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# EVALUATION OF DUPONT AND CHEMSTRAND NYLON YARN

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Carpenter Litho & Prtg. Co., Springfield, O.
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FOREWORD

This report was prepared by the Textiles Branch and was initiated under Project No. 7320, "Air Force Textile Materials", Task No. 73201, "Textile Materials for Parachutes". It was administered under the direction of the Materials Laboratory, Directorate of Research, Wright Air Development Center, with 1st Lt Peter Y. Stanton acting as project engineer.

This report covers work from November 1954 to May 1956.

# ABSTRACT


The investigation undertaken herein was two phase, namely:

1. To compare nylon yarns of various deniers manufactured by the E. I. duPont de Nemours and Company with nylon yarns of the same denier manufactured by the Chemstrand Corporation.

2. The service testing of personnel parachutes of which the canopy material was fabricated from Chemstrand nylon and the remainder of the parachute fabricated from duPont nylon as a comparison to the same type parachutes fabricated wholly from duPont nylon.

A comparison of the nylon yarns manufactured by duPont with the nylon yarns manufactured by Chemstrand shows no meaningful difference between the two with regard to breaking strength, tenacity, elongation, energy absorption and melting point. Also, a comparison of the high and low temperature characteristics of the yarns manufactured by both companies shows no real difference between the two with regard to the properties investigated.

Service tests have shown that the parachutes fabricated from Chemstrand yarn in the canopy are equal in performance to those manufactured wholly from duPont yarn.


## PUBLICATION REVIEW

This report has been reviewed and is approved:

FOR THE COMMANDER:

C. A. Willis

C. A. WILLIS
Chief, Textiles Branch
Materials Laboratory
Directorate of Research

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## Section I

## INTRODUCTION AND OBJECTIVES

In 1952 duPont's patent rights on nylon "66" expired which, in turn, allowed any other company to produce this yarn. At the present time only one company other than duPont, namely the Chemstrand Corporation, is producing nylon "66" in filament form.

During the period when duPont was the only producer of nylon "66", the yarn properties were held at a satisfactory level. The introduction of a new nylon producer made it essential to make sure that the product was of the same quality as that of duPont. It may seem obvious that if two yarns are chemically alike and manufactured by essentially the same process there should be no difference between them. However, the end items into which the yarns will be fabricated, such as safety restraining webbing, parachute materials, and aircraft overrun barriers, make it essential that the highest quality of production be adhered to.

The comparison of Chemstrand and duPont nylon yarns contained herein was two-phase, namely:

1. The laboratory evaluation of producers yarns with regard to breaking strength, tenacity, energy absorption, elongation, and melting point.

2. The service testing of personnel parachutes of which the canopy material was fabricated from Chemstrand nylon and the remainder of the parachute fabricated from duPont nylon as a comparison to the same type parachutes fabricated wholly from duPont nylon.

Six different denier nylon yarns, namely, 30, 40, 70, 100, 210, and 840, produced by both duPont and Chemstrand, were initially investigated for breaking strength and elongation. Of these six deniers, four (namely, 30, 100, 210 and 840) were evaluated at various temperatures for breaking strength, tenacity, energy absorption and elongation.

A study of the effect of temperature on various textile fibers was accomplished in 1953 by Fabric Research Laboratories, Inc., under Contract AF 33(038)-22932 and is presented in Wright Air Development Center Technical Report 55-21, "A Study of the Effect of Temperature on Textile Fibers". This study, however, did not compare the properties of nylon yarn manufactured by different manufacturers nor did this study investigate all the denier yarns presented in this report.

Manuscript released by the author April 1957 for publication as a WADC Technical Report.

Section II

## MATERIALS EVALUATED

The following nylon yarns were preliminarily investigated:

Manufactured by the E. I. duPont de Nemours and Company

| Nominal Denier | Actual Denier | Filaments | Type* | Merge |
|---|---|---|---|---|
| 30** | 29.791 | 10 | 200 | 752 |
| 40 | 39.998 | 13 | 200 | 740 |
| 70 | 69.798 | 34 | 300 | 753 |
| 100 | 101.074 | 34 | 300 | 696 |
| 210 | 209.023 | 34 | 300 | 703 |
| 840 | 827.850 | 140 | 300 | 670 |

* Type: 200 signifies normal tenacity (4.6-5.3 g/d)
300 signifies high tenacity (6.1-7.4 g/d)

** This 30 denier yarn is a special merge for Air Force application and has a tenacity of approximately 5.5 g/d which is slightly above the tenacity of the normal yarn.

Manufactured by the Chemstrand Corporation

| Nominal Denier | Actual Denier | Filaments | Type* | Bobbin Ident. |
|---|---|---|---|---|
| 30 | 30.774 | 10 | SD | 63985 |
| 30 | 30.125 | 10 | HSD | 63983 |
| 40 | 40.124 | 13 | SD | 63981 |
| 70 | 71.105 | 34 | B | 63984 |
| 100 | 100.667 | 34 | HB | 63980 |
| 210 | 209.988 | 34 | HB | 63982 |
| 840 | 846.080 | 140 | HB | 63986 |

* SD - normal tenacity semi dull
B - normal tenacity bright
HSD - high tenacity - semi dull
HB - high tenacity - bright

Representative curves of tenacity vs elongation of these yarns are shown in Figures 1 through 6.

The following yarns chosen from those initially investigated were evaluated with regard to breaking strength, tenacity, energy absorption, and elongation under high and low temperature conditions:

**duPont**

| Denier | Type |
|---|---|
| 30 | 200 (special merge) |
| 100 | 300 |
| 210 | 300 |
| 840 | 300 |

**Chemstrand**

| Denier | Type |
|---|---|
| 30 | HSD |
| 100 | HB |
| 210 | HB |
| 840 | HB |

Only one bobbin of each denier yarn was evaluated. In view of this it should not be construed that a random sample of each denier yarn was chosen.

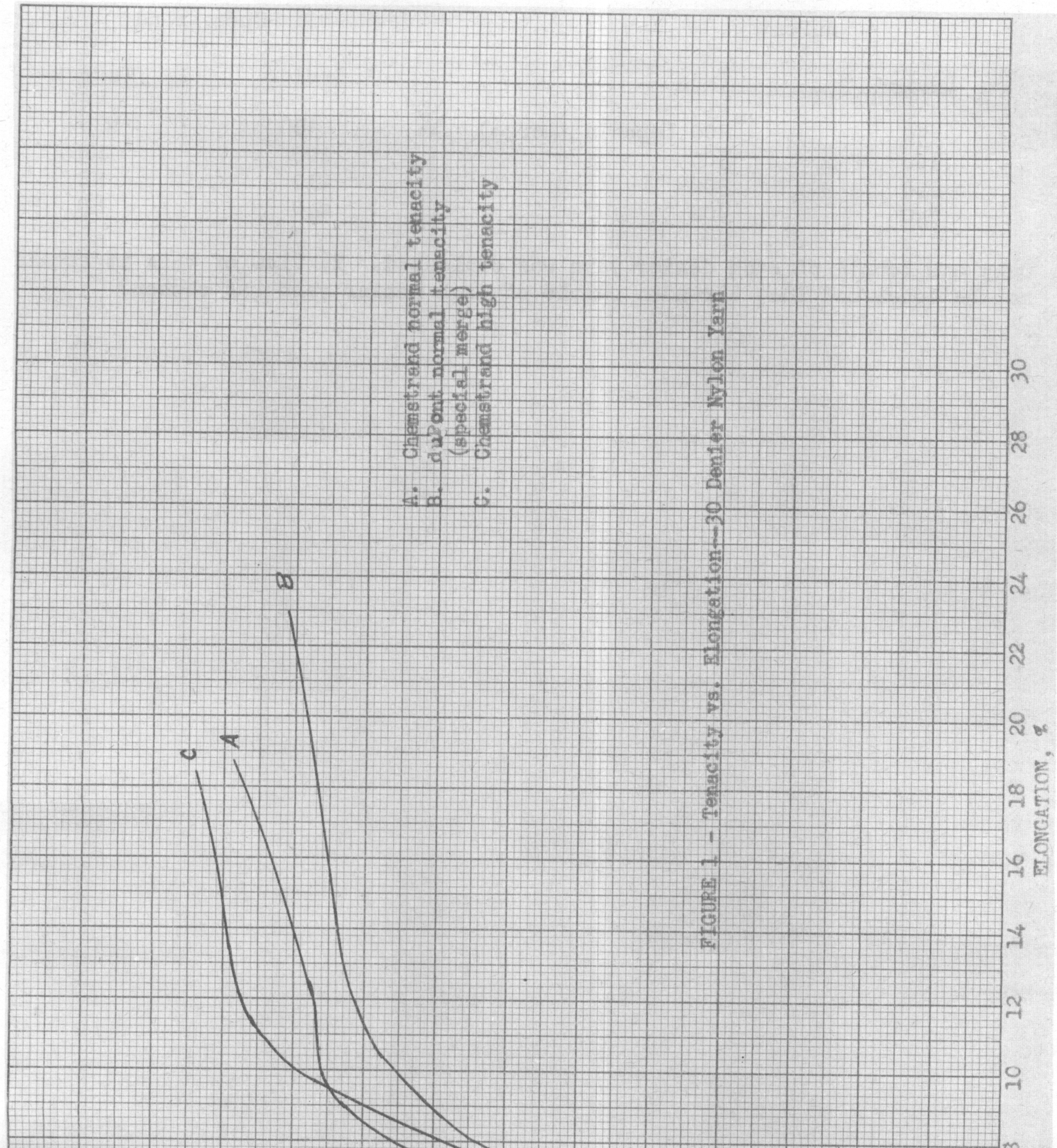


FIGURE 1 - Tenacity vs. Elongation--30 Denier Nylon Yarn

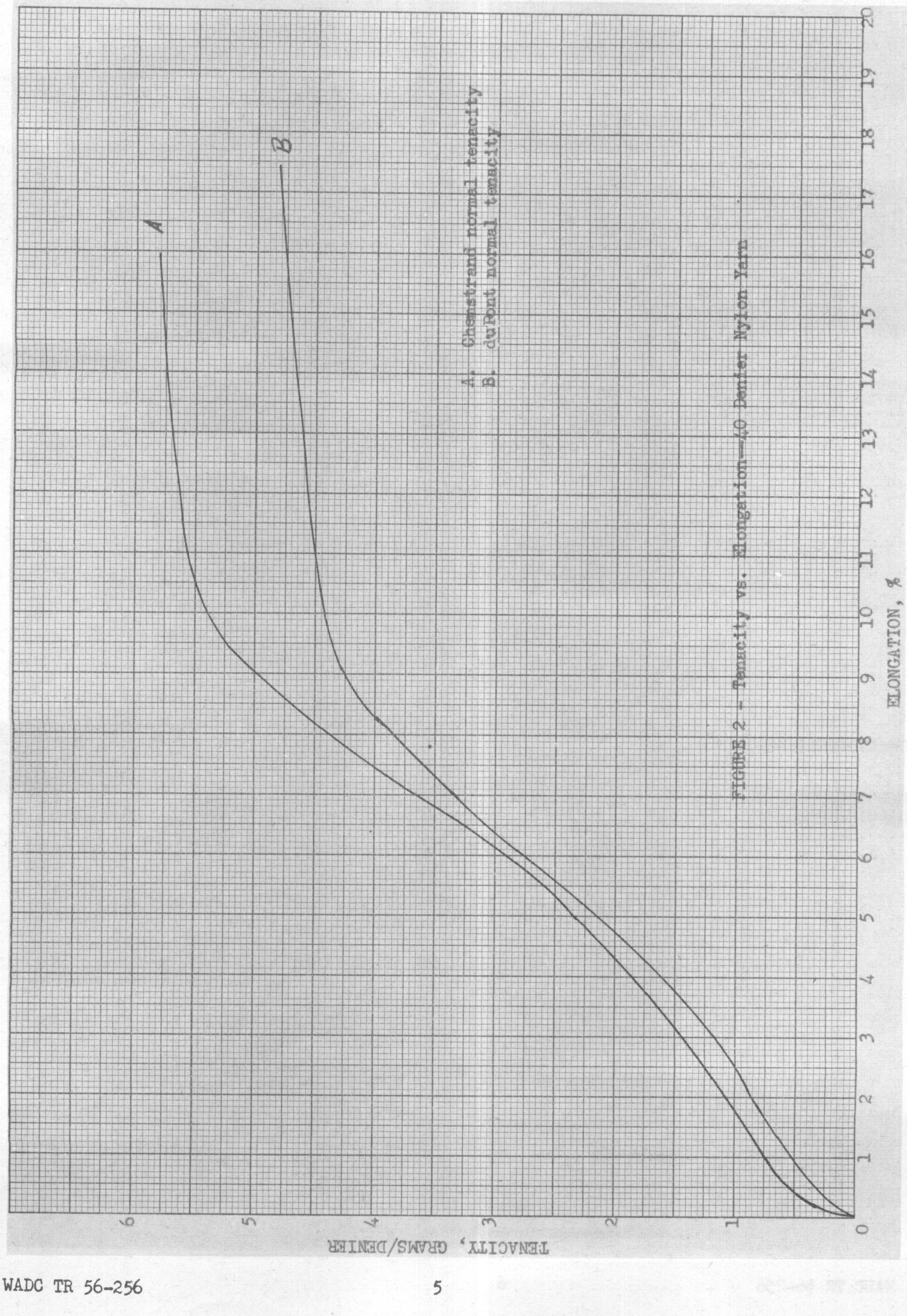


FIGURE 2 - Tenacity vs. Elongation—40 Denier Nylon Yarn

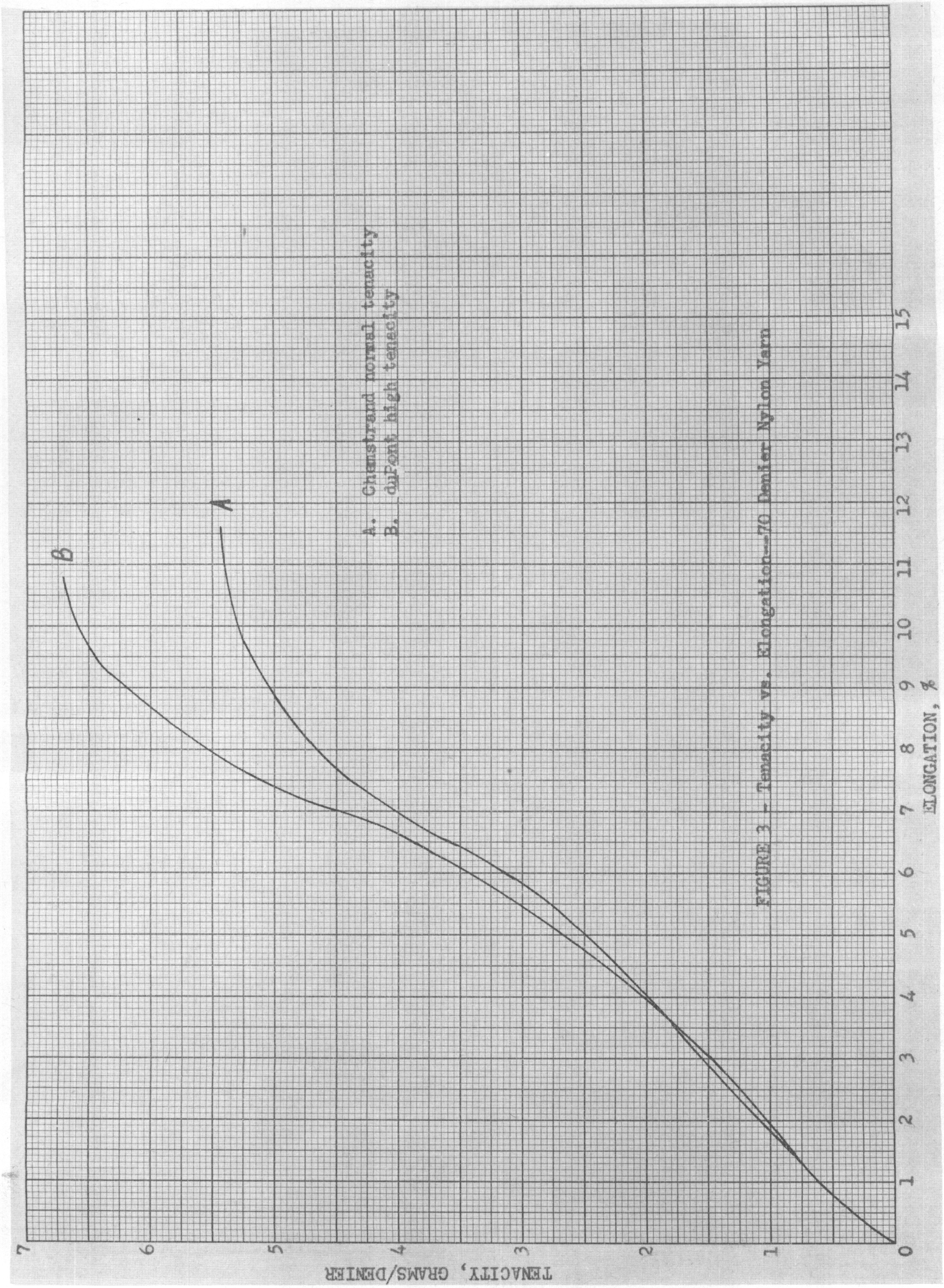


FIGURE 3 - Tenacity vs. Elongation--70 Denier Nylon Yarn

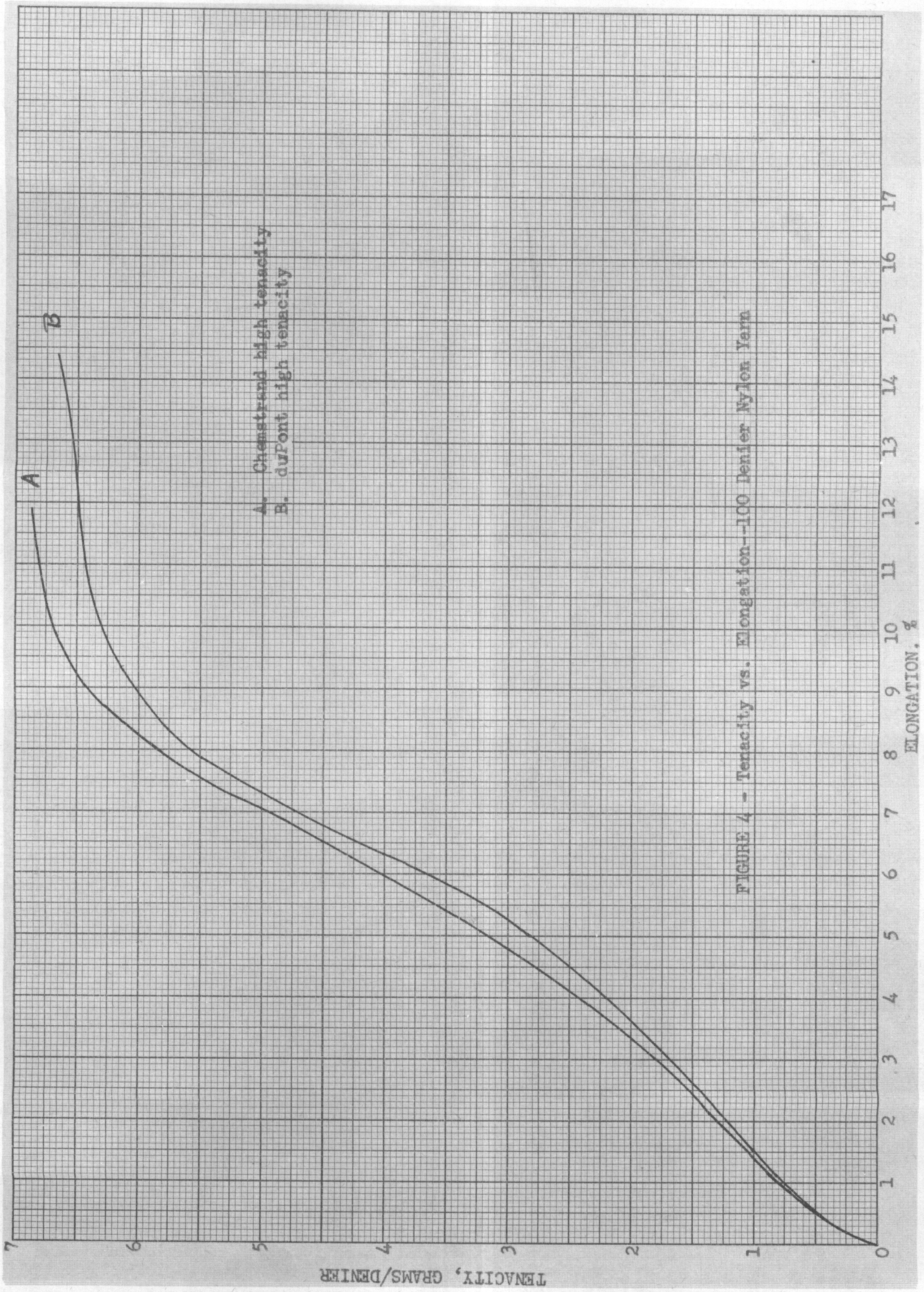


FIGURE 4 - Tenacity vs. Elongation--100 Denier Nylon Yarn

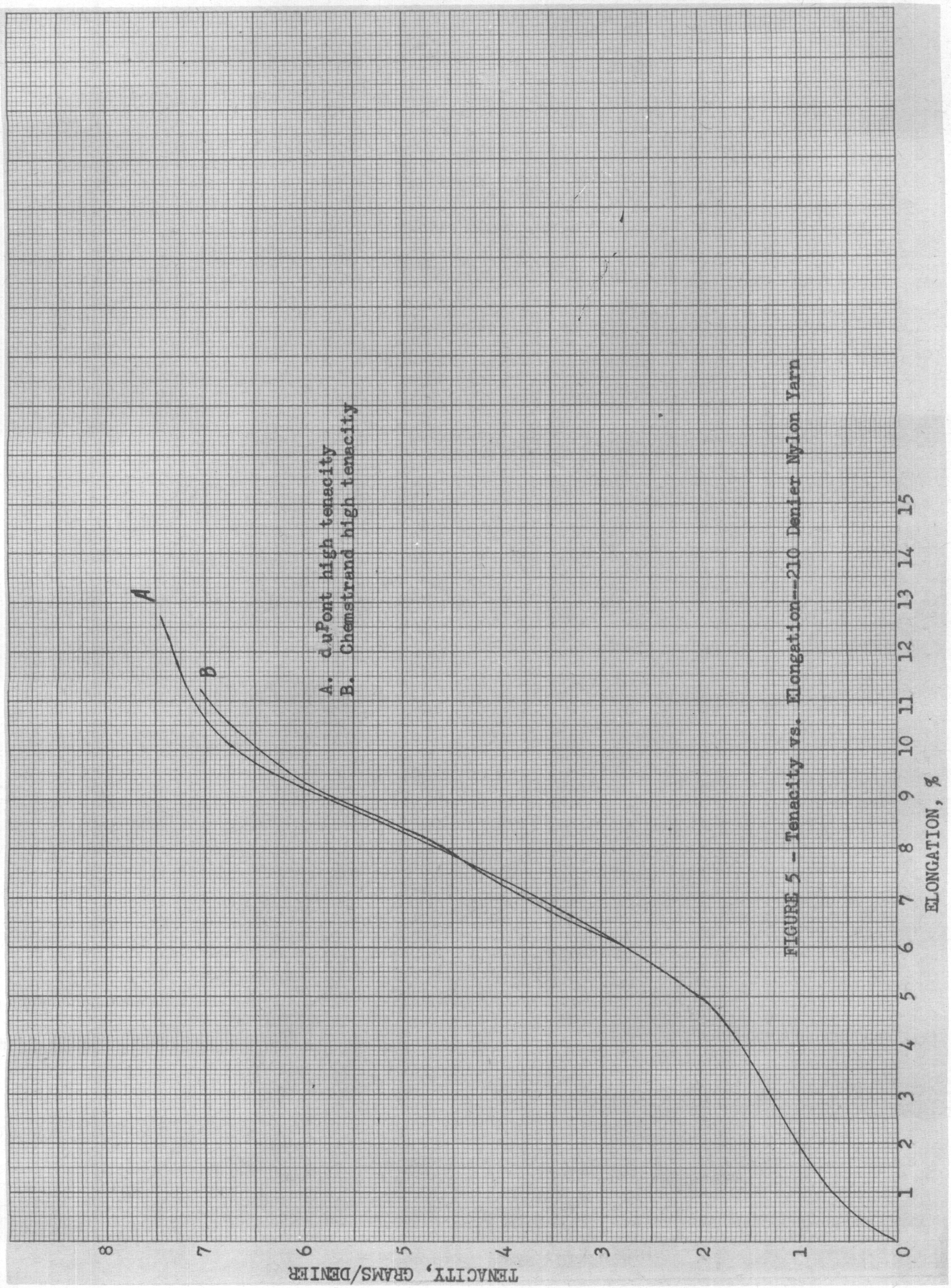


FIGURE 5 - Tenacity vs. Elongation--210 Denier Nylon Yarn

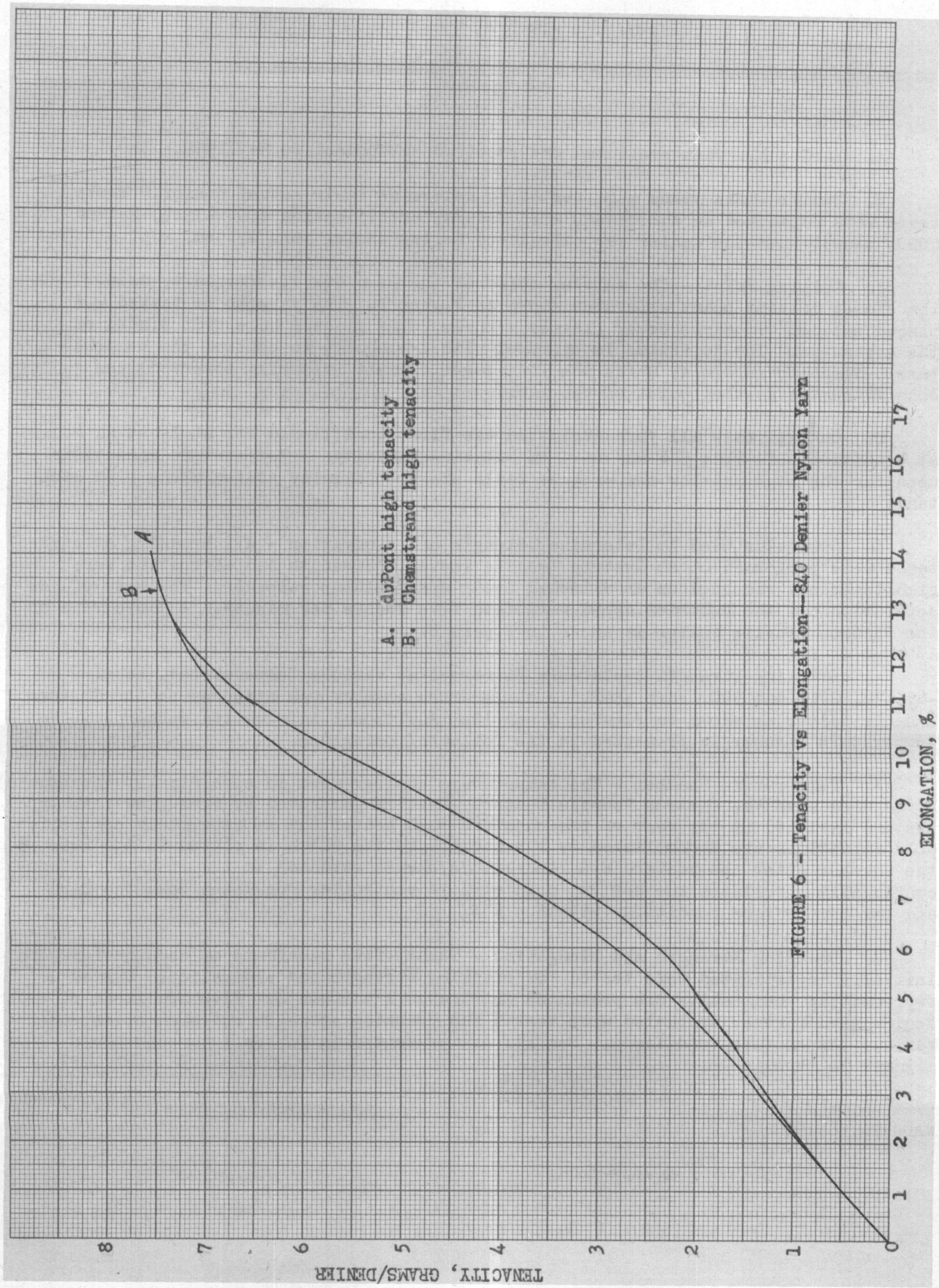


FIGURE 6 - Tenacity vs Elongation--840 Denier Nylon Yarn

# Section III

## PROCEDURES

A. Yarn - All yarn evaluated was received subsequent to May 1954.

B. Denier - All yarns were tested to determine their actual denier. These tests were conducted in accordance with Federal Specification CCC-T-191b, Method 4020, except that the denier was calculated on the denier yarn system.

C. Melting Point - The melting point of the yarn was determined by using the Fisher melting point apparatus shown in Figure 7. The yarn to be tested was placed between two micro cover glasses. These cover glasses were then placed on the apparatus. The apparatus is equipped with a rheostat to control the temperature. The temperature at which the yarn began to melt (visually observed) was considered the melting point of the yarn.

D. Conditions - All yarn evaluated was first conditioned for at least 24 hours at conditions of $70 \pm 5^{\circ}F$ and $65 \pm 5\%$ Relative Humidity. Temperature conditions used for the high and low temperature tests are specifically stated along with each test.

E. Apparatus Used to Determine Strength and Elongation - All breaking strength tests were performed on an Instron Tensile Tester. Strength and elongation were simultaneously recorded on an attached Leeds and Northrup recorder. The rate of jaw separation and the recorder speed were both five inches per minute. A photograph of the Instron Tensile Tester is shown in Figure 8.

Breaking strength tests were performed at various temperatures, namely, -65, 72, 200, and 300, each $\pm 5^{\circ}F$. A temperature chamber was attached to the Instron Tensile Tester as shown in Figures 9 and 10. Additional information concerning the temperature chamber is presented in the following paragraph.

F. Temperature Chamber - The temperature chamber used is specifically constructed to be used with the Instron Tensile Tester. Heat is generated by five glow coil type heaters situated at the rear of the chamber. Each heater can be separately controlled. Cold conditions are accomplished by the use of dry ice which is placed in the rear of the chamber after the heaters are removed. A blower attached to the chamber continually circulates the hot or cold air. A controller regulates both the high and low temperature conditions within $\pm 5^{\circ}F$.

G. Breaking Strength and Elongation - Twenty-five specimens of each denier yarn initially investigated were tested for breaking strength and elongation. Curves representing the results are presented in Figures 1 through 6. Five specimens of each denier yarn further evaluated were tested for breaking strength and elongation under various temperature conditions. Results are presented in Tables 1 through 4 and Figures 11 through 18.

The length of yarn between jaws (bite to bite) before testing was always ten inches. The type jaws used are shown in Figure 10.

Each specimen tested at elevated temperature was first attached by one end to the upper jaw of the tester. The specimen was then allowed to condition for one minute at the testing temperature. The other end of the specimen was thereafter attached to the lower jaw of the tester and the yarn was allowed to condition at testing temperature for an additional two minutes. Consideration was not given to the time it takes the chamber to again reach testing temperature after closing its door since this time varied with the heater settings. However, when investigated, this time appeared to be no greater than 60 seconds.

Each specimen tested at -65°F was attached to both jaws and allowed to condition at the testing temperature for four minutes. Again, the time taken to reach testing temperature after closing the door of the chamber was not considered since this time varied. However, when investigated this time appeared to be no greater than 75 seconds.

H. Tenacity - Tenacity was calculated for each denier yarn. The following formula was used:

$$\text{Tenacity (grams/denier)} = \frac{\text{Breaking strength of yarn (grams)}}{\text{Actual denier of yarn}}$$

Tenacity of the yarns is presented in tabular form in Tables 1 through 4.

I. Energy Absorption: Energy absorption of the yarns was investigated as a function of three factors, namely, manufacturer, denier, and temperature.

Energy absorption was examined up to two different stresses, namely:

1. Yield point
2. Maximum load point

The yield point is shown as Point D in Figure 19.

The energy absorption was calculated by taking the area under the stress-strain curve up to the yield and maximum load points. An approximation of this area was made by taking the area of a triangle most nearly representing this area under the curve. An example of this is shown in Figure 19.

A statistical analysis of the energy absorption characteristics of the yarns up to the two stresses was accomplished and is presented in Tables 5 through 8. Comments regarding these analyses are presented in the tables.

Investigation of actual stress-strain curves has shown that the energy absorption past the yield point is highly affected by elongation. This is shown in Figure 20 where Point A is the yield point and Point B is the maximum load point. Both curves represent the same type yarn under the same conditions. It can be seen that between Points A and B the elongation is unpredictable, possibly due to some unknown features of the yarn.

Graphical representation of the interaction between temperature x denier, temperature x manufacturer, and denier x manufacturer is shown in Figures 21 through 23.

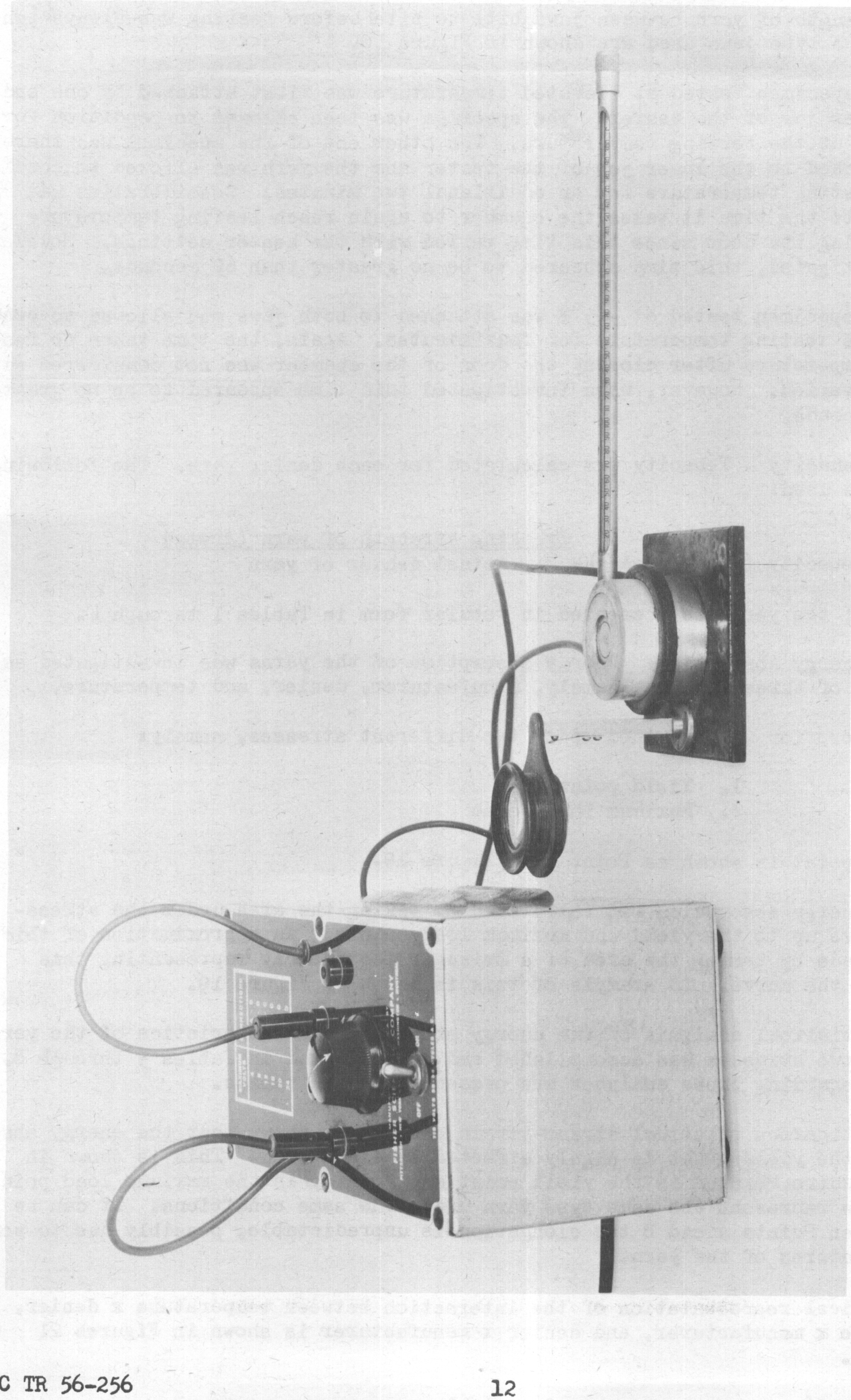

FIGURE 7 - Fisher Melting Point Apparatus

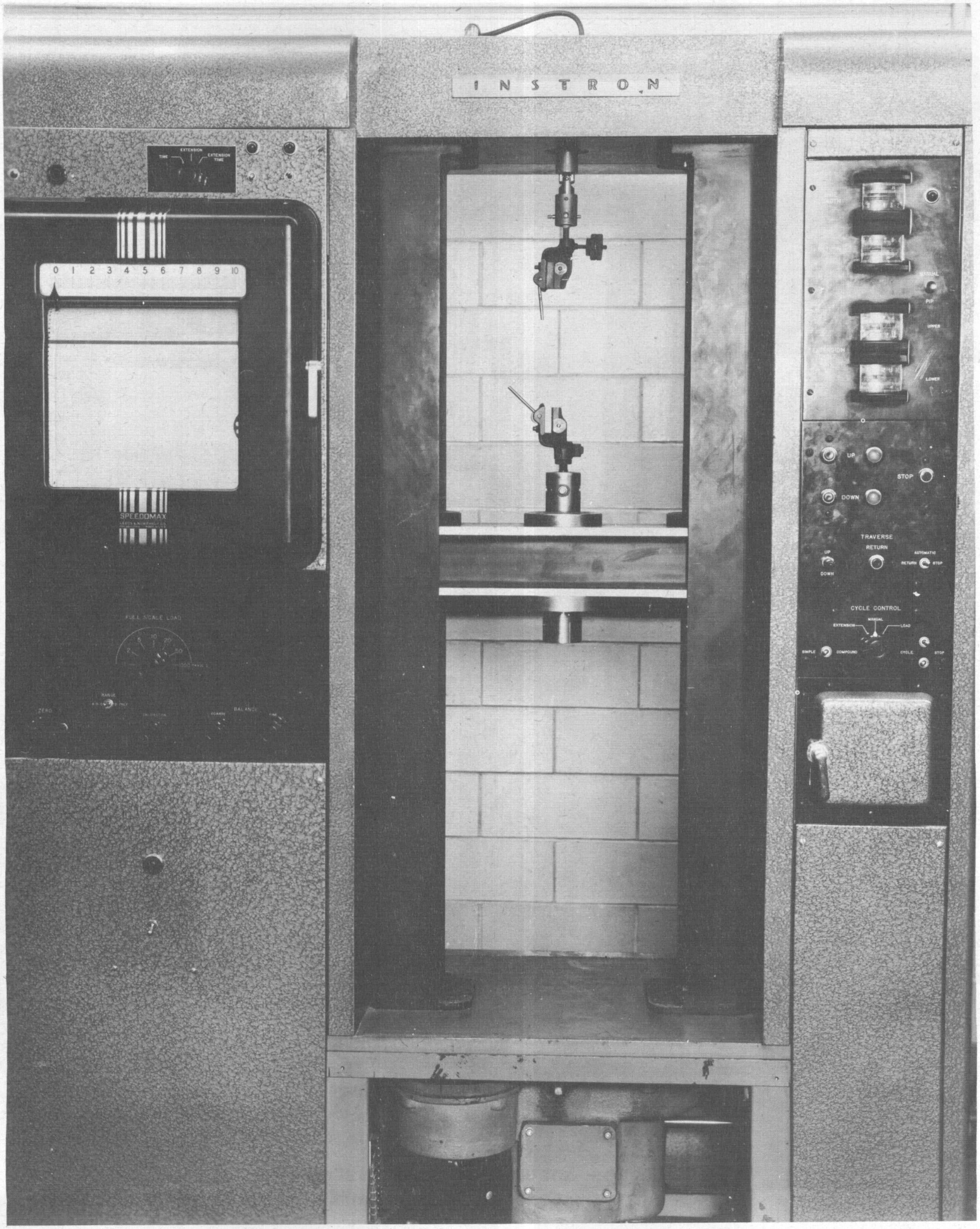


FIGURE 8 - Instron Tensile Tester

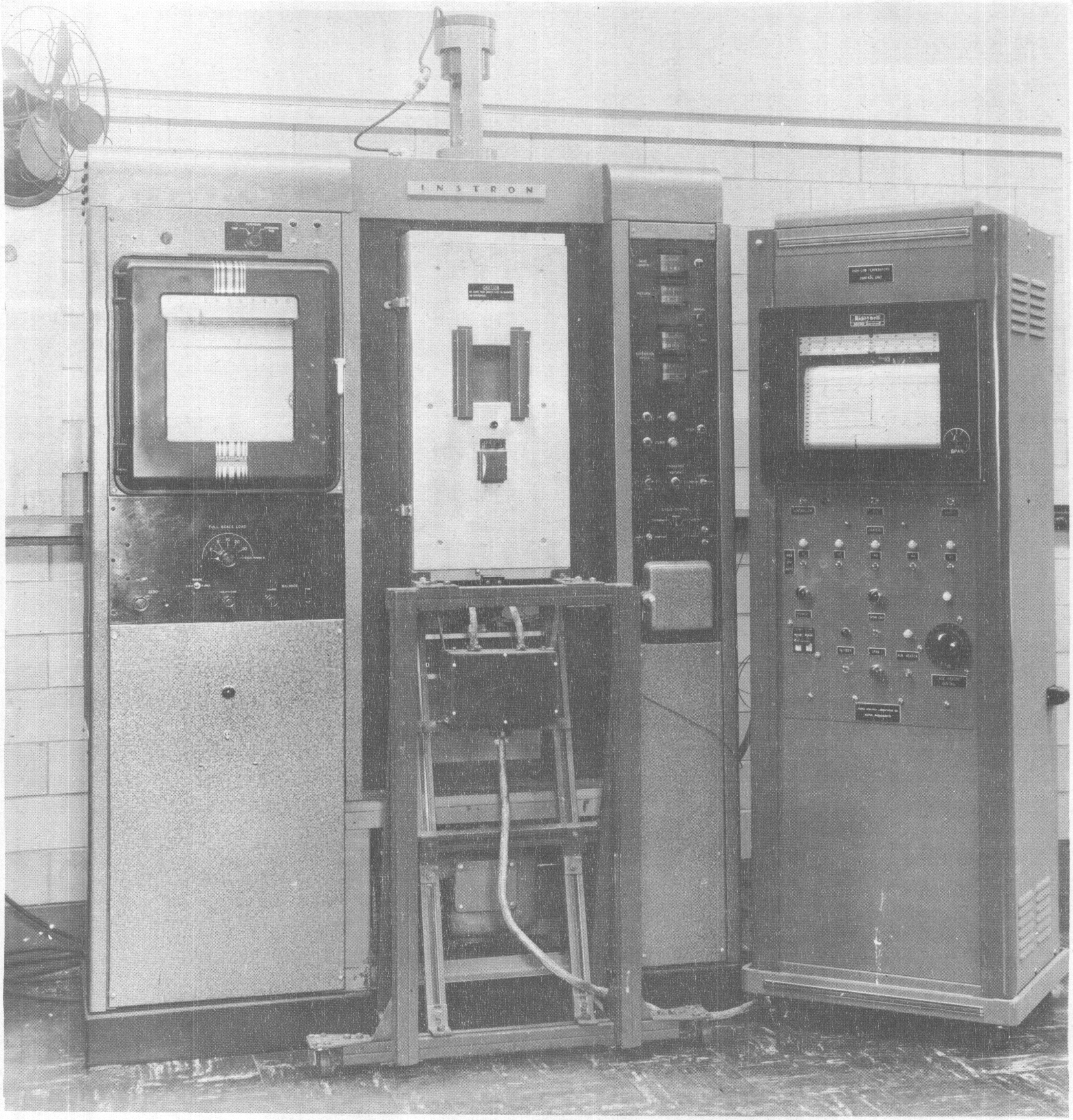


FIGURE 9 - Instron Tensile Tester and
Attached Temperature Chamber

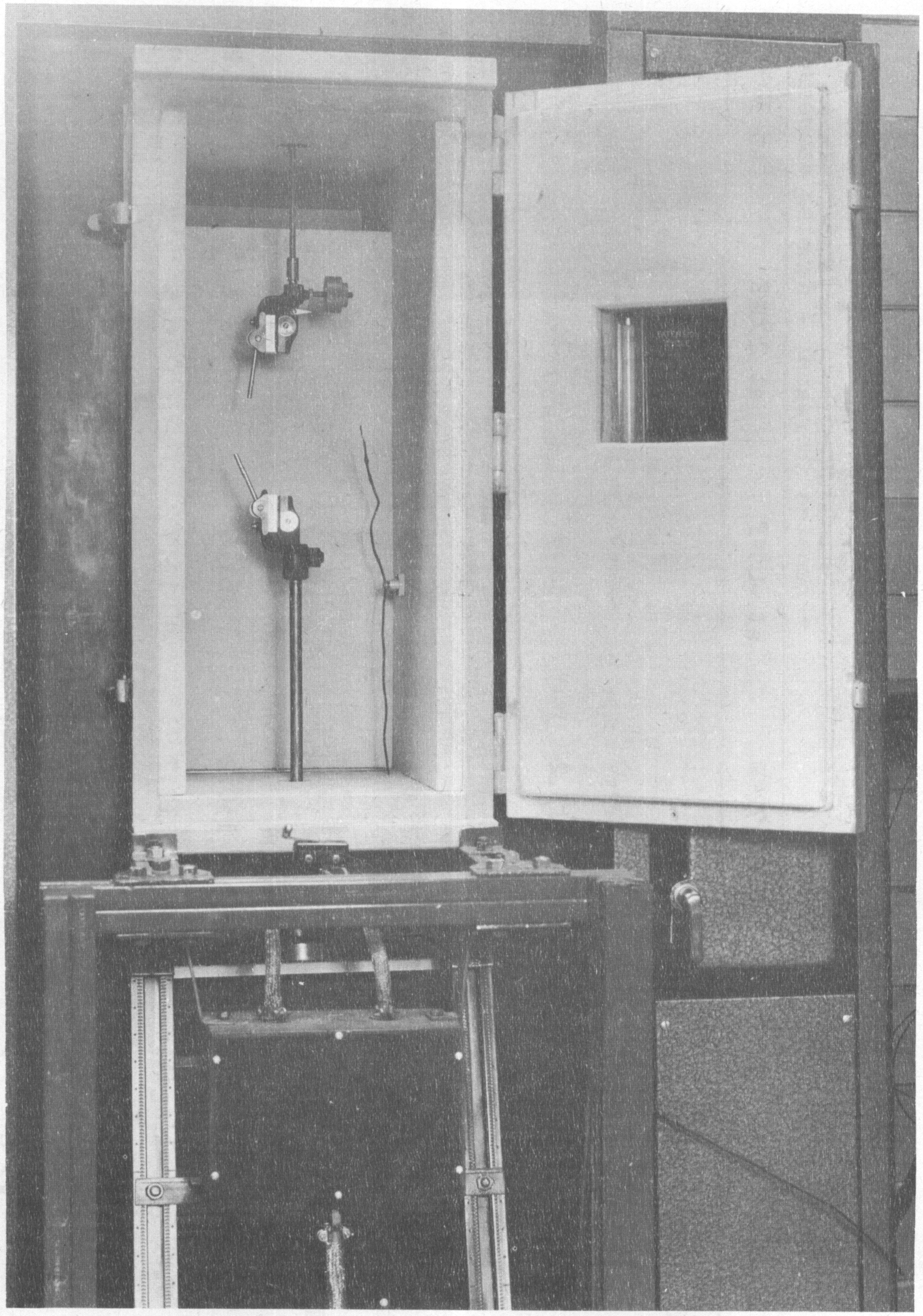

FIGURE 10 - Temperature Chamber

TABLE 1

Properties of 30 Denier Yarns at Various Temperatures

+ denotes increase; - denotes decrease

| Yarn | Property | at 72°F | at -65°F | at 200°F | at 300°F |
|---|---|---|---|---|---|
| 30 denier - Type 200* duPont | | | | | |
| | Breaking strength, grams | 158.0 | 250.6 | 128.4 | 84.6 |
| | Ultimate elongation, % | 15.2 | 11.9 | 24.2 | 27.5 |
| | Change in breaking strength from 72°F, % | --- | 58.6+ | 18.7- | 46.5- |
| | Tenacity, grams per denier | 5.3 | 8.4 | 4.3 | 2.8 |
| 30 denier - Type HSD Chemstrand | | | | | |
| | Breaking strength, grams | 150.2 | 261.8 | 132.2 | 89.2 |
| | Ultimate elongation, % | 12.7 | 12.7 | 16.5 | 25.9 |
| | Change in breaking strength from 72°F, % | --- | 74.3+ | 11.9- | 40.6- |
| | Tenacity, grams per denier | 5.0 | 8.7 | 4.4 | 3.0 |

* special merge

TABLE 2

Properties of 100 Denier Yarns at Various Temperatures

+ denotes increase; - denotes decrease

| Yarn | Property | at 72°F | at -65°F | at 200°F | at 300°F |
|---|---|---|---|---|---|
| 100 denier - Type 300 duPont | | | | | |
| | Breaking strength, grams | 641.2 | 963.4 | 529.0 | 380.8 |
| | Elongation, % | 11.0 | 9.5 | 14.7 | 24.7 |
| | Change in breaking strength from 72°F, % | --- | 33.5+ | 17.4- | 40.6- |
| | Tenacity, grams per denier | 6.3 | 9.5 | 5.2 | 3.8 |
| 100 denier - Type HB Chemstrand | | | | | |
| | Breaking strength, grams | 594.0 | 898.4 | 475.8 | 340.0 |
| | Ultimate elongation, % | 11.5 | 10.7 | 14.4 | 20.7 |
| | Change in breaking strength from 72°F, % | --- | 33.9+ | 19.9- | 42.8- |
| | Tenacity, grams per denier | 5.9 | 8.9 | 4.7 | 3.4 |

TABLE 3

Properties of 210 Denier Yarns at Various Temperatures

+ denotes increase; - denotes decrease

| Yarn | Property | at 72°F | at -65°F | at 200°F | at 300°F |
|---|---|---|---|---|---|
| 210 denier - Type 300 duPont | | | | | |
| | Breaking strength, grams | 1490.0 | 2200.0 | 1196.0 | 839.6 |
| | Ultimate elongation, % | 11.0 | 11.8 | 14.8 | 22.4 |
| | Change in breaking strength from 72°F, % | --- | 32.3+ | 19.7- | 43.6- |
| | Tenacity, grams per denier | 7.1 | 10.5 | 5.7 | 4.0 |
| 210 denier - Type HB Chemstrand | | | | | |
| | Breaking strength, grams | 1495.0 | 2286.1 | 1260.0 | 890.6 |
| | Ultimate elongation, % | 11.3 | 12.5 | 15.9 | 22.9 |
| | Change in breaking strength from 72°F, % | --- | 34.6 | 15.7- | 40.4- |
| | Tenacity, grams per denier | 7.1 | 10.9 | 6.0 | 4.2 |

TABLE 4

Properties of 840 Denier Yarns at Various Temperatures

+ denotes increase; - denotes decrease

| Yarn | Property | at 72°F | at -65°F | at 200°F | at 300°F |
|---|---|---|---|---|---|
| 840 denier - Type 300 duPont | | | | | |
| | Breaking strength, grams | 6350.4 | 8609.3 | 5098.5 | 3556.2 |
| | Ultimate elongation, % | 15.1 | 13.0 | 15.8 | 27.2 |
| | Change in breaking strength from 72°F, % | --- | 25.8+ | 19.7 | 44.0- |
| | Tenacity, grams per denier | 7.7 | 10.4 | 6.2 | 4.3 |
| 840 denier - Type HB Chemstrand | | | | | |
| | Breaking strength, grams | 6404.8 | 8654.7 | 5044.0 | 3456.4 |
| | Ultimate elongation, % | 16.3 | 12.6 | 18.5 | 23.6 |
| | Change in breaking strength from 72°F, % | --- | 26.0+ | 21.2- | 46.0- |
| | Tenacity, grams per denier | 7.6 | 10.2 | 6.0 | 4.1 |

TABLE 5

Energy Absorption up to the Maximum Load Point

Energy Absorption = inch-grams/inch denier

| Temperature, °F | MANUFACTURER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | duPont | | | | Chemstrand | | | |
| | Denier Yarn | | | | Denier Yarn | | | |
| | 30 | 100 | 210 | 840 | 30 | 100 | 210 | 840 |
| -65 | .549 | .441 | .581 | .621 | .529 | .465 | .644 | .609 |
| 72 | .579 | .377 | .372 | .568 | .377 | .326 | .354 | .595 |
| 200 | .642 | .435 | .376 | .492 | .434 | .323 | .441 | .392 |
| 300 | .438 | .491 | .446 | .601 | .400 | .353 | .512 | .460 |

Comments:

1. Each figure is a mean value derived from the average of five replications
2. The variance of replications was homogeneous among the groups
3. Pooled variance of replication is .0049 (128 d.f.)

TABLE 6

Analysis of Variance of Energy Absorption up to Maximum Load Point

Energy Absorption = inch-grams/inch denier

| Source | Degrees Freedom | Sum Square | Variance | F Analysis |
|---|---|---|---|---|
| Manufacturer | 1 | .100751 | .100751 | |
| Denier | 3 | .417294 | .139098 | |
| Temperature | 3 | .345434 | .115144 | |
| Manufacturer x Denier | 3 | .137487 | .045829 | |
| Manufacturer x Temperature | 3 | .058575 | .019525 | |
| Temperature x Denier | 9 | .339002 | .037666 | |
| Manufacturer x Denier Temperature | 9 | .118525 | .013169 | 9F128 = 2.70 (1% level 2.56)** |
| Error | 128 | .624108 | .004875 | |
| Total | 159 | 2.141176 | | |

** Significant at 1% level

Comments:

The third order interaction between manufacturer, denier, and temperature was significant. This shows that there are some undefined factors which affect the energy absorption up to the maximum load point.

TABLE 7

Energy Absorption up to the Yield Point

Energy Absorption = inch-grams/inch denier

| Temperature, °F | MANUFACTURER | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | duPont | | | | Chemstrand | | | |
| | Denier Yarn | | | | Denier Yarn | | | |
| | 30 | 100 | 210 | 840 | 30 | 100 | 210 | 840 |
| -65 | .410 | .384 | .526 | .540 | .413 | .389 | .552 | .511 |
| 72 | .213 | .236 | .282 | .380 | .208 | .232 | .269 | .371 |
| 200 | .229 | .252 | .274 | .341 | .246 | .214 | .308 | .300 |
| 300 | .190 | .239 | .267 | .304 | .185 | .224 | .294 | .277 |

Comments:

1. Each figure is a mean value derived from the average of five replications
2. The variance of replication was homogeneous among the groups
3. Pooled variance of replication is .00053 (128 d.f.)

TABLE 8

Analysis of Variance of Energy Absorption up to the Yield Point

Energy Absorption = inch-grams/inch denier

| Source | Degrees Freedom | Sum Square | Variance | F Analysis |
|---|---|---|---|---|
| Manufacturer | 1 | .000869 | .000869 | 1F140 = 1.60 (5% level 3.91) |
| Denier | 3 | .386800 | .128933 | 3F140 = 237.99**(1% level 29.46) |
| Temperature | 3 | 1.233108 | .411036 | 3F140 = 758.37**(1% level 6.99) |
| Manufacturer x Denier | 3 | .011273 | .003757 | 3F140 = 6.93** (1% level 3.94) |
| Manufacturer x Temperature | 3 | .000494 | .000164 | 3F137 = .30 (5% level 2.68) |
| Temperature x Denier | 9 | .074475 | .008275 | 9F140 = 15.27**(1% level 2.53) |
| Manufacturer x Denier x Temperature | 9 | .007407 | .000823 | 9F128 = 1.55 (5% level 1.95) |
| Error | 128 | .068109 | .000532 | |
| Total | 159 | 1.782535 | | |
| New Error 1/ | 137 | .075516 | .000551 | |
| New Error 2/ | 140 | .076010 | .000542 | |

1/ Including original error plus the third order interaction between temperature x manufacturer x denier.

2/ Including new error 1/ plus the second order interaction between manufacturer and temp.

** Significant at the 1% level

Comments:

1. The third order interaction between manufacturer, temperature, and denier is not significant.
2. The second order interaction between manufacturer and temperature regardless of denier is not significant as seen in Figure 22.
3. There appears to be no significant difference between the manufacturers as seen in Figure 22.
4. The second order interaction between denier and temperature regardless of manufacturer is significant as seen in Figure 21.
5. The second order interaction between denier and manufacturer regardless of temperature is significant as seen in Figure 23.
6. There appears to be a difference between deniers as seen in Figure 23.
7. There appears to be a difference in temperatures as seen in Figures 21 and 22.

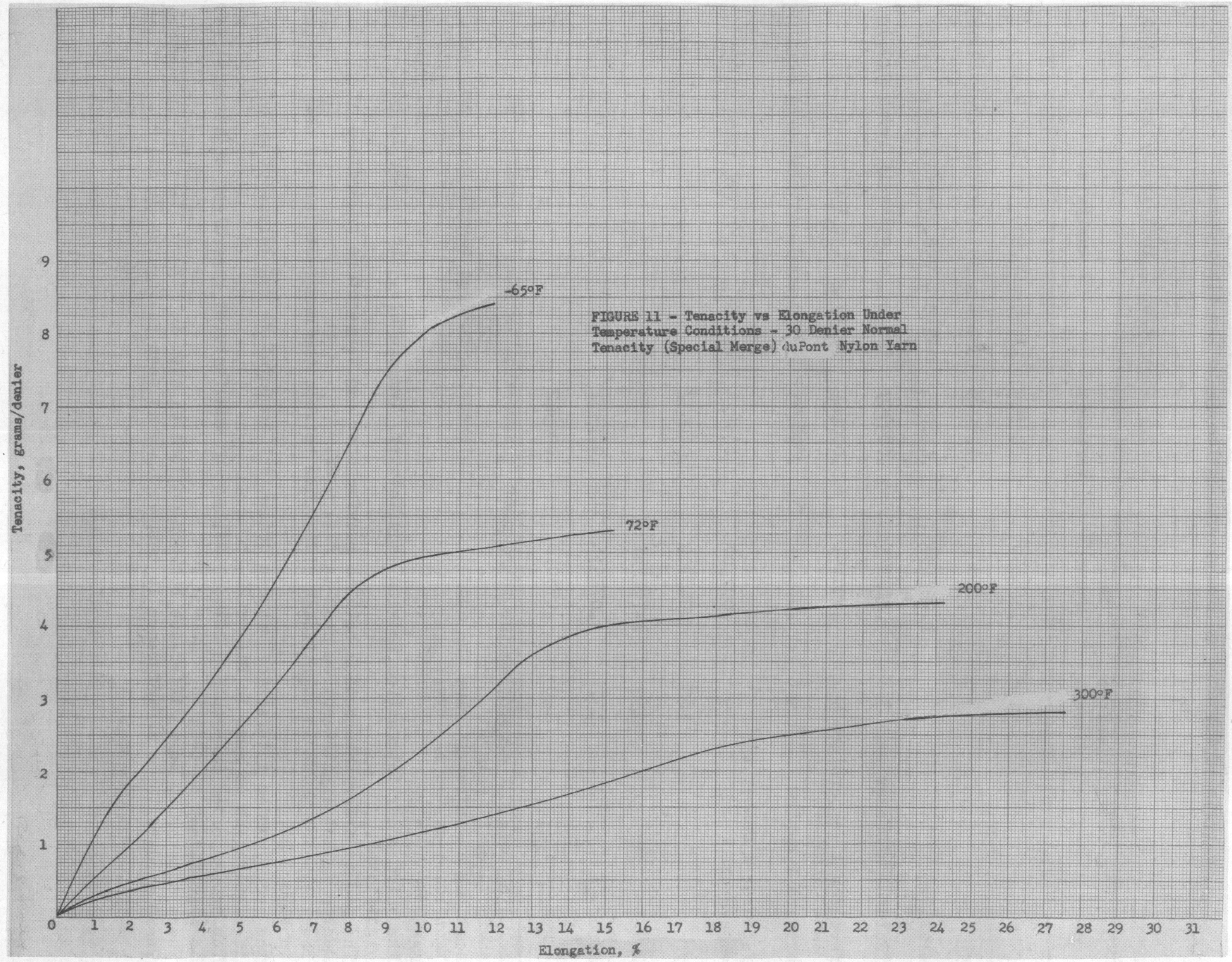


FIGURE 11 - Tenacity vs Elongation Under Temperature Conditions - 30 Denier Normal Tenacity (Special Merge) duPont Nylon Yarn

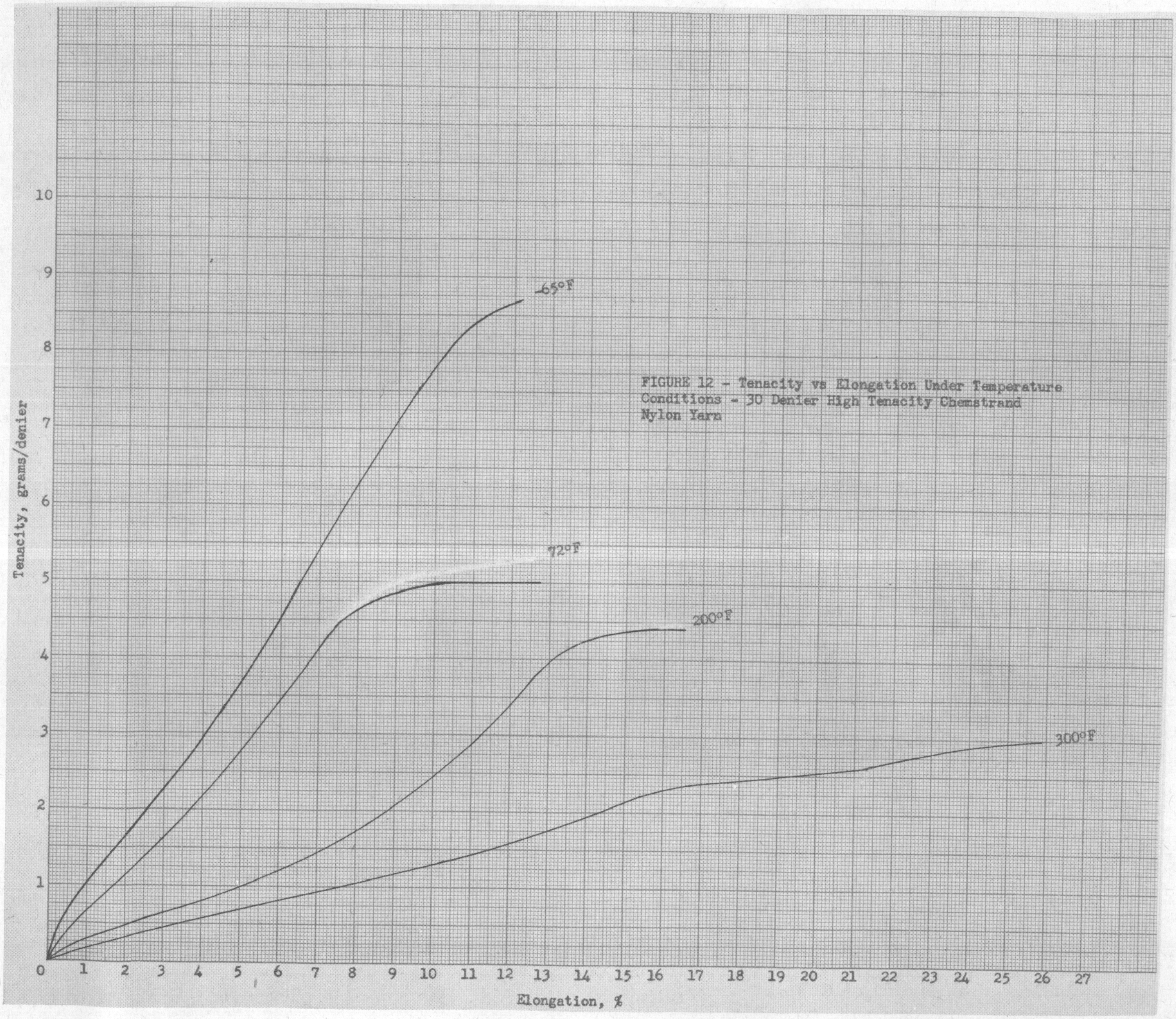


FIGURE 12 - Tenacity vs Elongation Under Temperature Conditions - 30 Denier High Tenacity Chemstrand Nylon Yarn

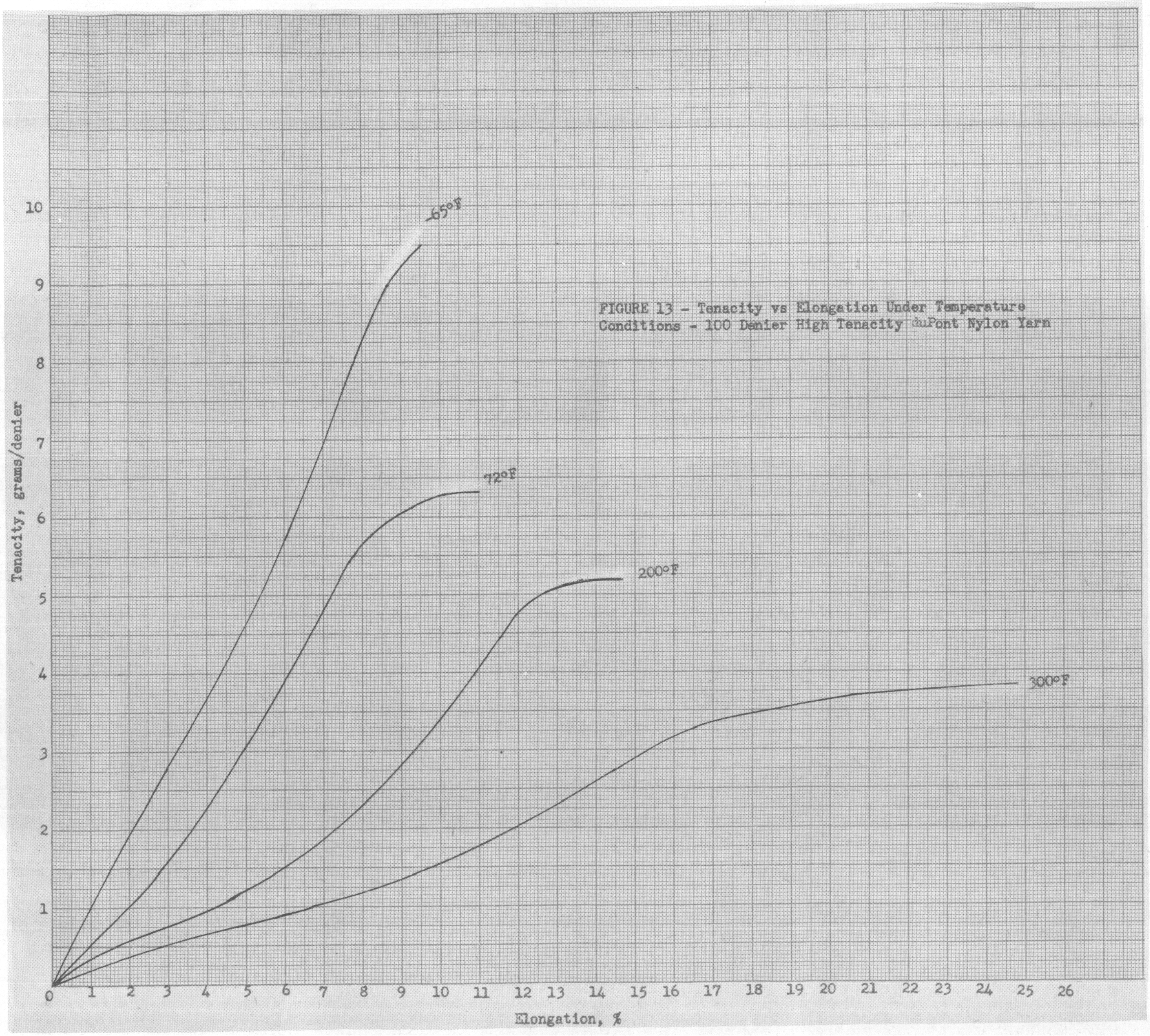


FIGURE 13 - Tenacity vs Elongation Under Temperature Conditions - 100 Denier High Tenacity duPont Nylon Yarn

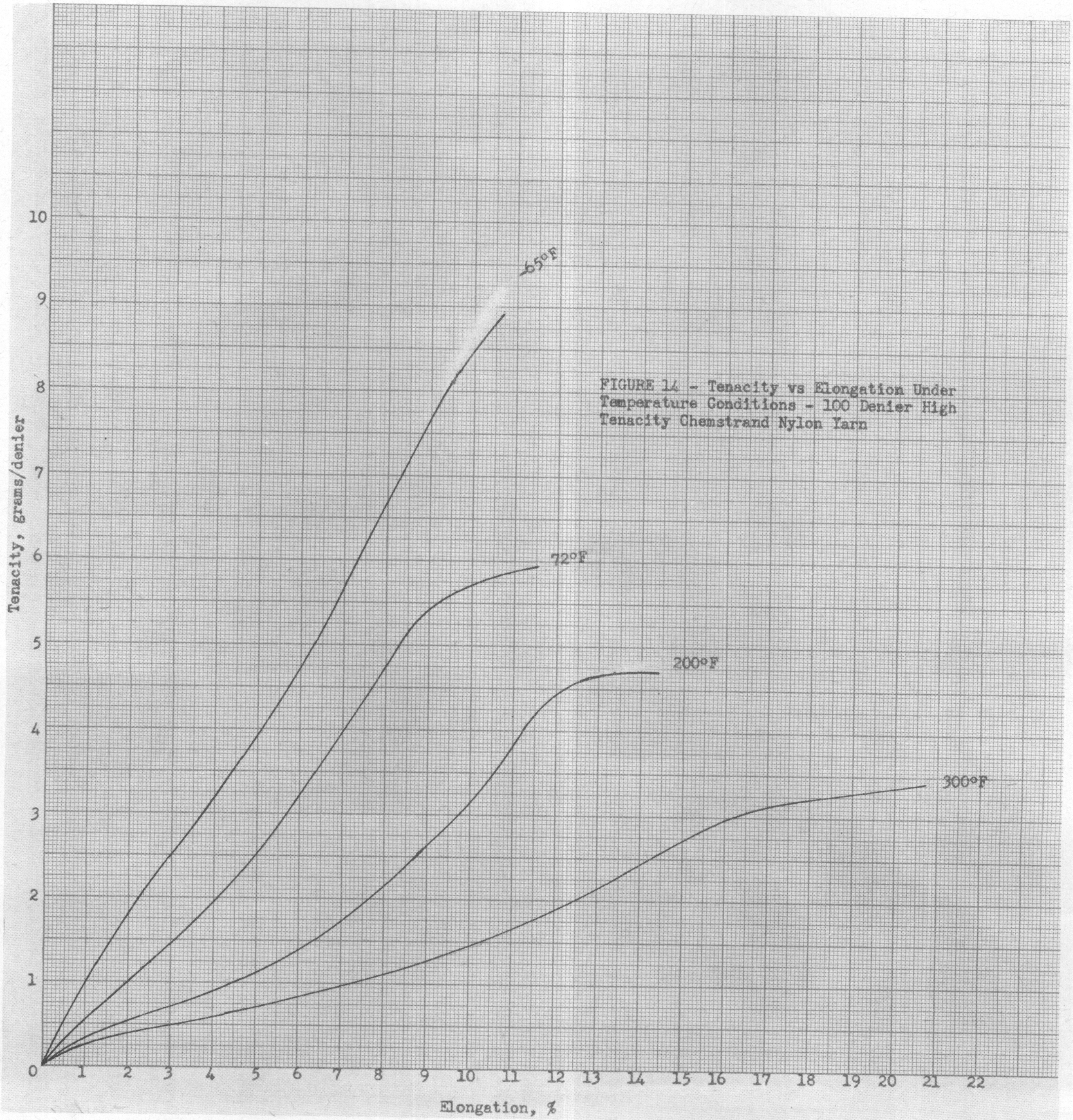


FIGURE 14 - Tenacity vs Elongation Under Temperature Conditions - 100 Denier High Tenacity Chemstrand Nylon Yarn

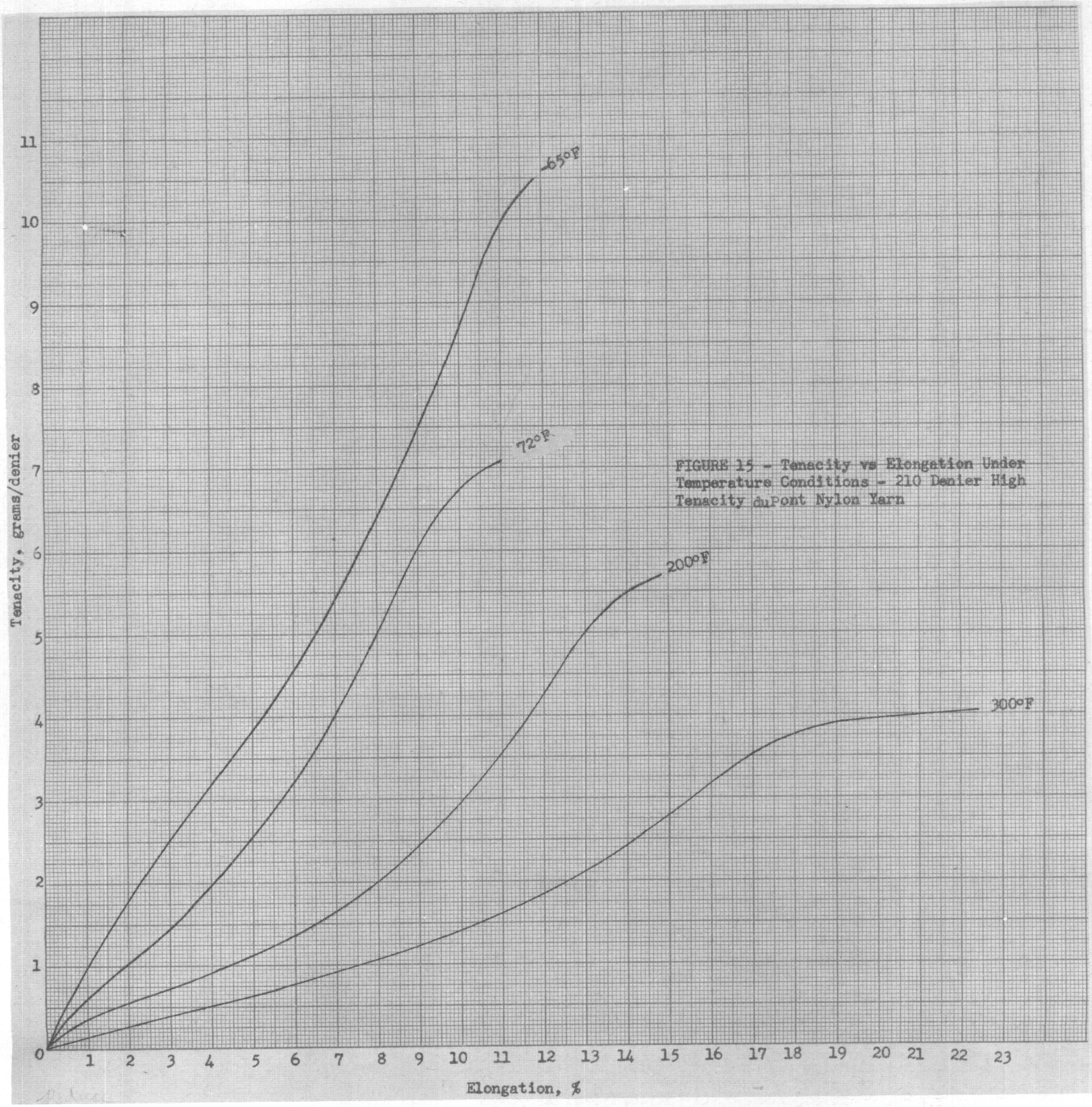


FIGURE 15 - Tenacity vs Elongation Under Temperature Conditions - 210 Denier High Tenacity duPont Nylon Yarn

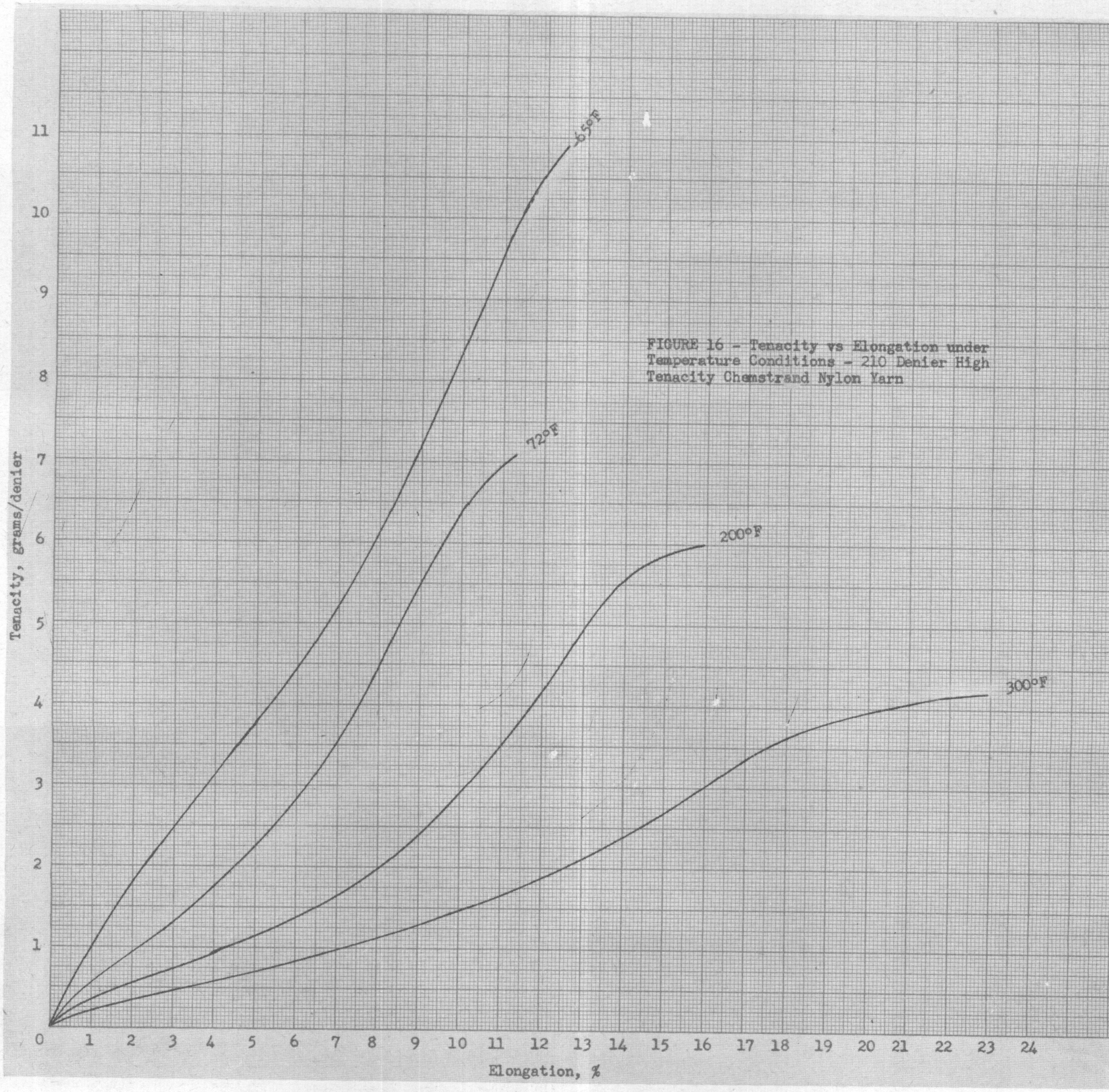


FIGURE 16 - Tenacity vs Elongation under Temperature Conditions - 210 Denier High Tenacity Chemstrand Nylon Yarn

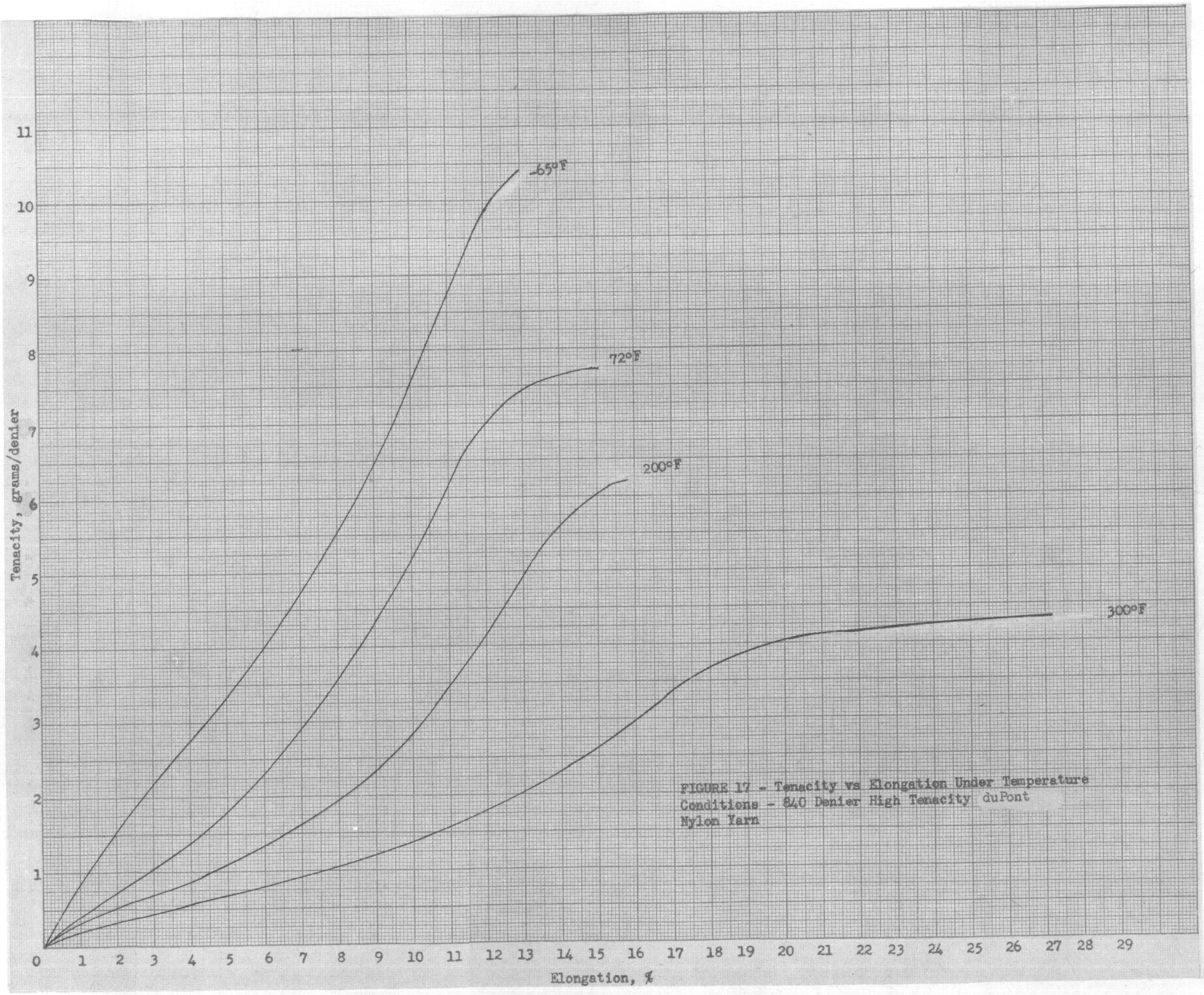


FIGURE 17 - Tenacity vs Elongation Under Temperature Conditions - 840 Denier High Tenacity duPont Nylon Yarn

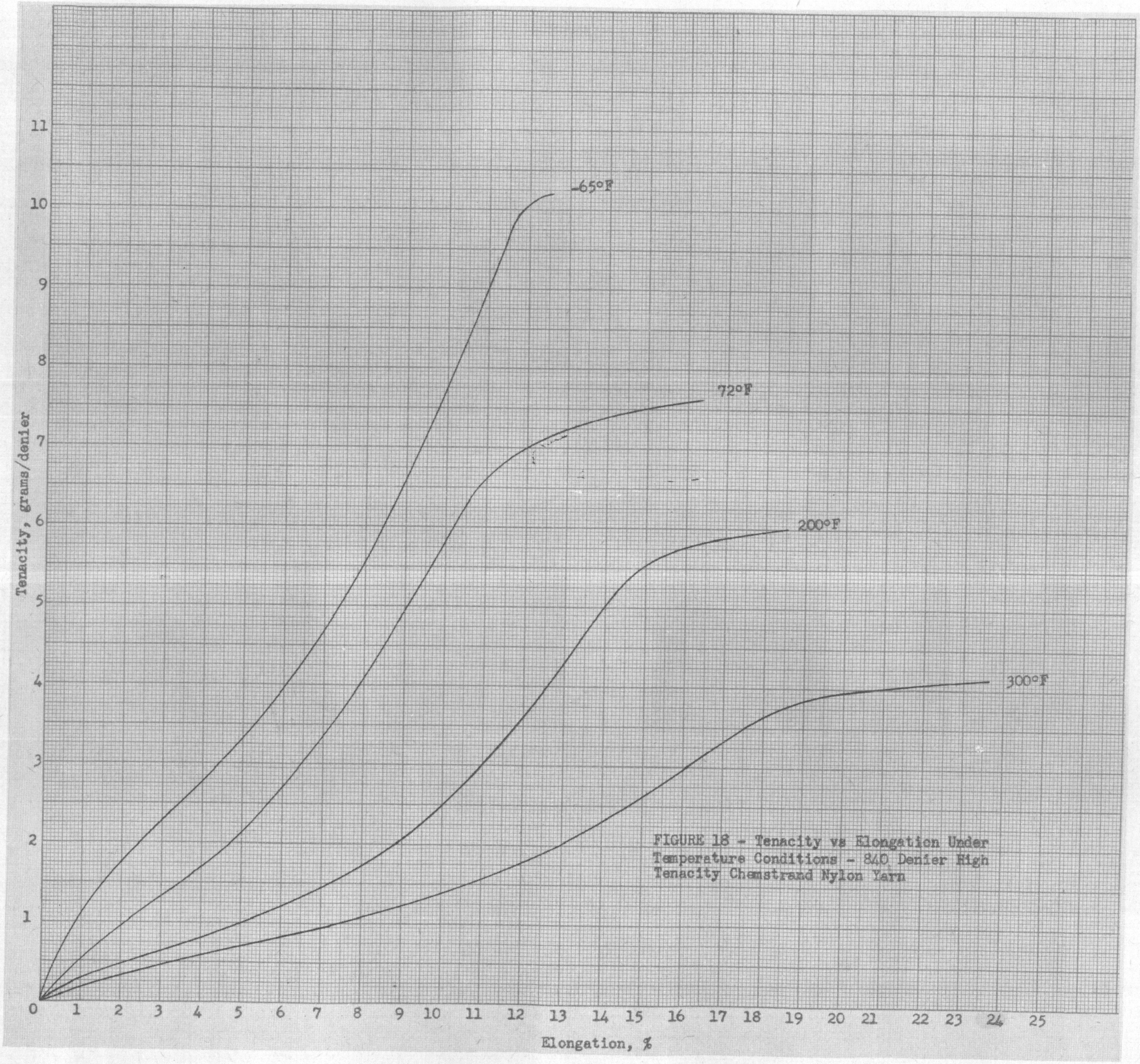


FIGURE 18 - Tenacity vs Elongation Under Temperature Conditions - 840 Denier High Tenacity Chemstrand Nylon Yarn

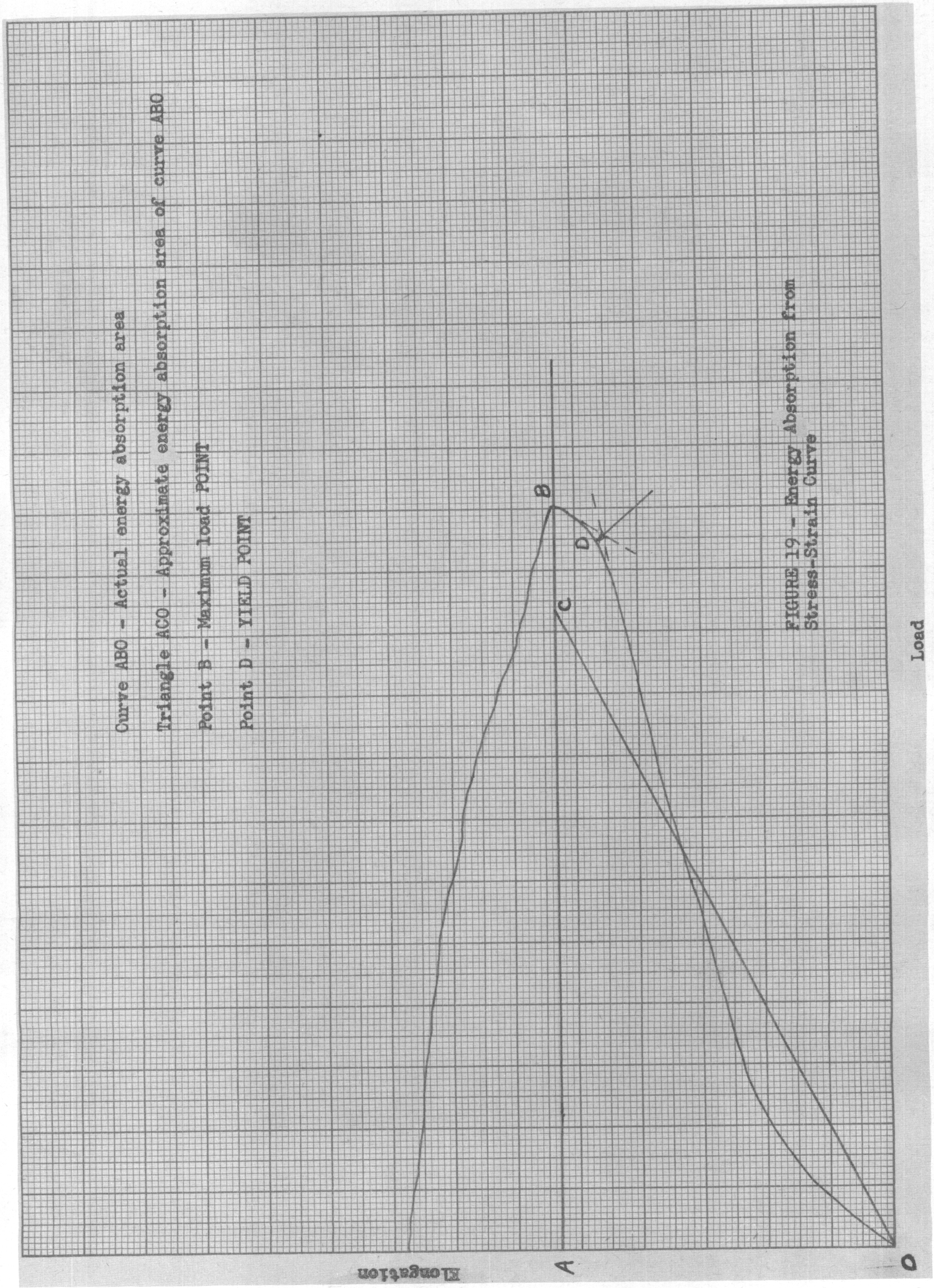


FIGURE 19 - Energy Absorption from Stress-Strain Curve

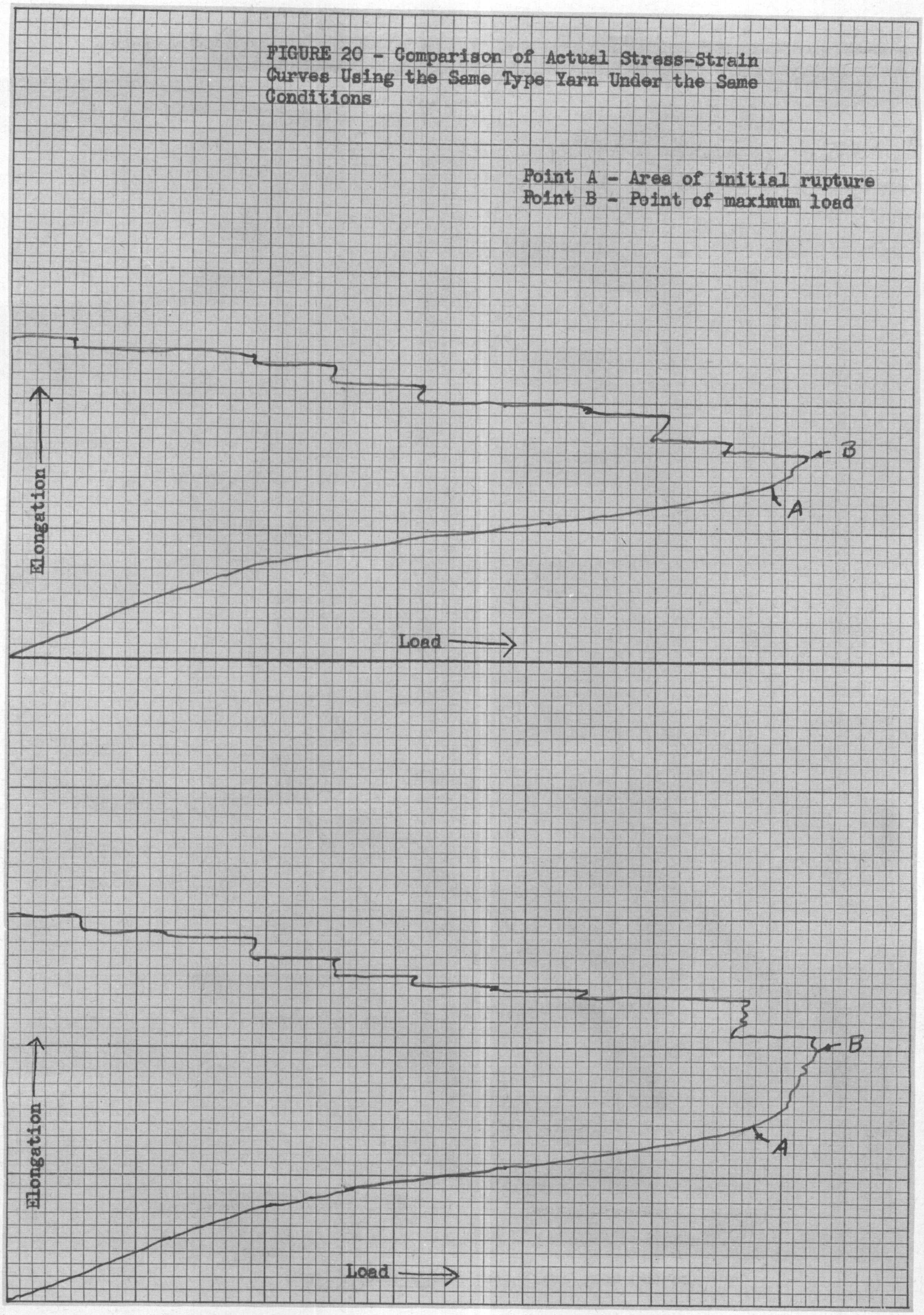

FIGURE 20 - Comparison of Actual Stress-Strain Curves Using the Same Type Yarn Under the Same Conditions

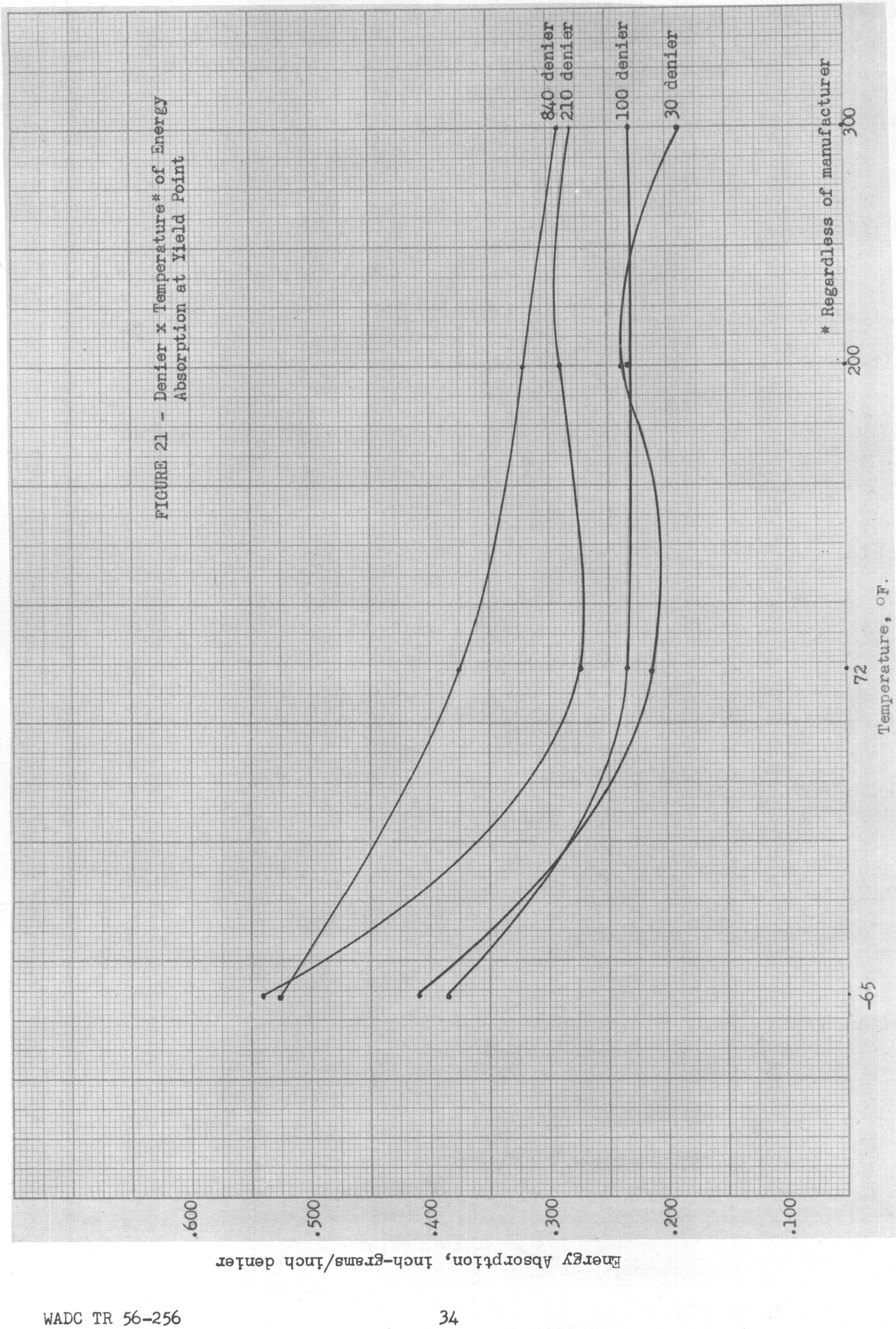


FIGURE 21 - Denier x Temperature* of Energy Absorption at Yield Point

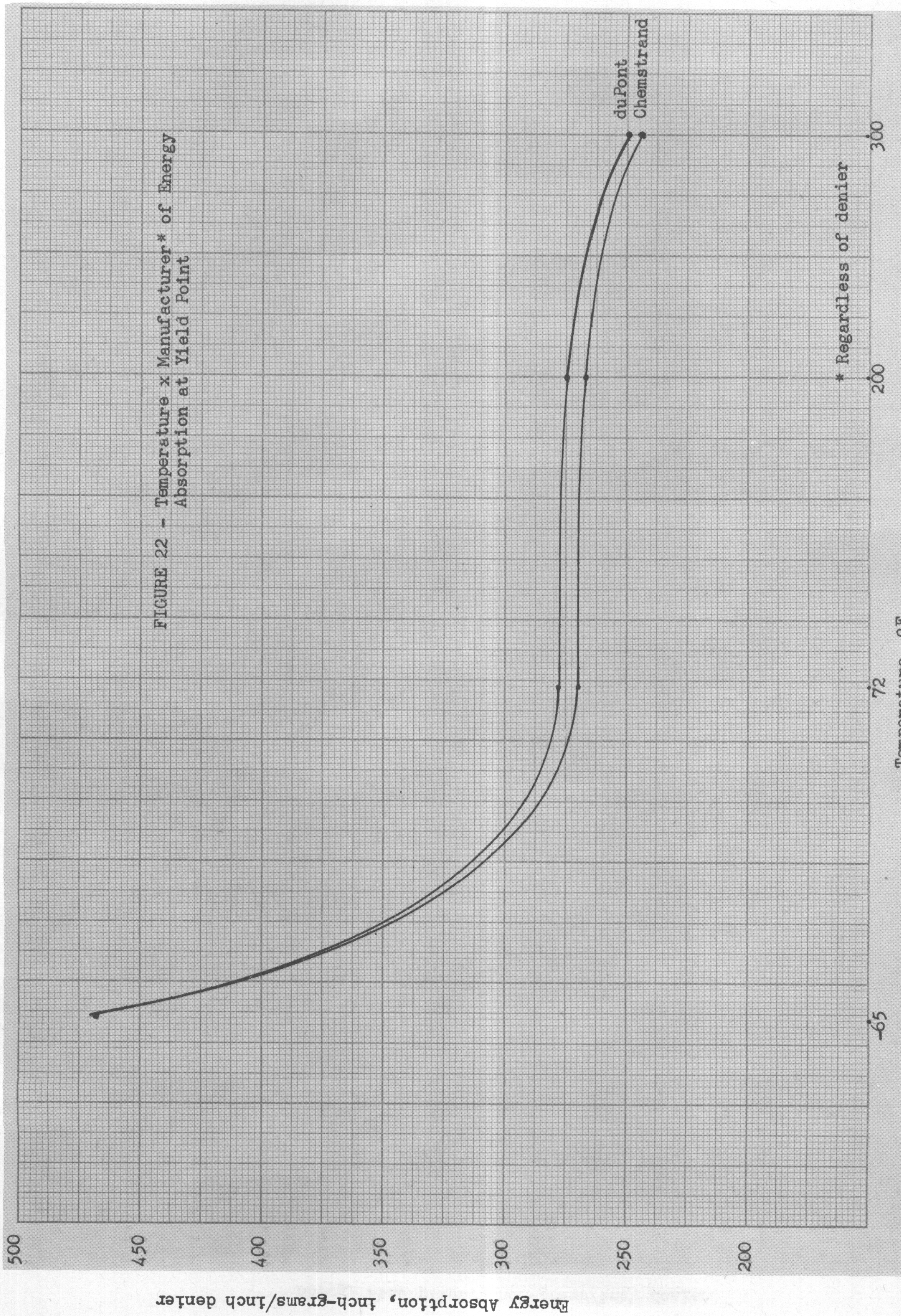


FIGURE 22 - Temperature x Manufacturer* of Energy Absorption at Yield Point

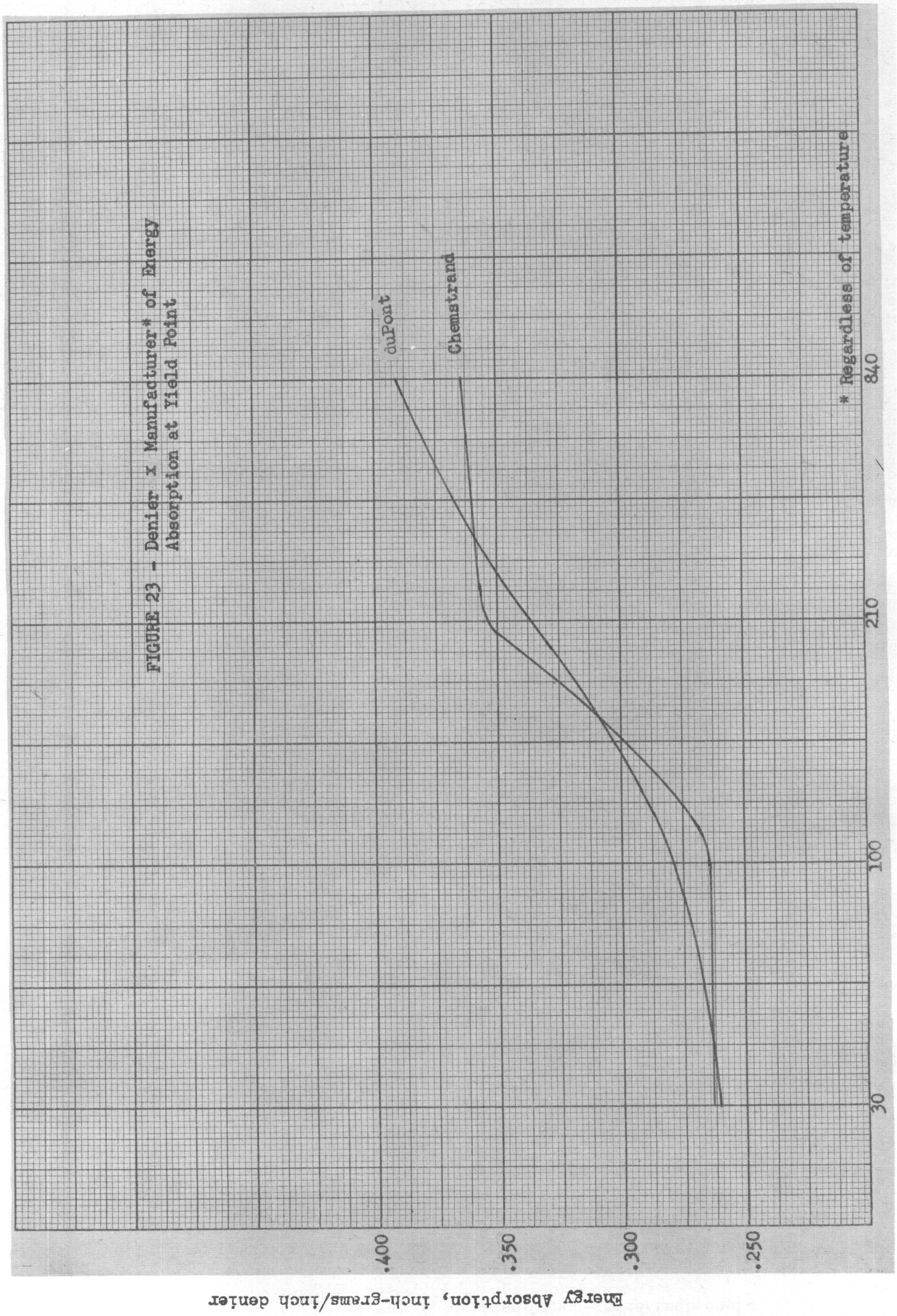


FIGURE 23 - Denier x Manufacturer* of Energy Absorption at Yield Point

# Section IV

## SERVICE TESTING OF PARACHUTES

Twenty-five back style parachutes, the canopies (critical portion of parachute) of which were fabricated from Chemstrand nylon, and the remainder of the parachutes fabricated from duPont nylon, and twenty-five back style parachutes fabricated wholly from duPont nylon were submitted for service test. This service test was initiated to determine whether there appeared to be any difference between Chemstrand and duPont nylon after fabrication into parachutes.

Testing was accomplished by the 6511th Test Group (Parachute), Air Force Flight Test Center in coordination with Parachute Branch, Equipment Laboratory, WADC.

The following tests were accomplished:

1. Twisted line tests - aircraft drops.

2. Opening shock and ultimate strength tests - whirl tower deployments.

3. Destruction tests - whirl tower deployments.

4. Porosity tests of the canopy fabric before and after deployment.

Results have shown no difference between the performance characteristics of the duPont and Chemstrand (canopy only) nylon parachutes. An additional 950 back style parachutes of which the canopies were fabricated from Chemstrand nylon have been released into normal service.

## Section V

## CONCLUSIONS

The melting points of both the duPont nylon yarn and the Chemstrand nylon yarn are within the tolerance of 475 - 485°F.

The actual denier of each denier yarn investigated except the 840 denier yarn is within 2.0 denier of the nominal denier. The actual denier of the 840 denier yarn of both manufacturers appears to vary considerably from the nominal denier.

The breaking strength and tenacity of all nylon yarns decreased as the temperature increased. In general the energy absorption of the nylon yarns decreased with an increase in temperature, especially in the range -65 to 72°F. The elongation of all nylon yarns increased as the temperature increased from 72°F.

An analysis of variance of energy absorption of the yarns to their maximum load point proved inconclusive, due to some undefined factors which were significant. An analysis of variance of energy absorption of the yarns to their yield point proved conclusive since there is no significant difference between the third order interaction of denier, temperature and manufacturer.

The following additional conclusions were obtained from the analysis of variance of energy absorption to the yield point.

1. There appears to be no significant difference between manufacturers.

2. There is no significant difference between the second order interaction of manufacturer and temperature regardless of denier.

3. There appears to be a significant difference between denier and temperature regardless of manufacturer.

4. There appears to be a significant difference between denier and manufacturer regardless of temperature.

5. There appears to be a difference in denier.

6. There appears to be a difference in temperatures.

Service tests have shown that the parachutes fabricated from Chemstrand yarn in the canopy and the remainder of the parachutes fabricated from duPont nylon are equal in performance characteristics to those manufactured wholly from duPont yarn.

A comparison of the nylon yarn manufactured by duPont with the nylon yarn manufactured by Chemstrand shows no meaningful difference between the two with regard to the properties investigated.