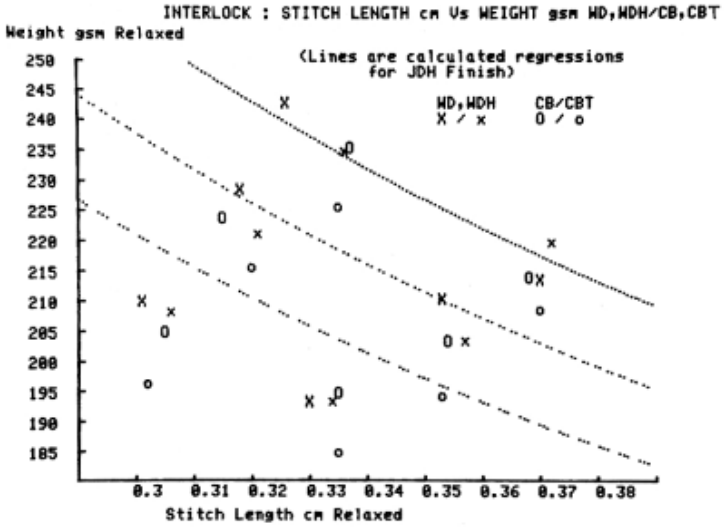

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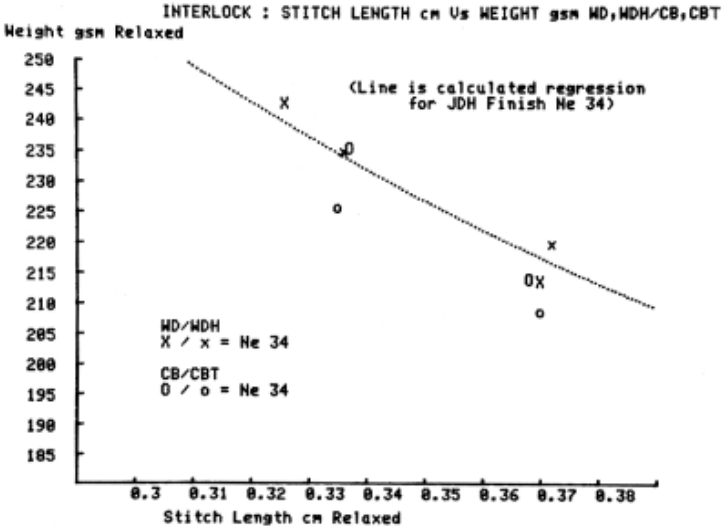

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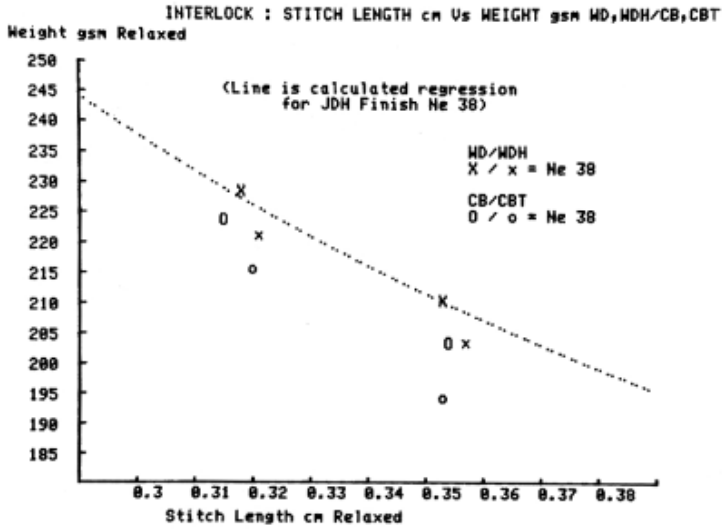

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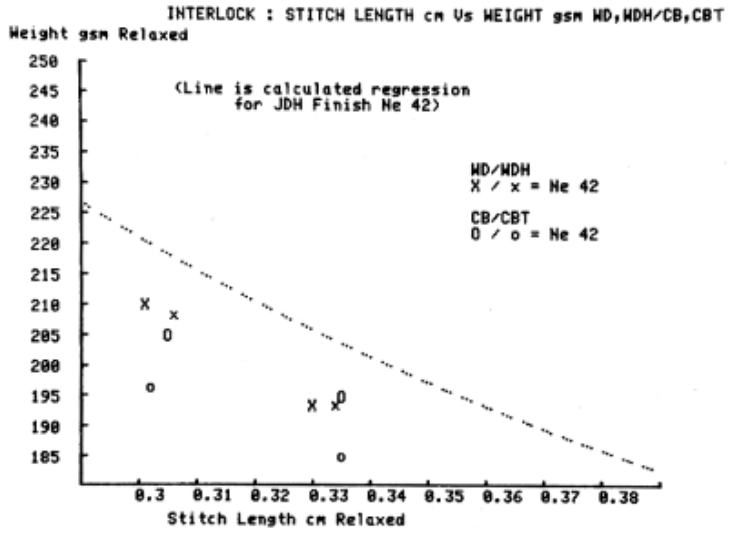

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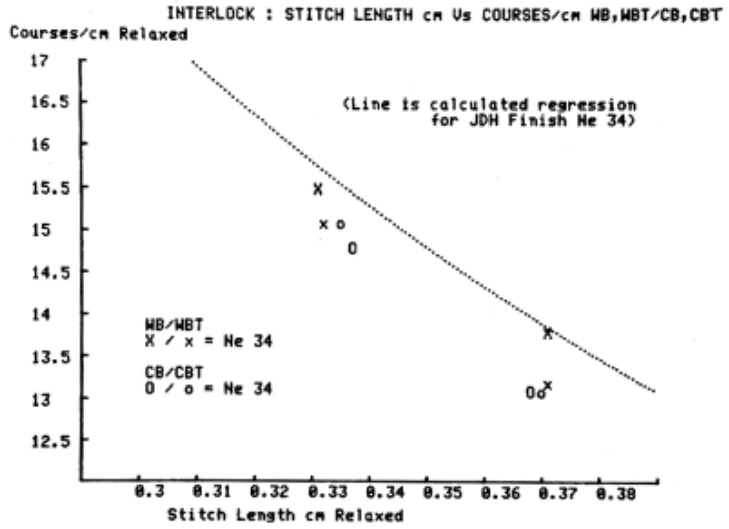

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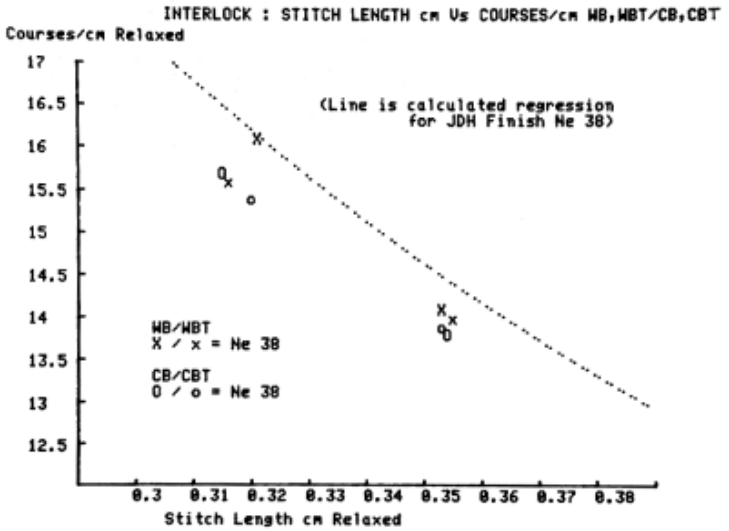

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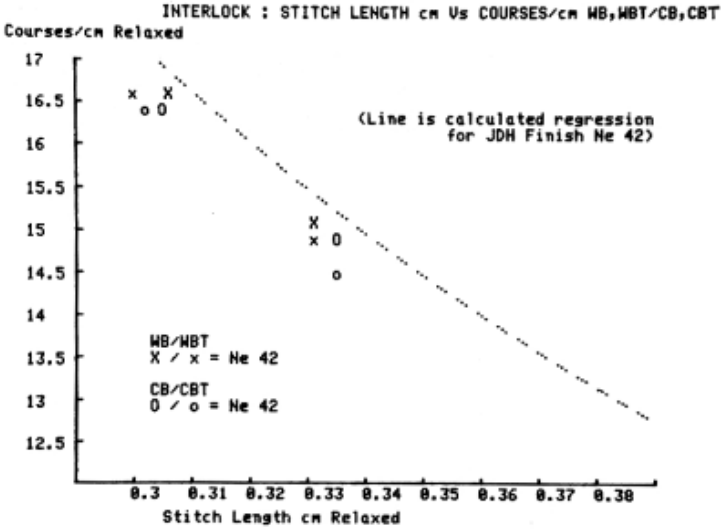

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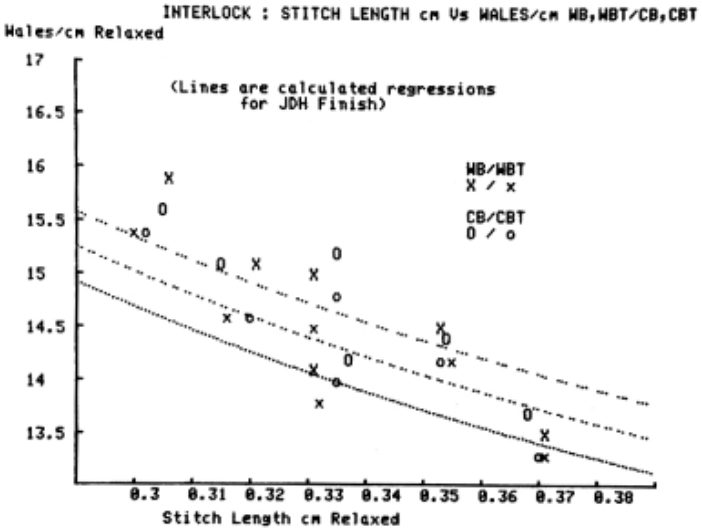

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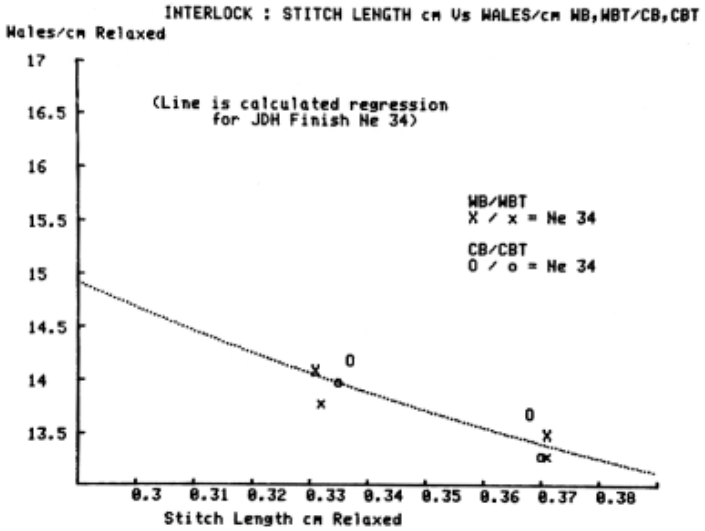

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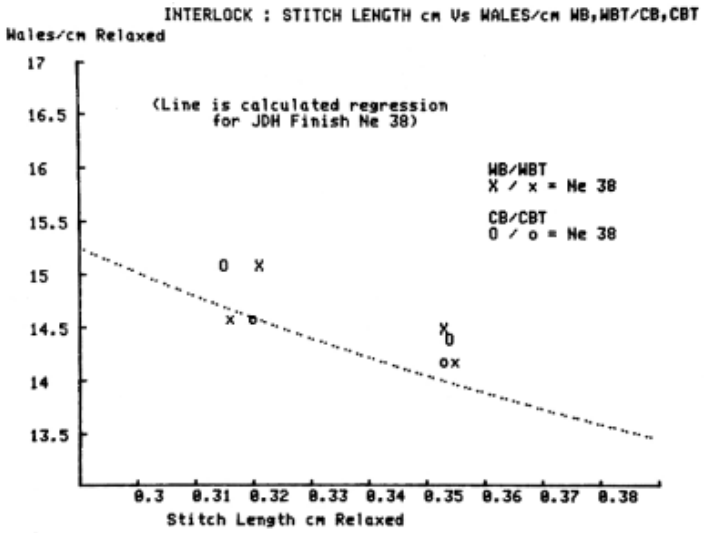

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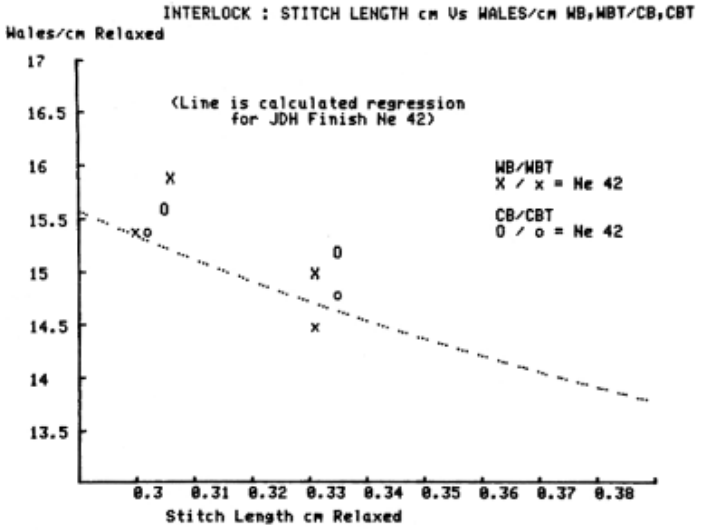

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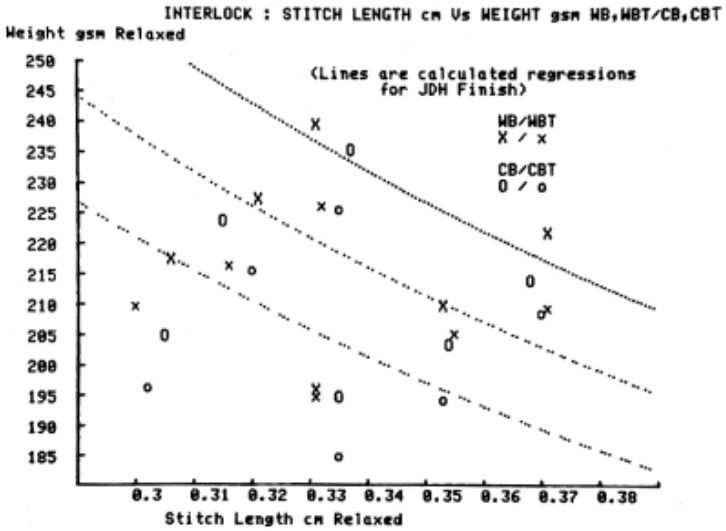

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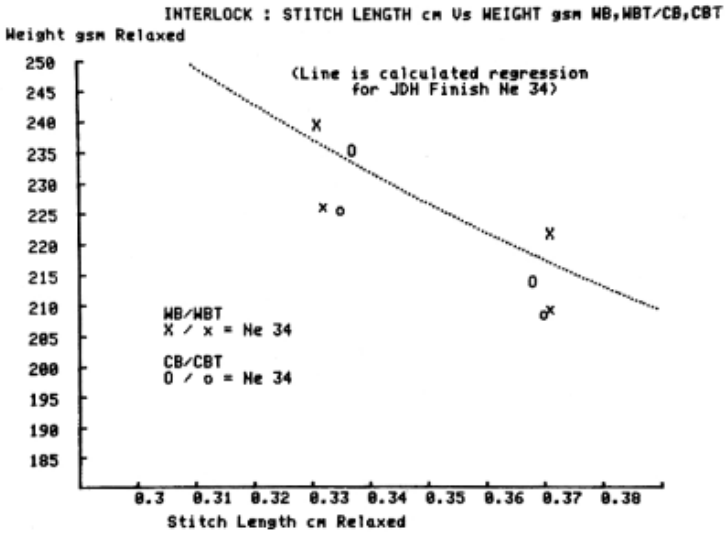

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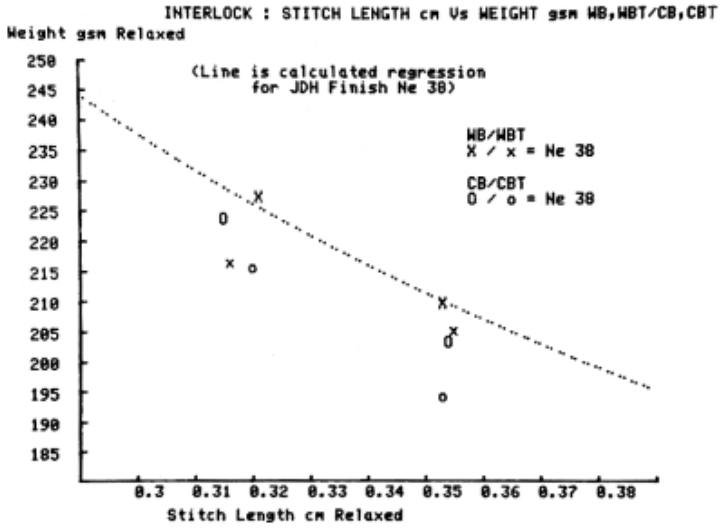

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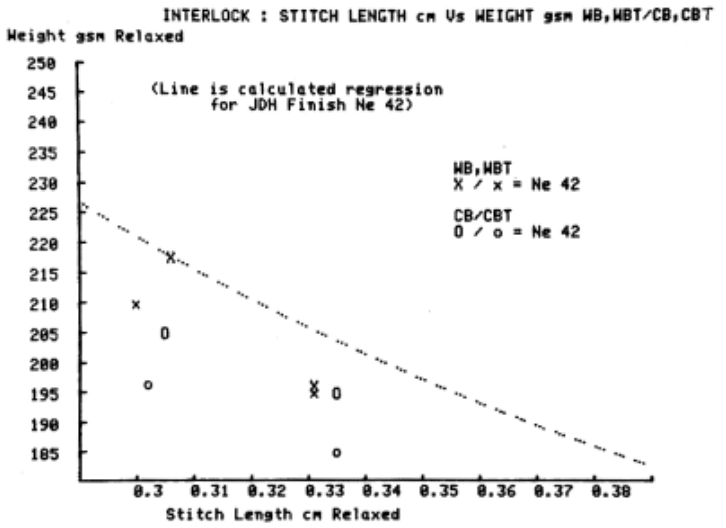

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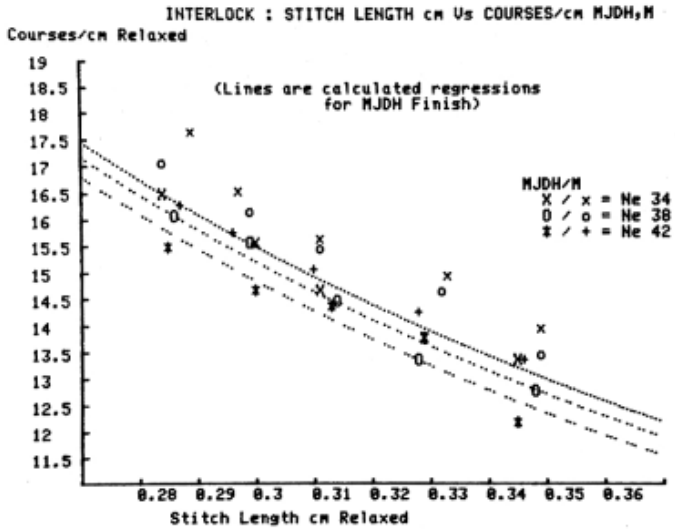

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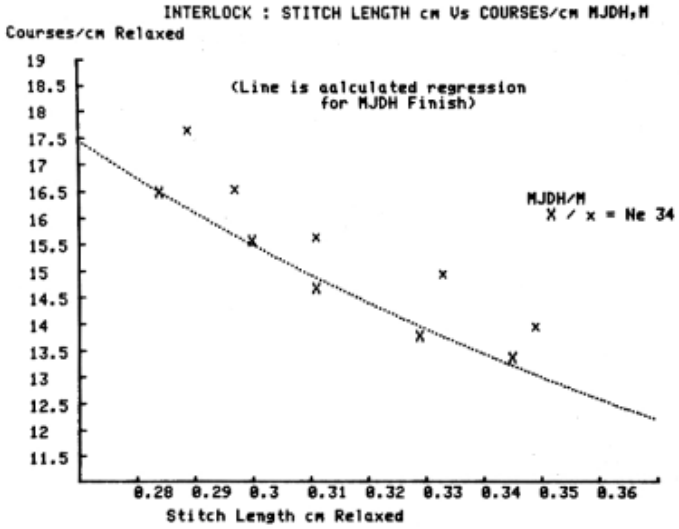

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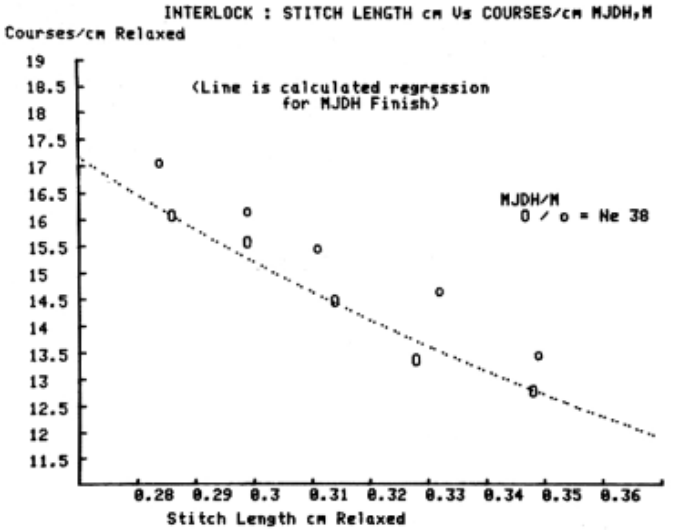

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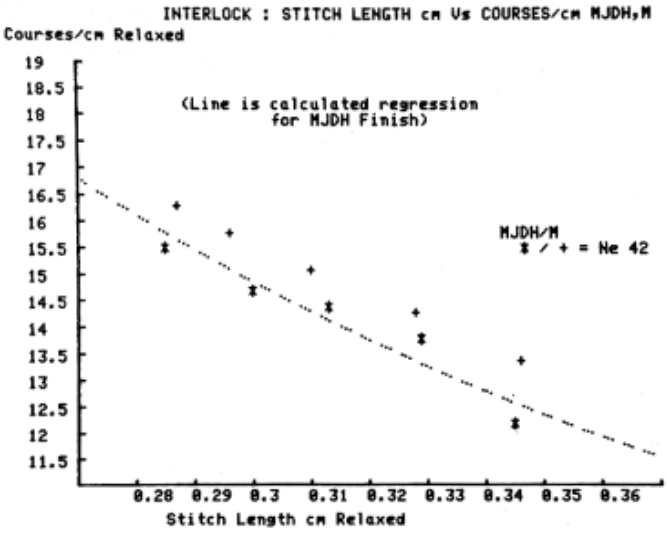

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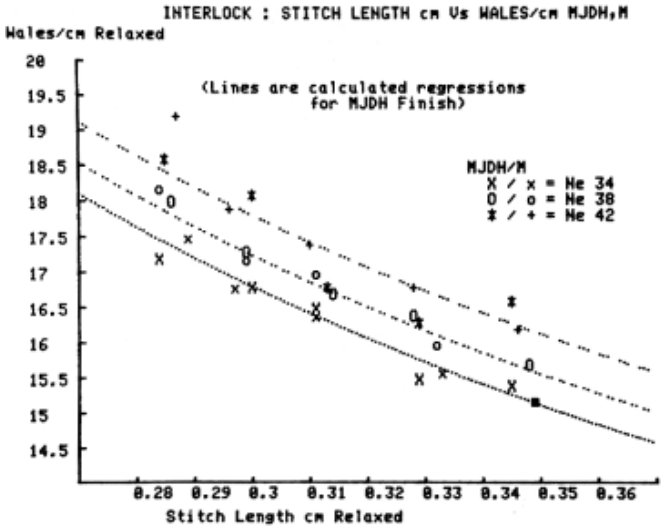

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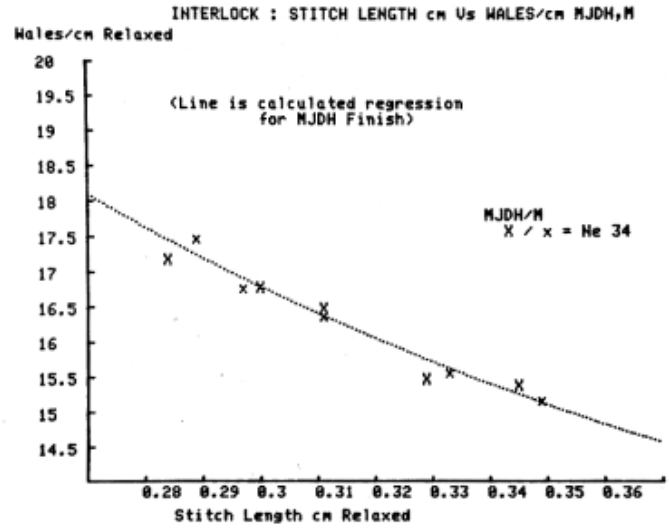

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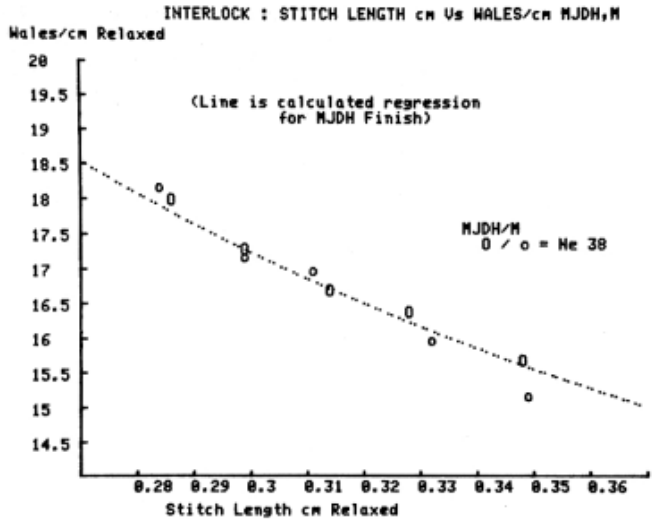

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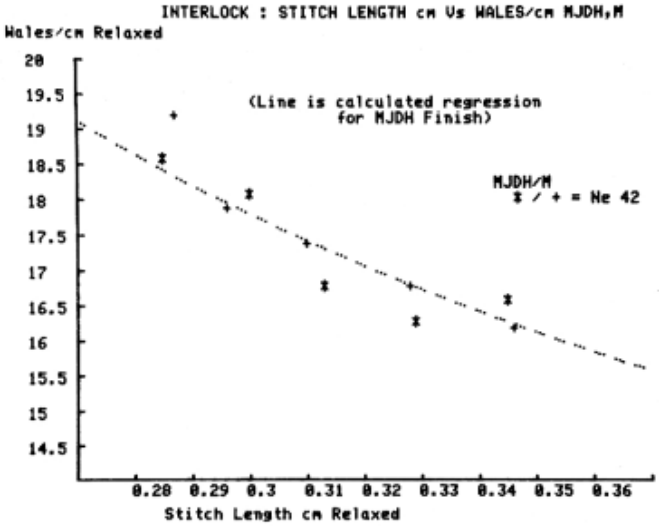

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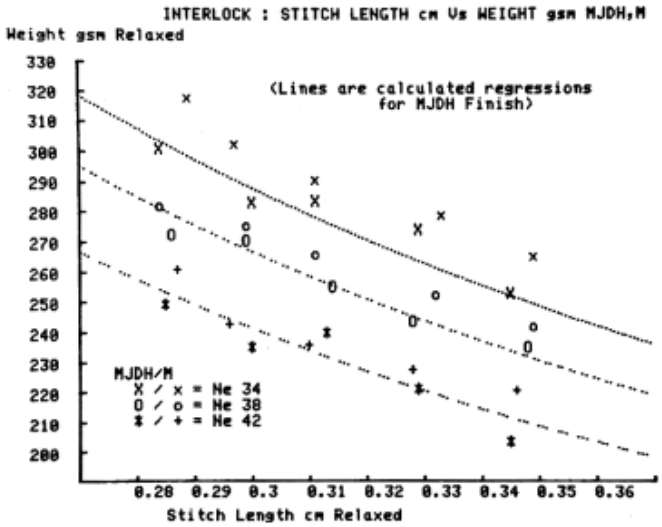

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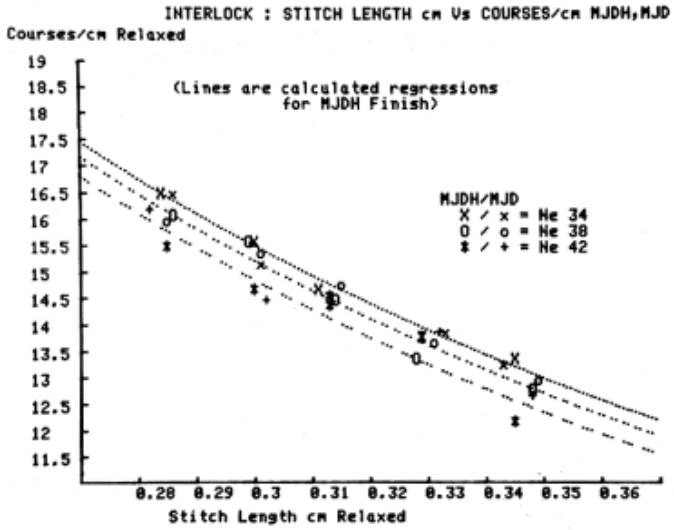

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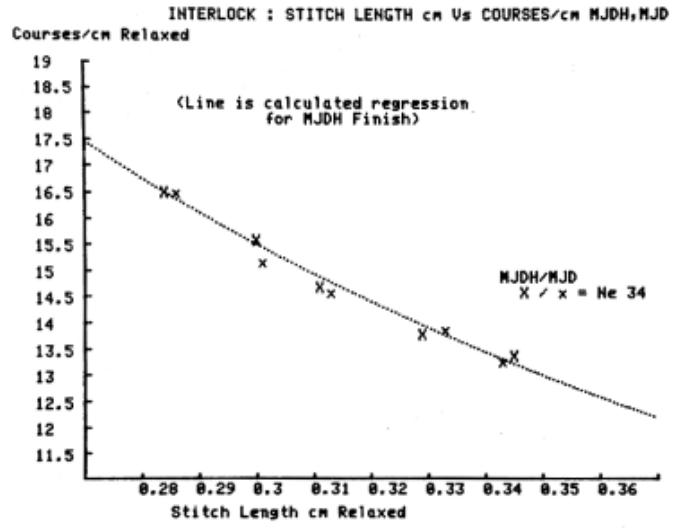

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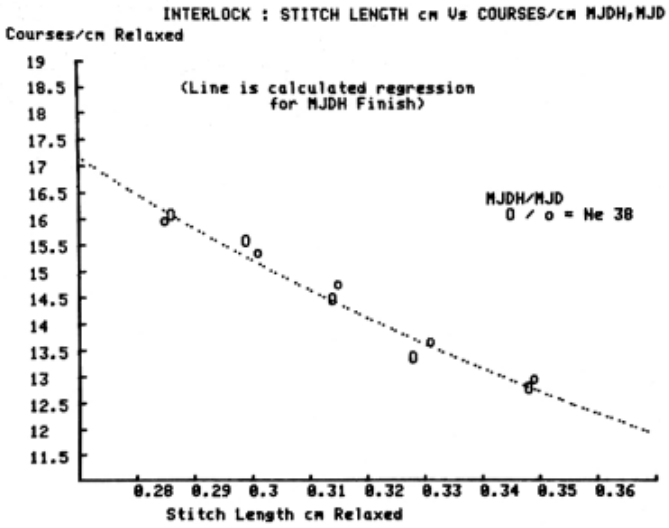

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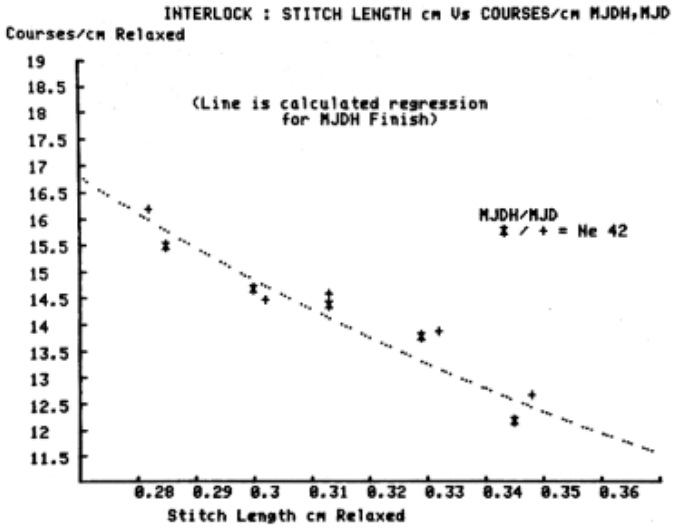

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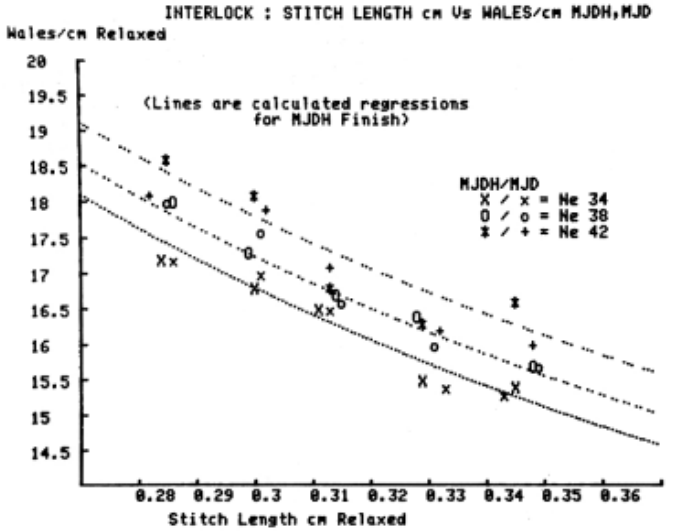

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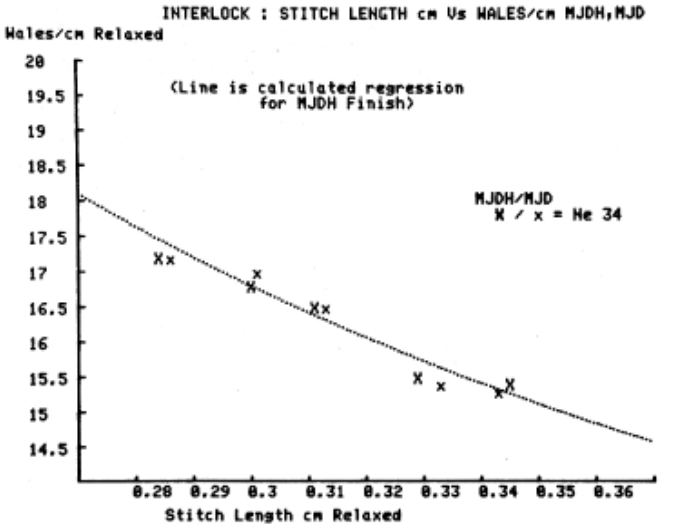

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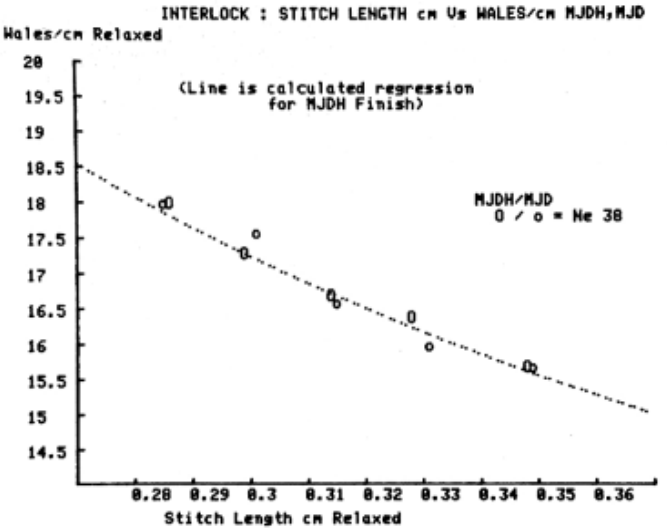

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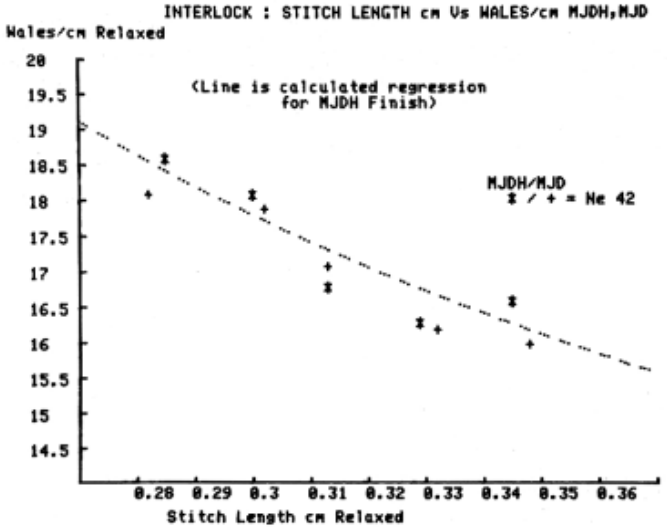

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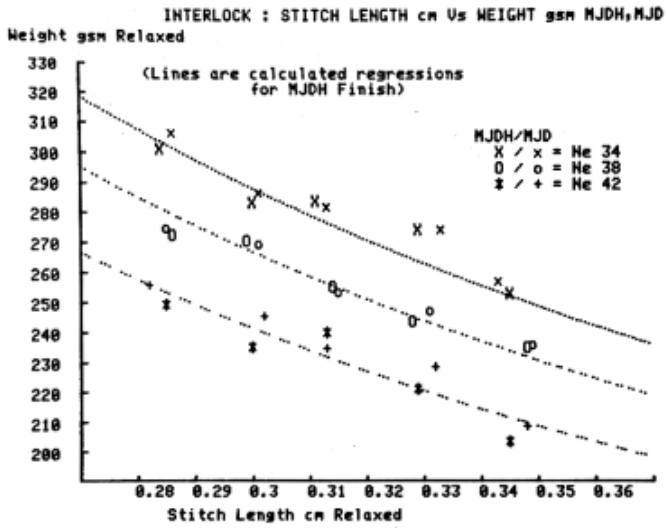
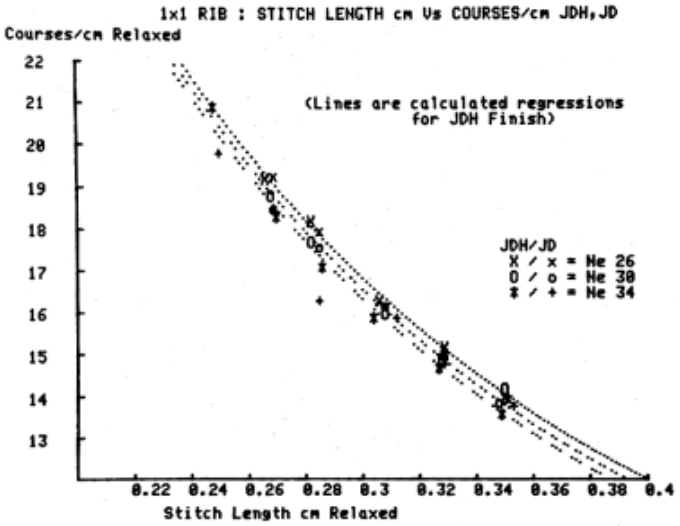


Figure 148



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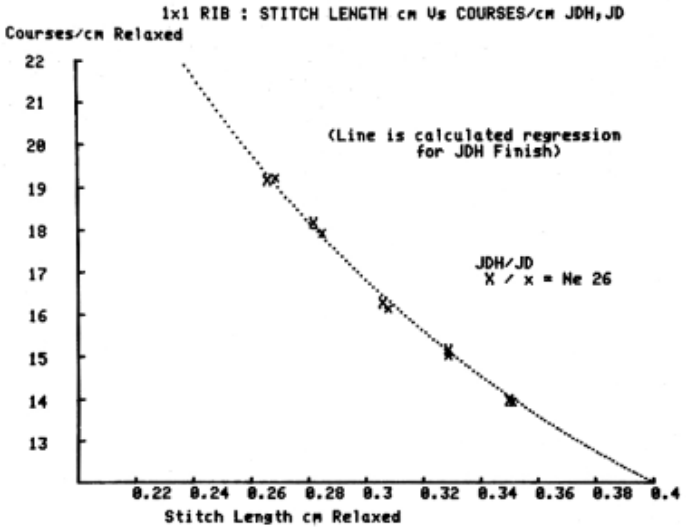

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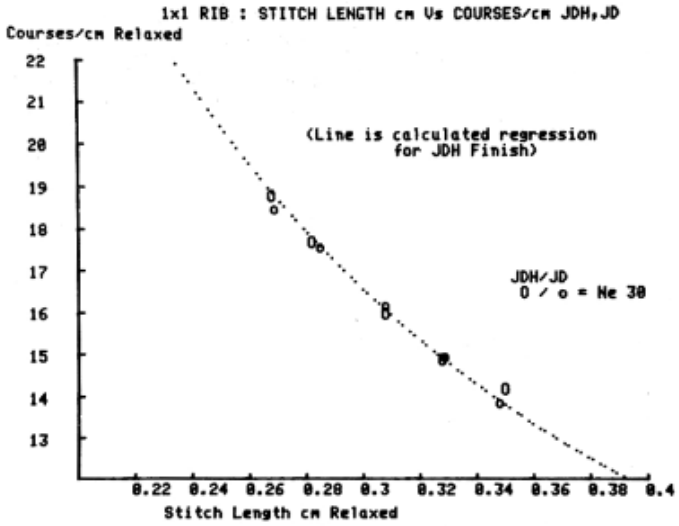

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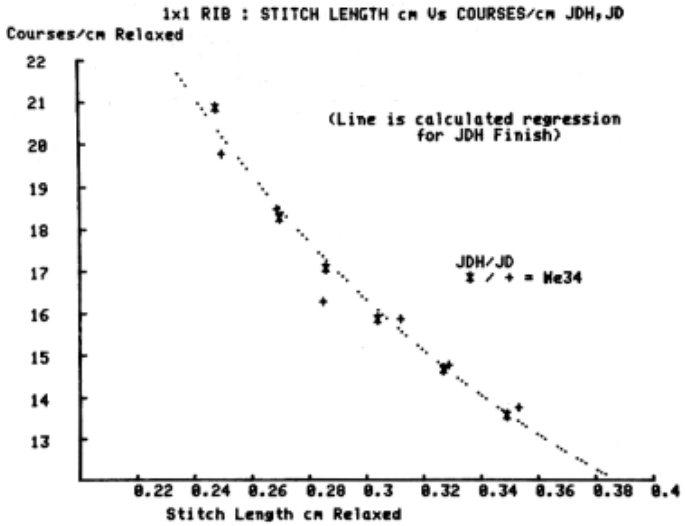

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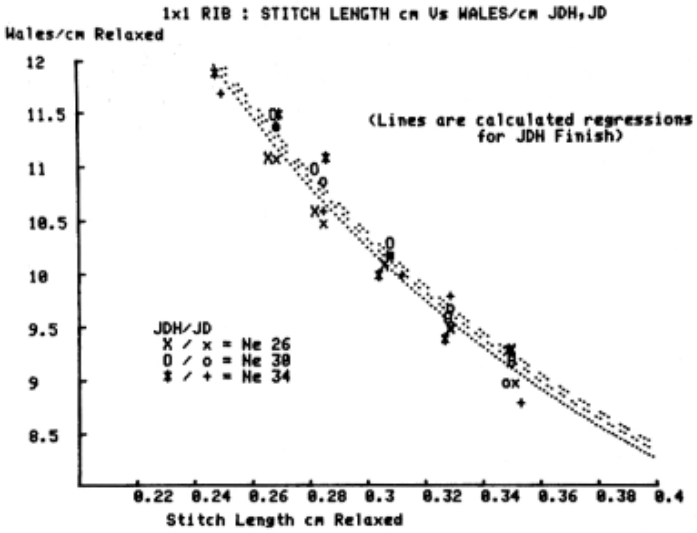

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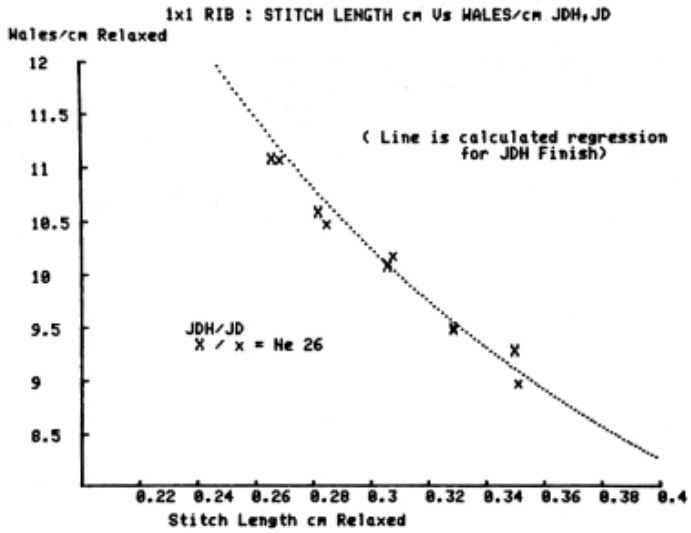

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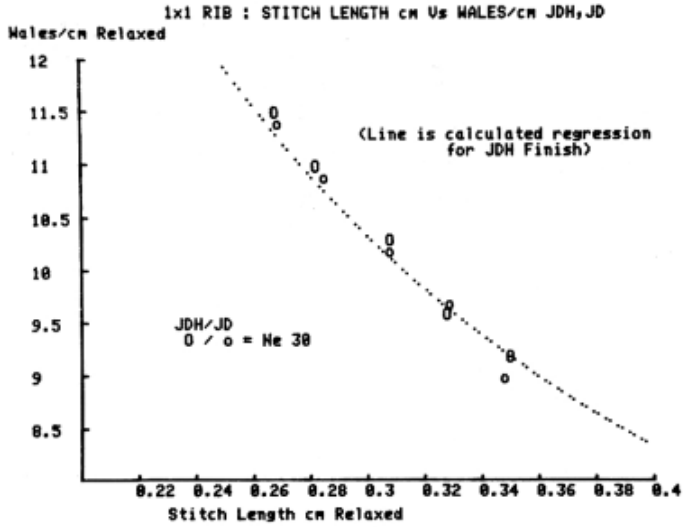

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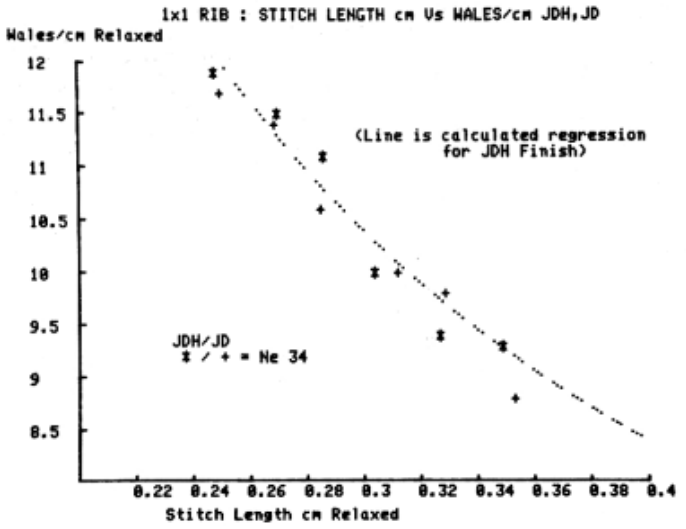

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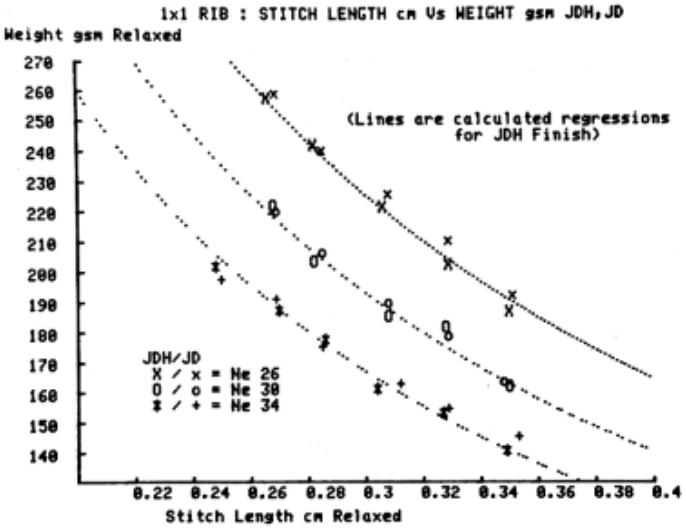

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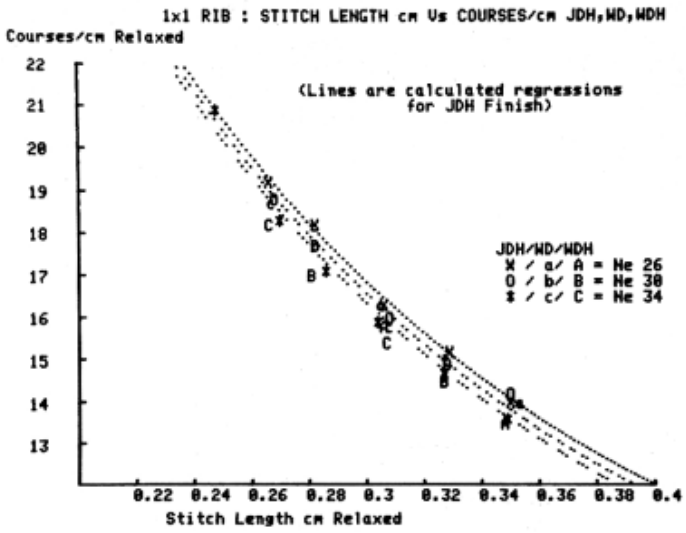

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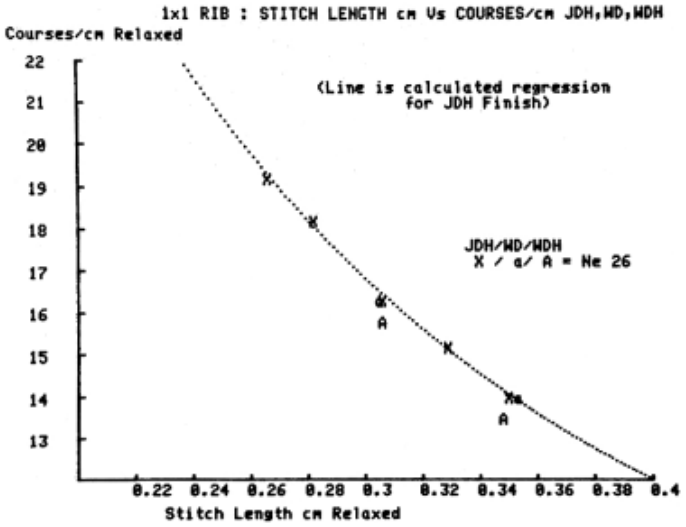

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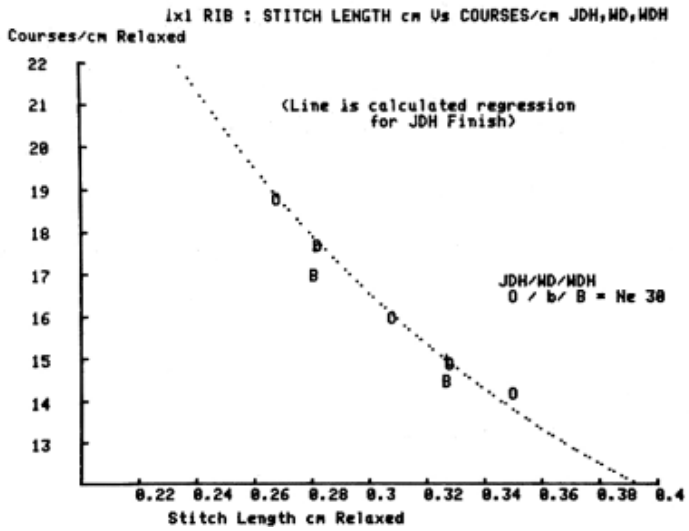

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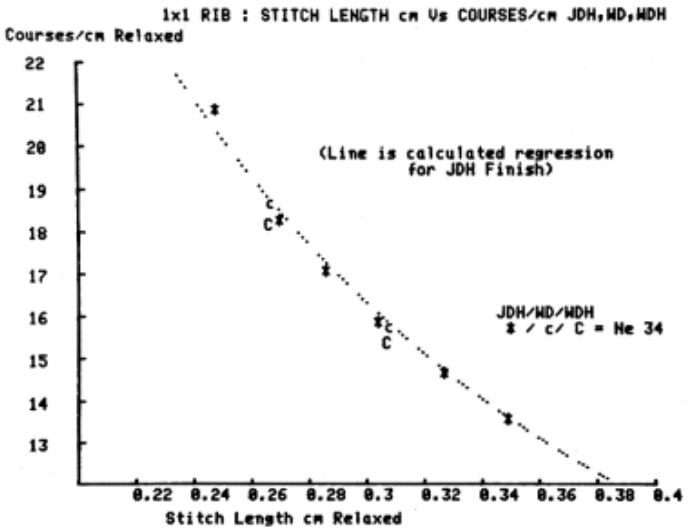

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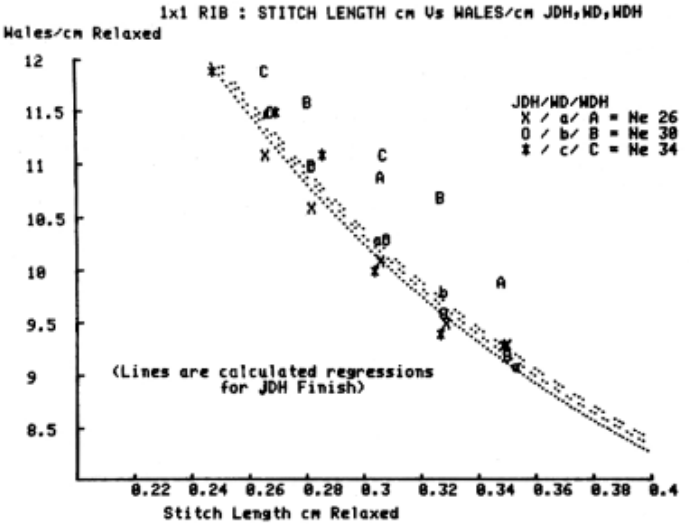

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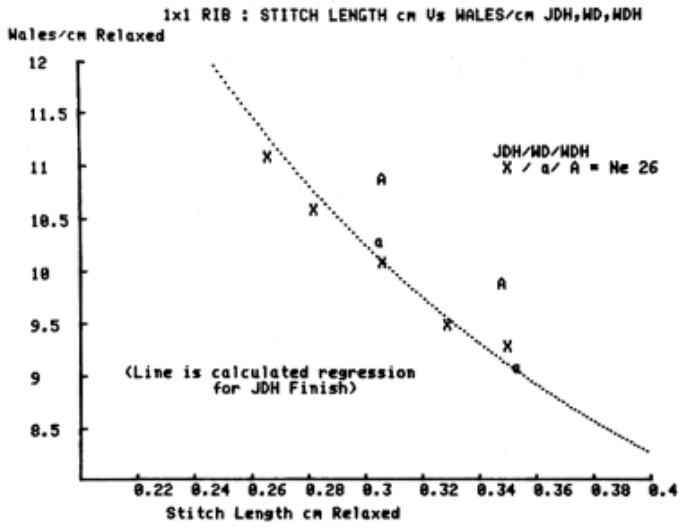

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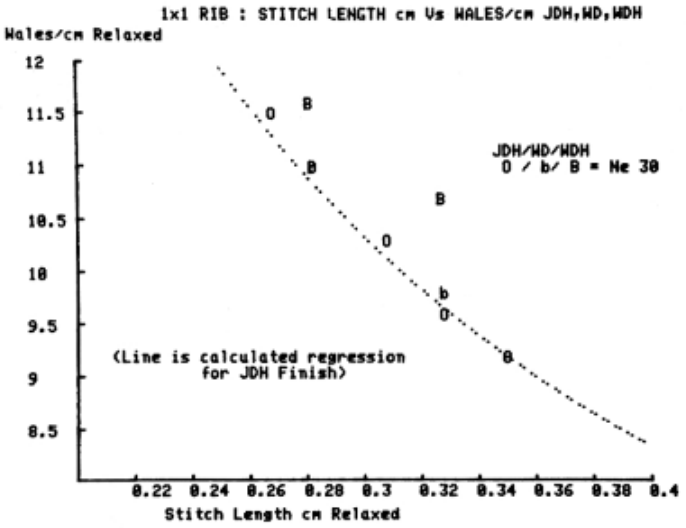

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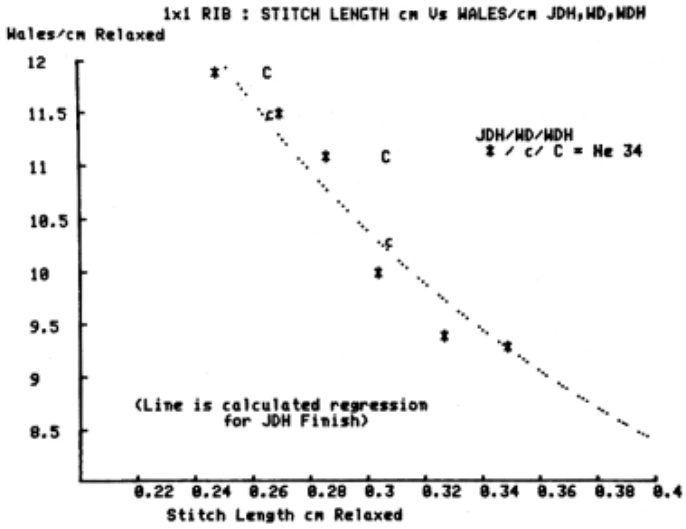

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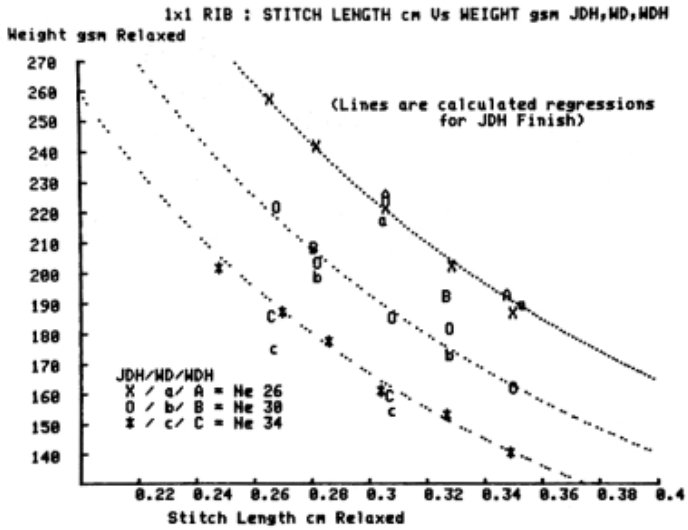

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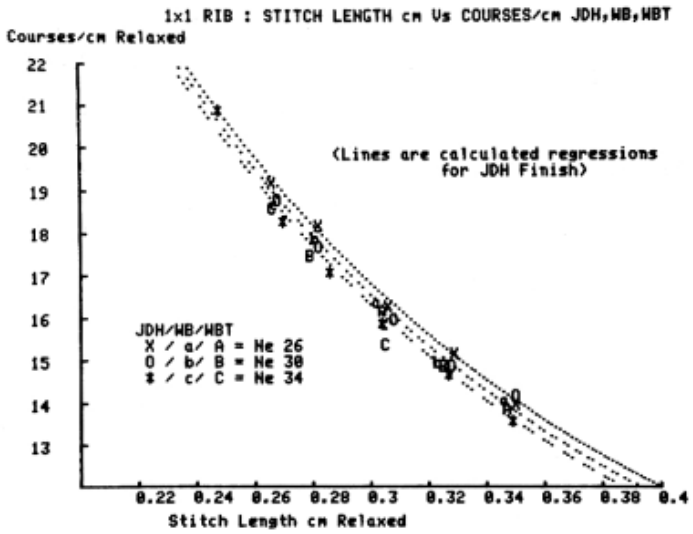

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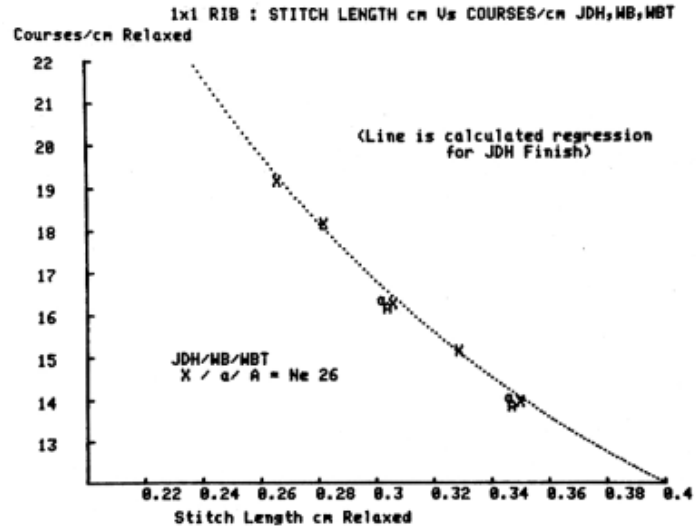

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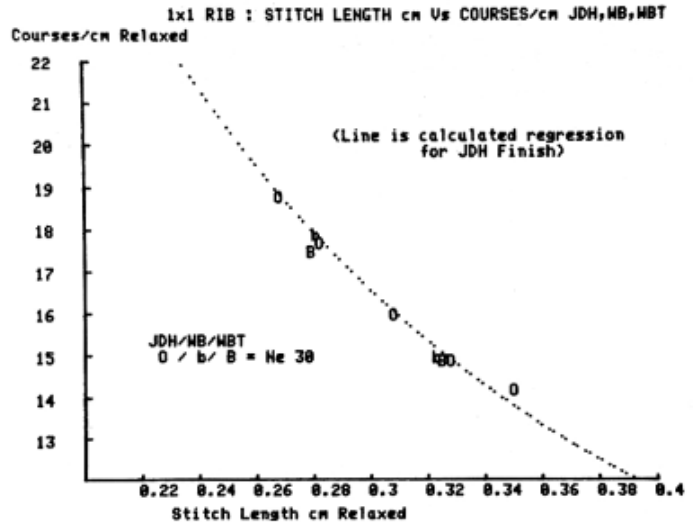

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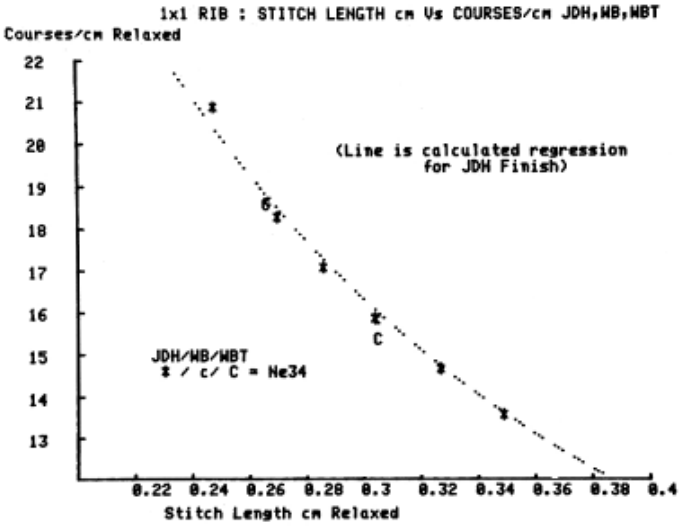

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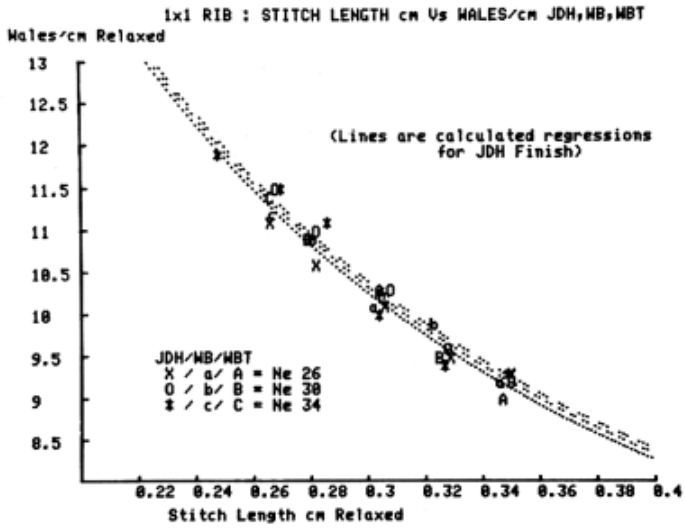

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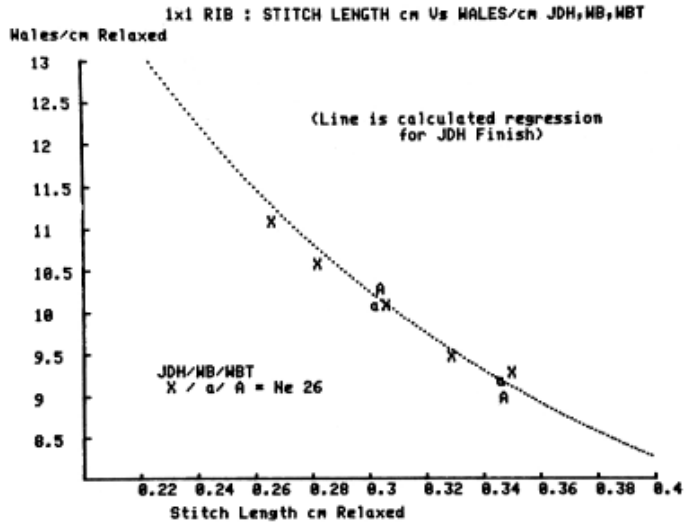

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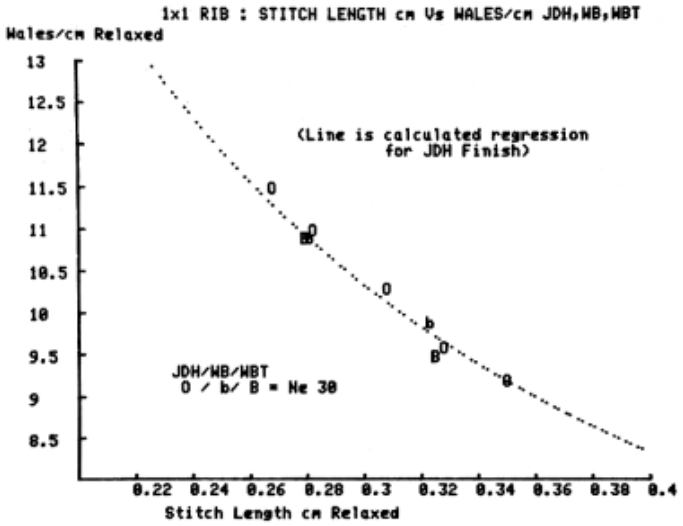

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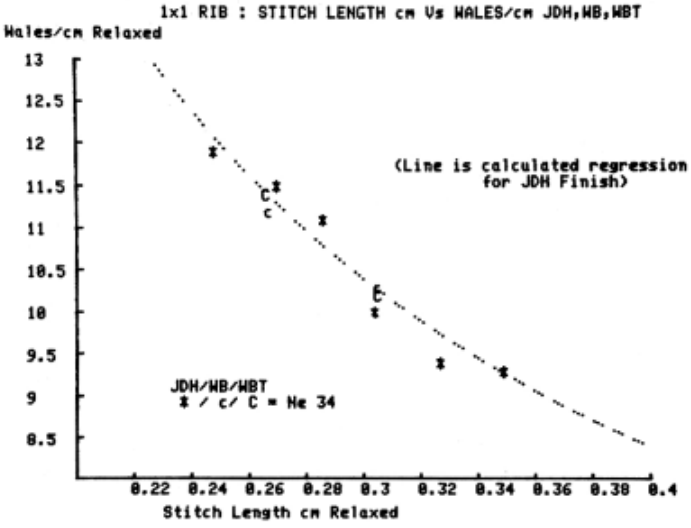

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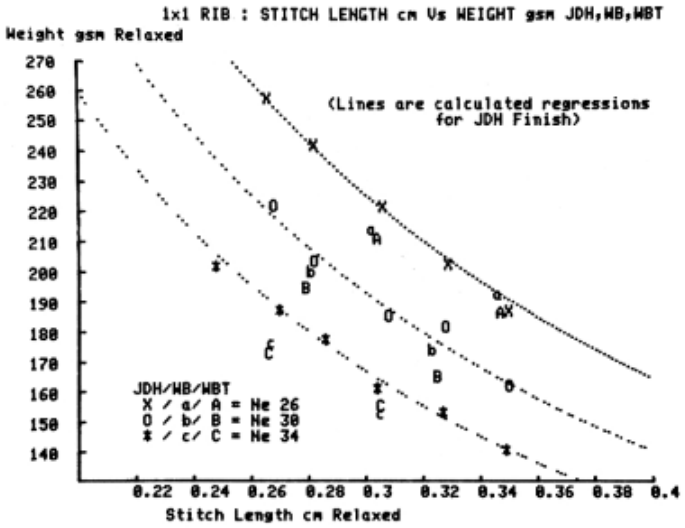

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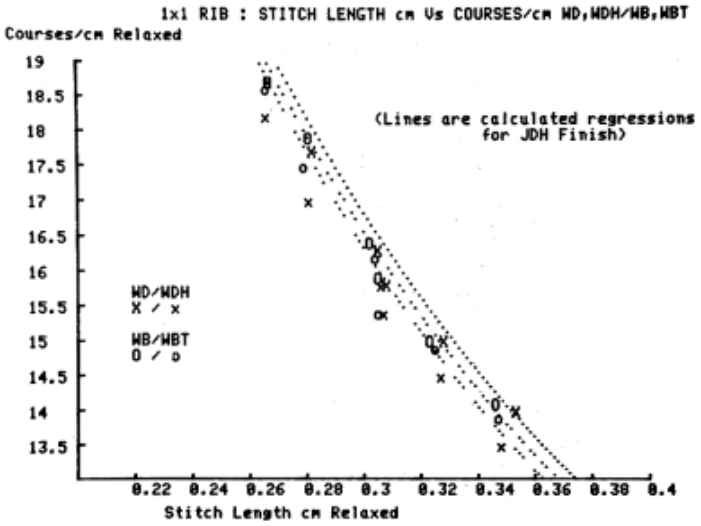

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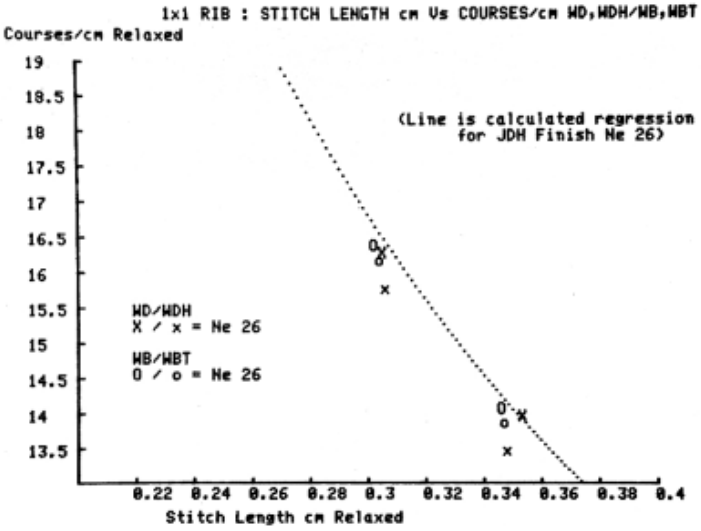

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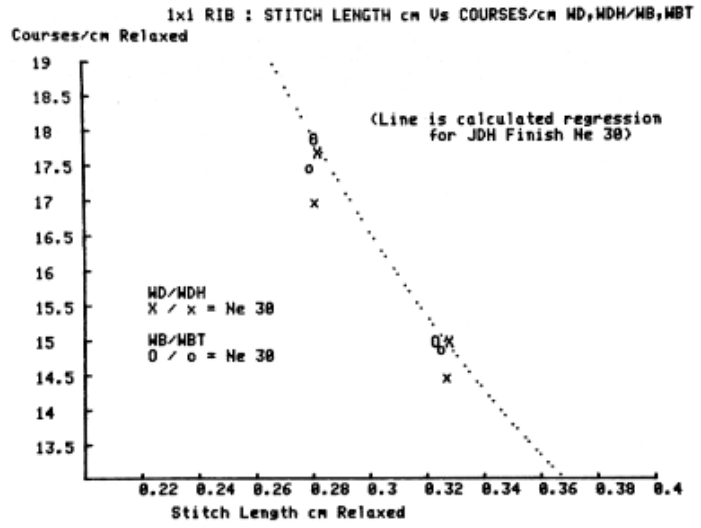

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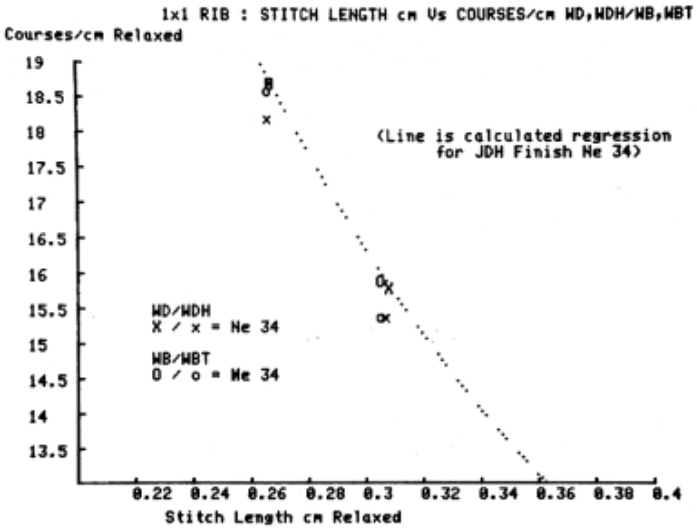

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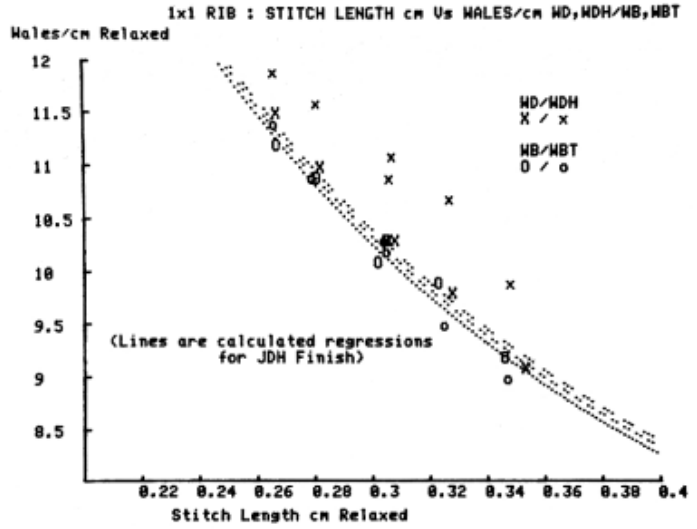

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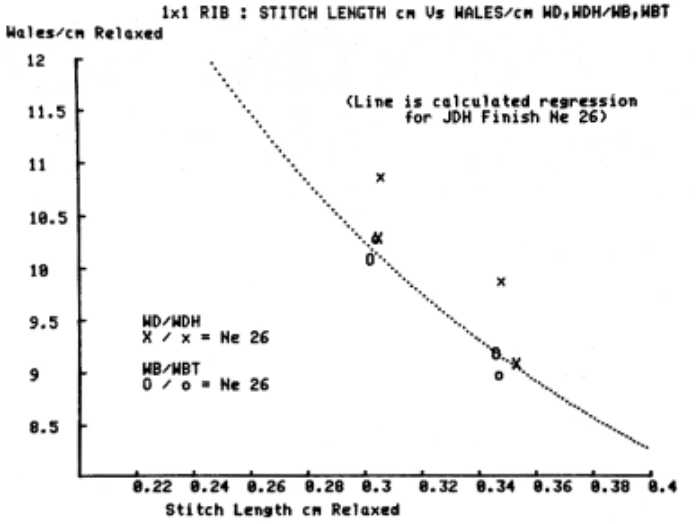

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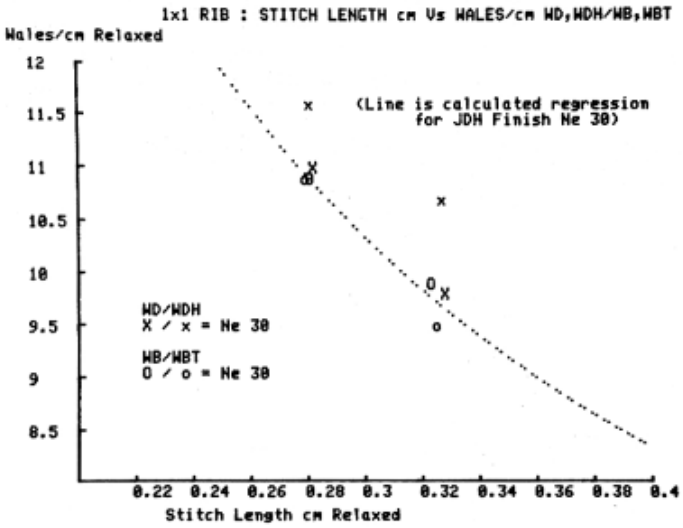

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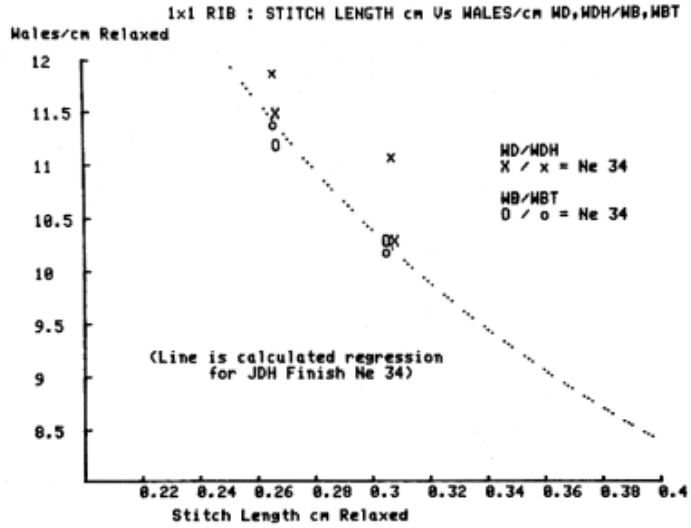

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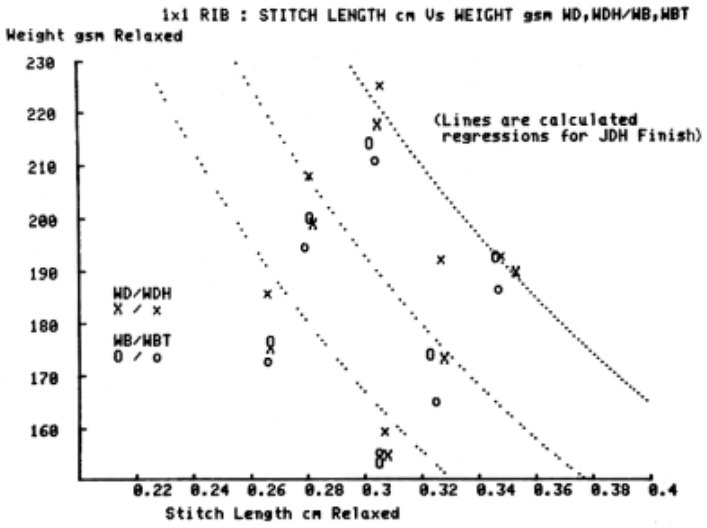

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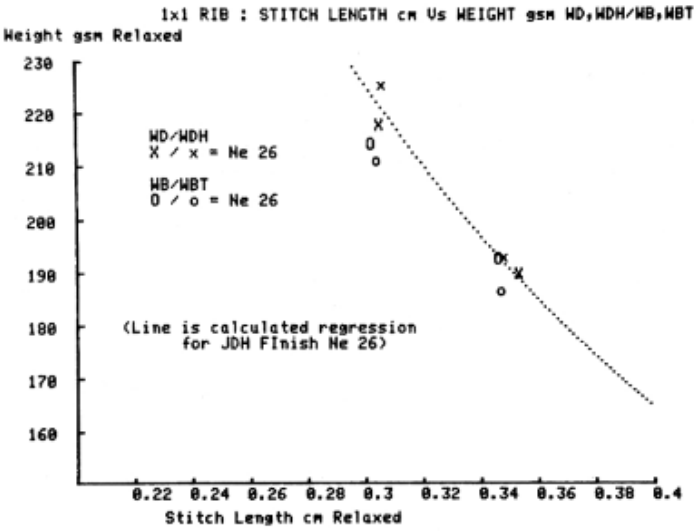

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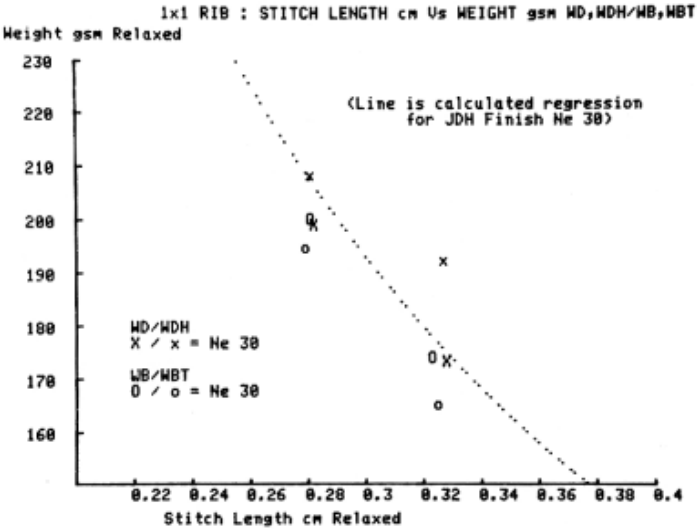

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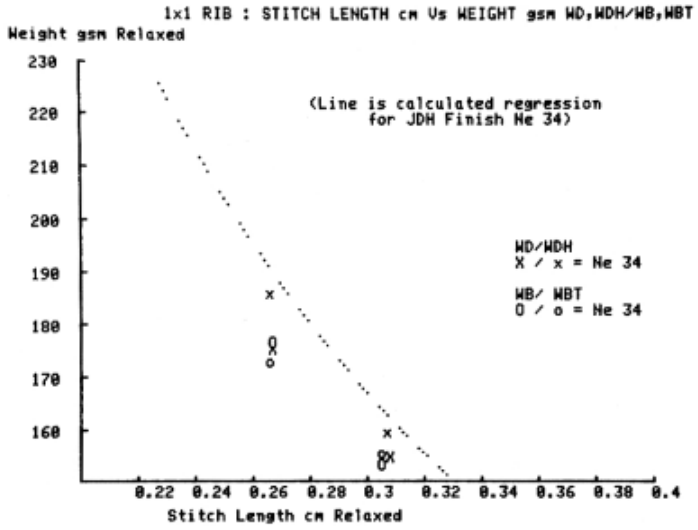

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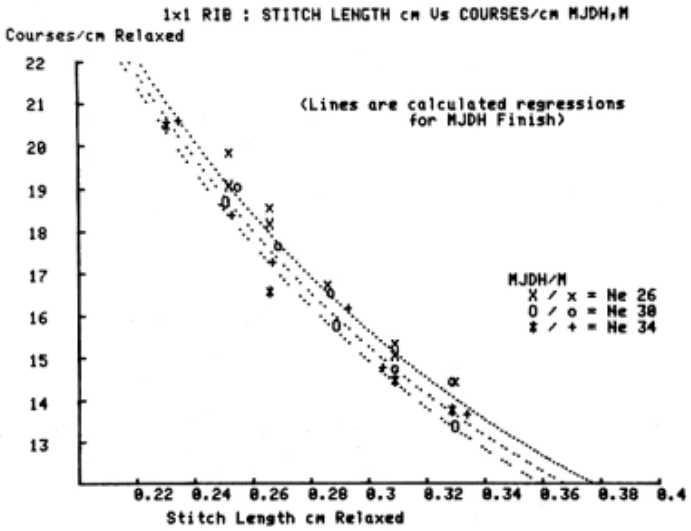

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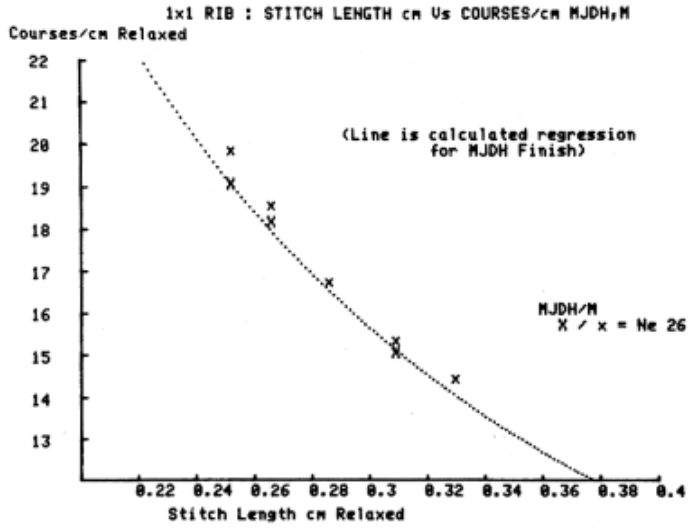

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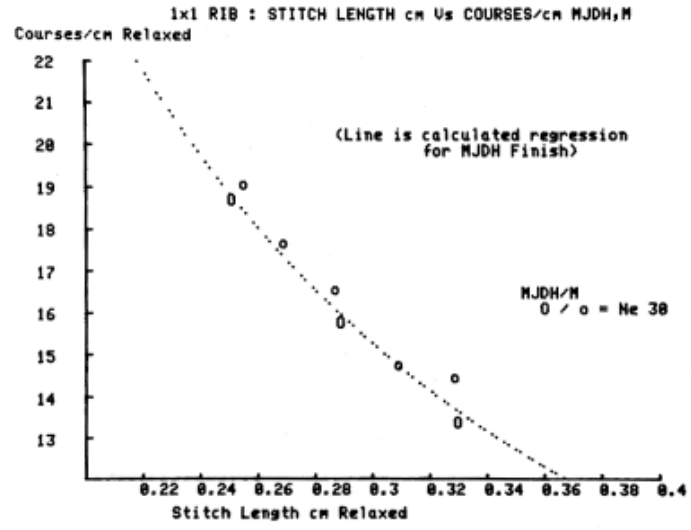

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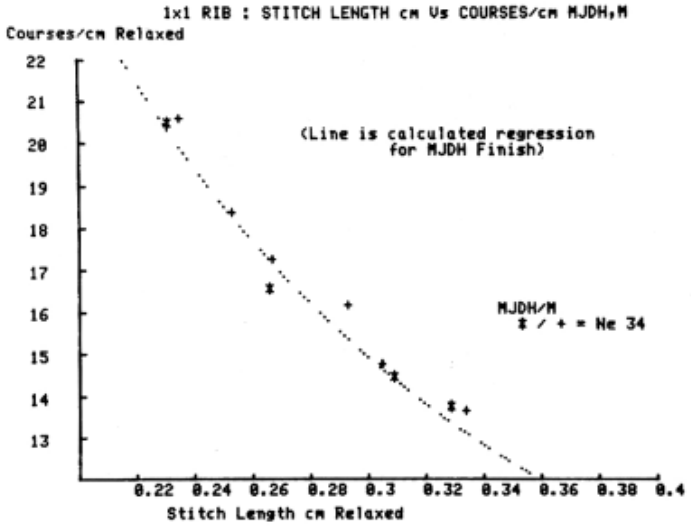

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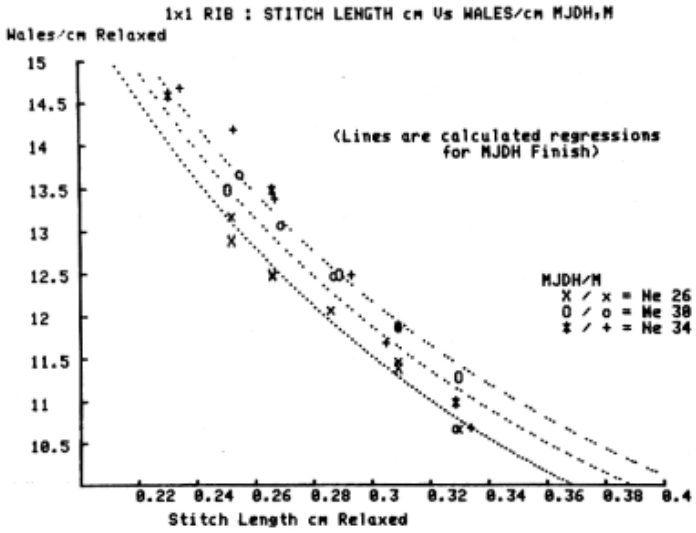

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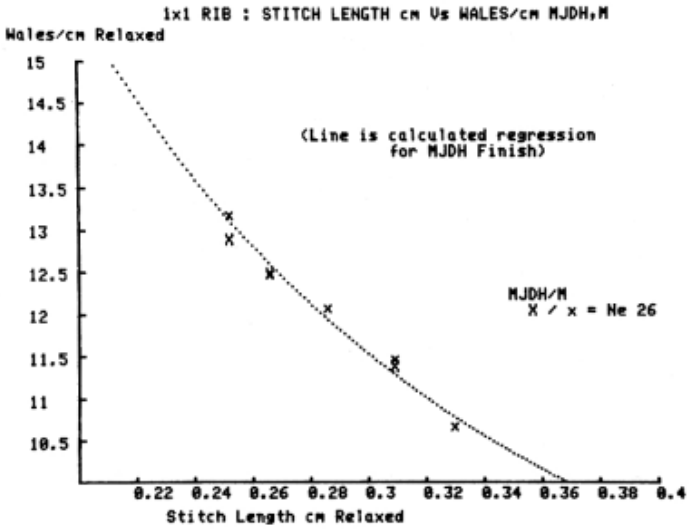

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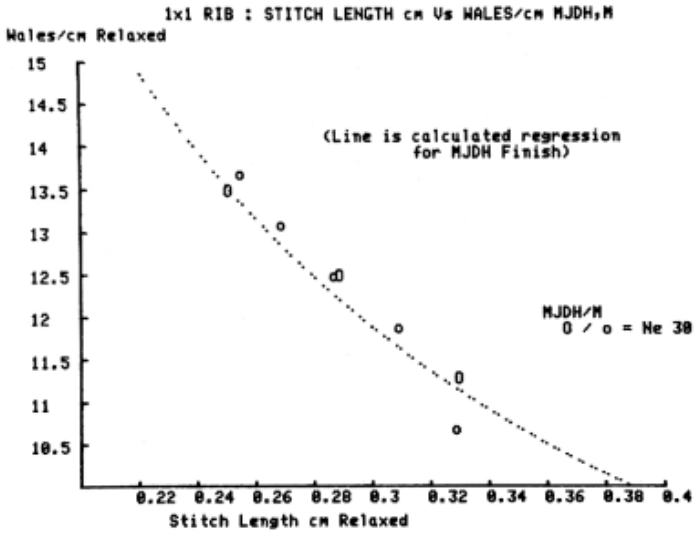

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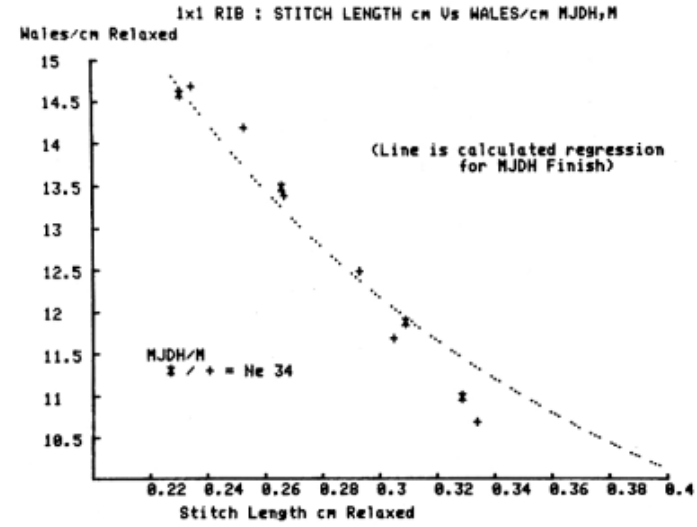

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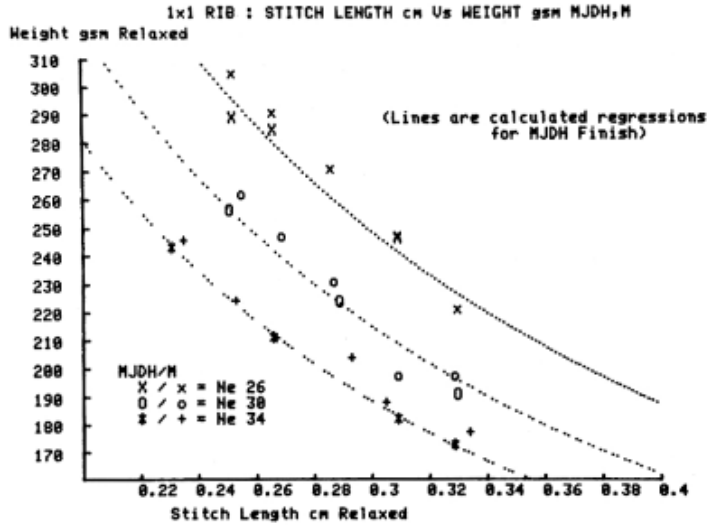

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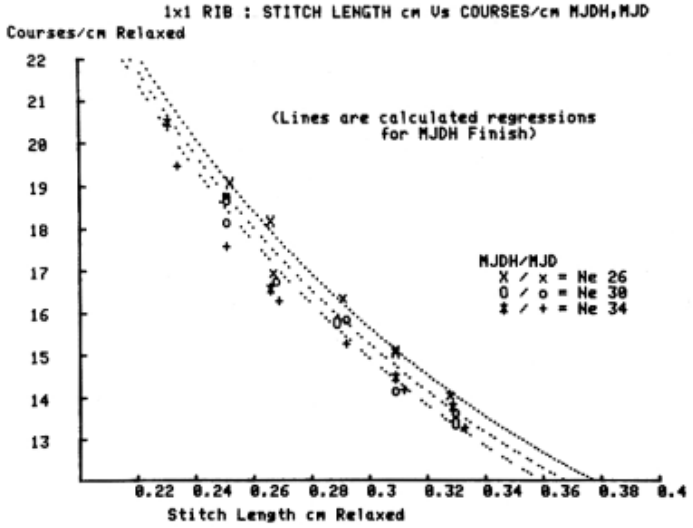

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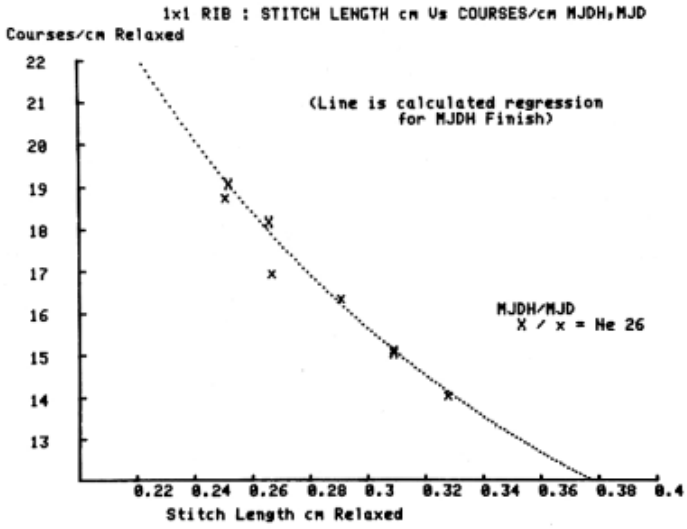

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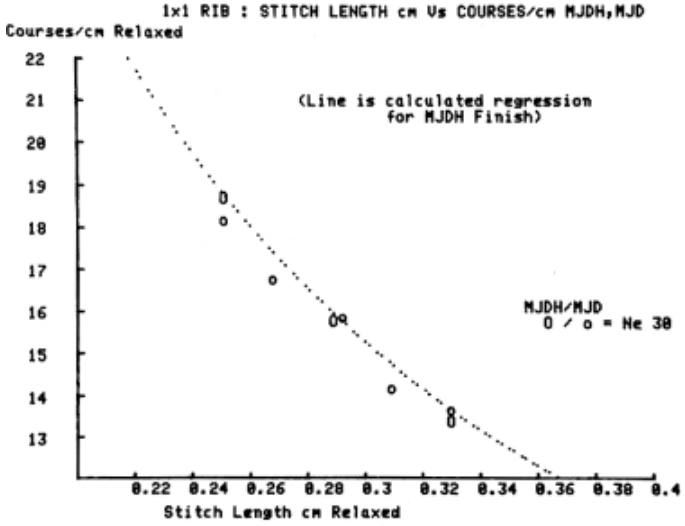

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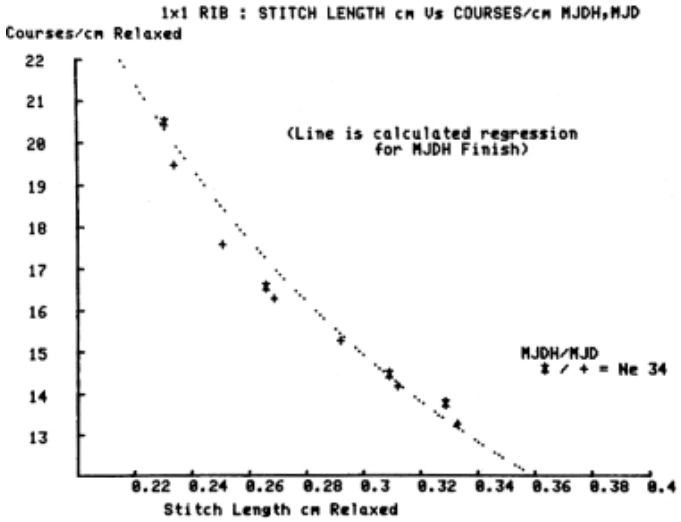

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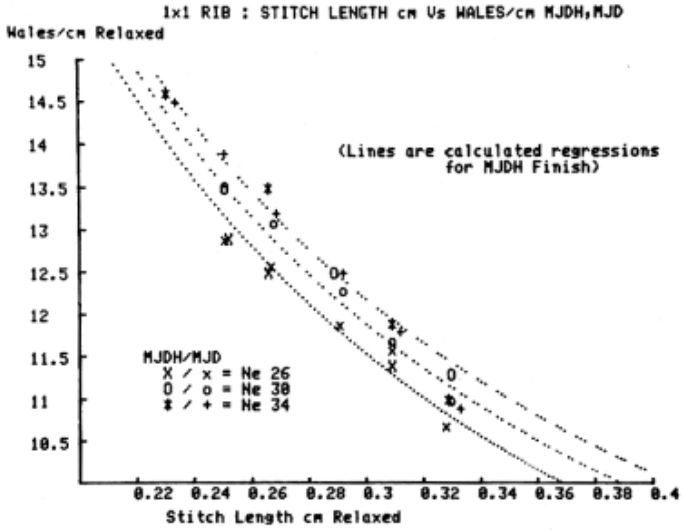

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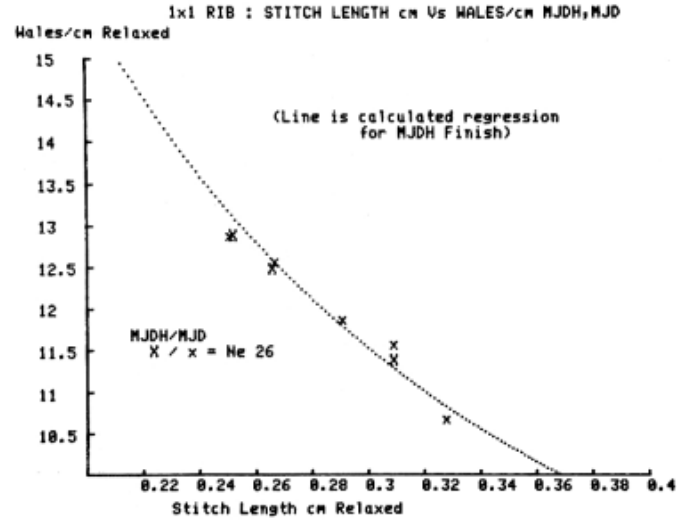

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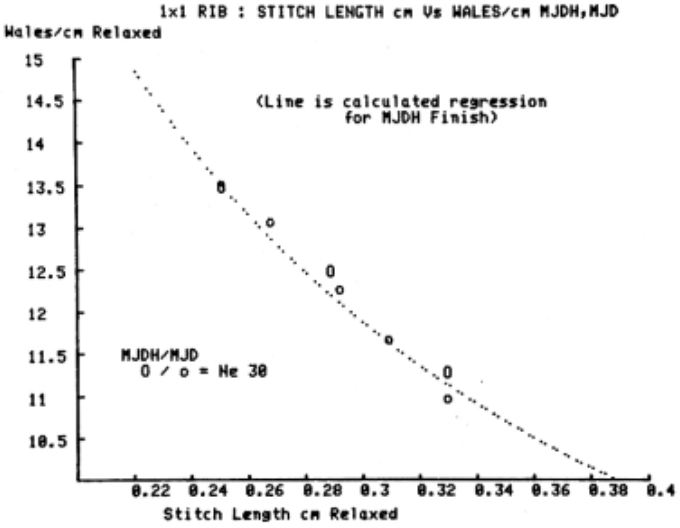

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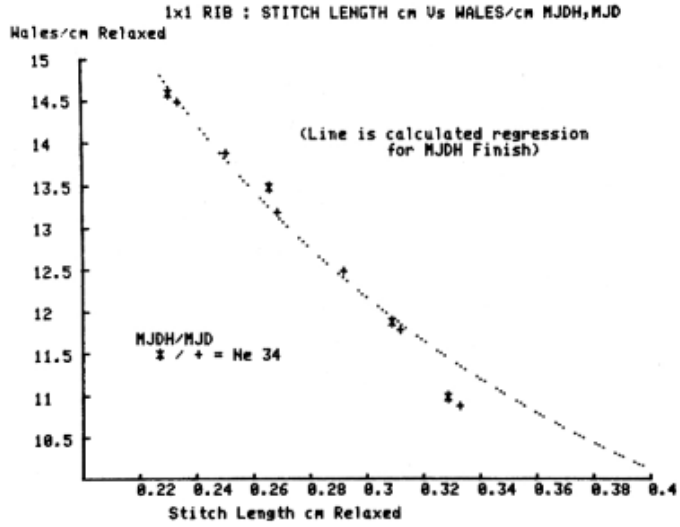

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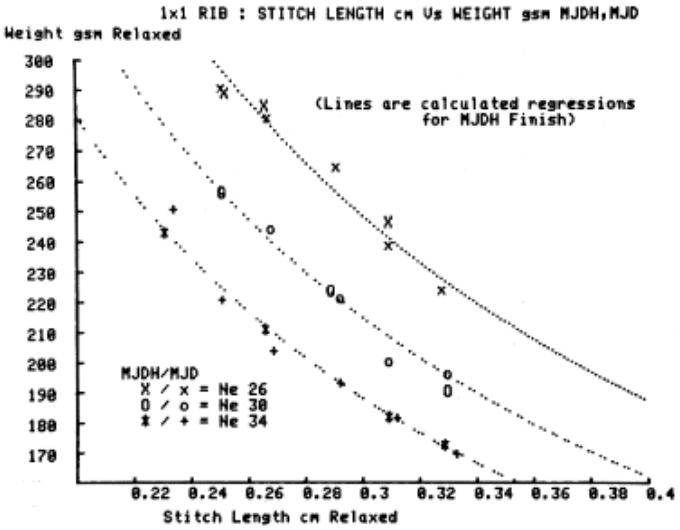

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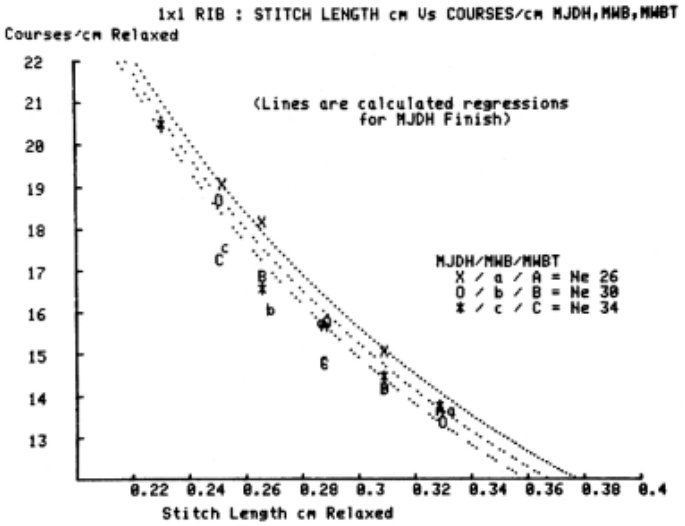

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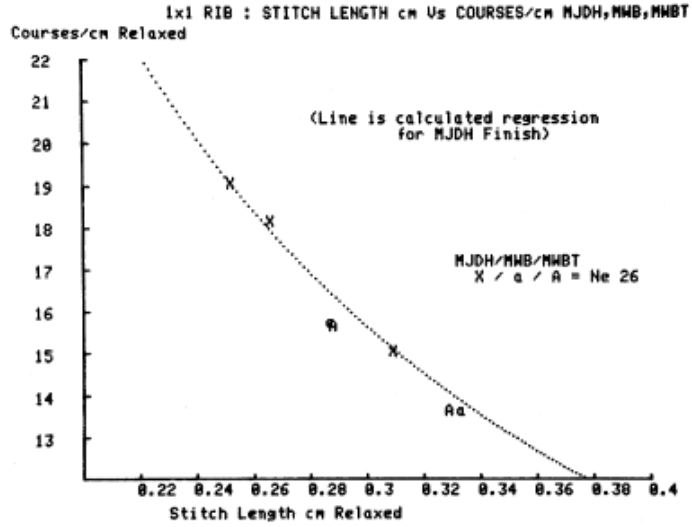

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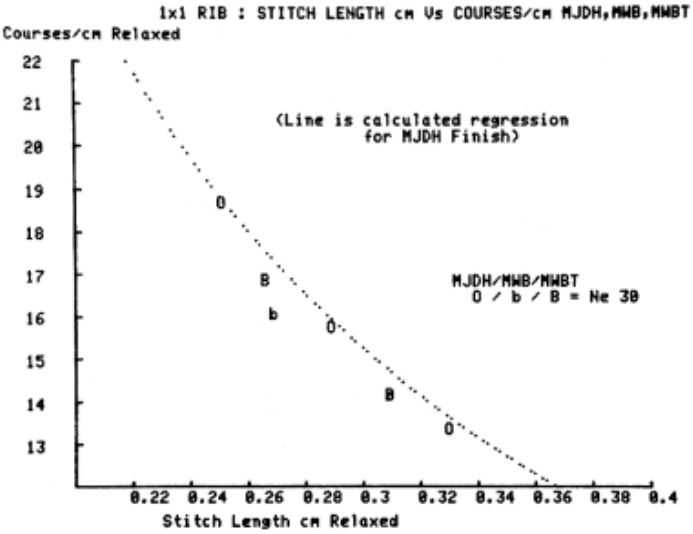

Figure 208

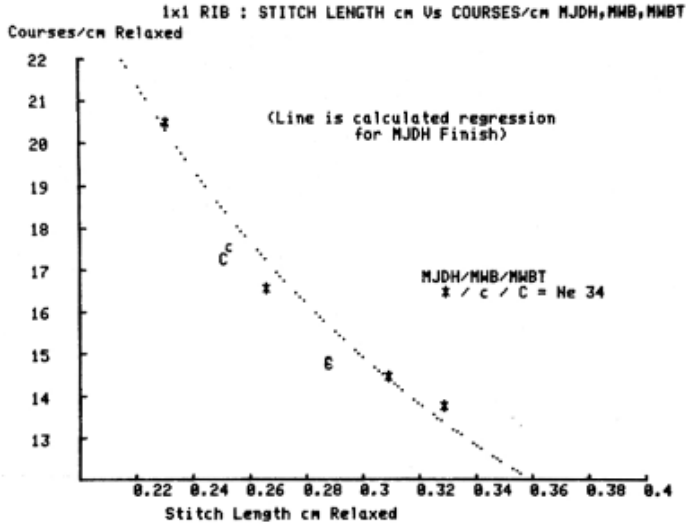

Figure 209

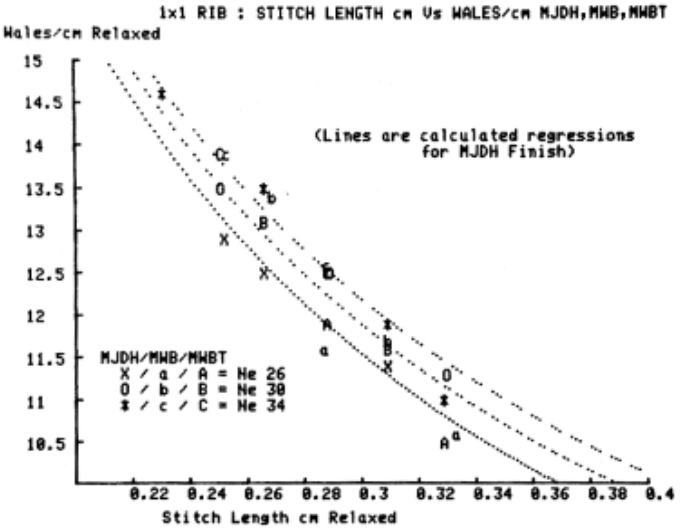

Figure 210

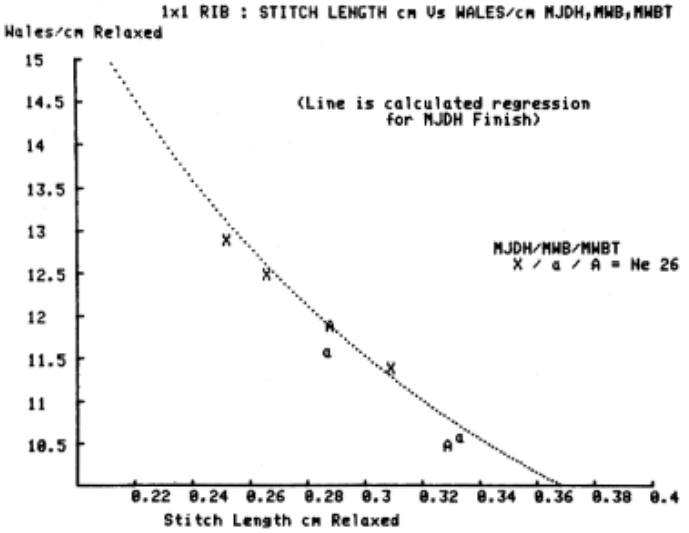

Figure 211

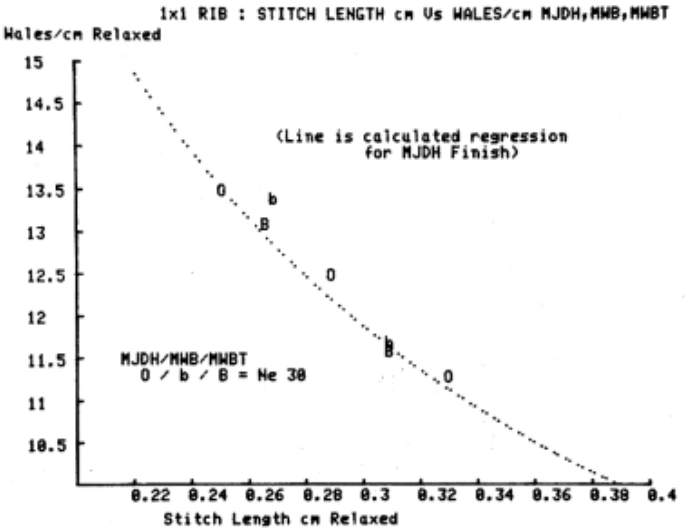

Figure 212

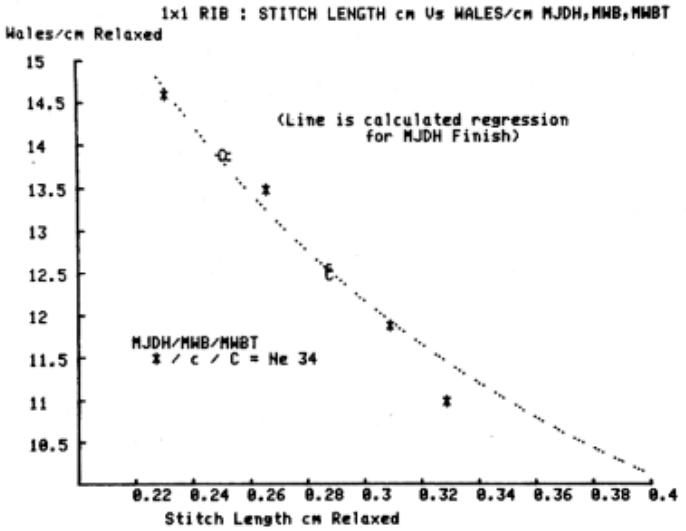

Figure 213