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THE POROSITY, TRANSLUCENCY AND DEFORMABILITY OF NYLON PARACHUTE FABRICS

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This note summarizes two separate investigations which could be combined in future work. In one investigation the translucency, and in the other the deformability, of lightweight plain-weave nylon fabrics was related to their porosity.

Experienced handlers of lightweight nylon fabrics may have noticed that porous fabrics are more translucent than less porous fabrics of similar weave and weight. The question is whether this observation can be put to practical use. If so, the weaver would have a valuable aid in the control of a somewhat intractable parameter because he could measure the translucency while weaving, and possibly adjust his loom photoelectrically.

The practical value of measurements of light transmission is, however, not easy to establish, because fabrics may be constructed in different ways, and it is probable that if the weave is changed, the relationship between translucency and air porosity will also be changed. Furthermore, as the porosity of a given roll of fabrics is a statistical property, so is its translucency. In addition, textile technology is a most fertile field for argument. The work here described has already been subjected to some criticism which indicates that much more remains to be done before we can say that translucency is a useful index of porosity.

The porosity was measured by observing the rate of airflow through fabric at an air pressure difference of 10 inches water guage 1/. The percentage light transmission was measured by projecting an enlarged image of fabric on to a selenium photocell. An apparatus previously described 2/ has recently been modified by adopting a magnification of 10.5 instead of 36 for the projected image. The mirror galvanometer has been replaced by a direct reading galvanometer with a scale calibrated in percentage light transmission.

1/ Carling, W.G., The Design of High Pressure Porosity Instrument. Tech. Note Aero 1804 July 1946

2/ Baker, A., Porosity and Translucency of Nylon Parachute Fabrics Tech. Note Chem. 1187 January 1953

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In the graph (Figure 8) each point represents the mean of 10 observations of porosity, and also of 10 estimations of translucency, taken at intervals across the width of a roll. To cover the range of porosity, shown on the graph, several nylon fabrics were examined, all of plain weave and of similar weight (approximately 1-1/2 ounces per square yard) but having different numbers of ends and picks per inch. Most of these fabrics had been woven from 45 denier yarn in both warp and weft, but some incorporated 60 denier. The warp twist was stated to be mainly 7 turns per inch; that of the weft varied from 7-1/2 to 3/4 inch different fabric specifications. It is doubtful whether the effect of twist was maintained in the weft during weaving, since the width of the yarn in fabric may be as much as twice that of the yarn on the spool. Consequently, the porosity is not readily predicted from the construction.

If the curve through the experimental points on the graph were a straight line, it would miss the zero origin when extrapolated. There is no reason why the curve should pass through the zero origin but it should go fairly near it, since an almost impervious fabric (of weight 3 ounces per square yard) was almost opaque under the experimental conditions. With that criterion, we assumed a linear relation between translucency and the square root of porosity. This gives Figure 9, having a satisfactory extrapolation. The actual line was located by the method of least squares, and was used to work backwards to the curve shown in Figure 8.

Unfortunately, there is really very little to choose between the square root law and some other power law, including (within limits) a linear law, to fit the experimental results, over the range of porosity investigated. Much more evidence is needed for plain-weave nylon fabrics alone. Then there are other kinds of weave and other materials to consider, not to mention knitted fabrics.

The question arises as to what would happen to the porosity and translucency of fabric if it were stretched on the bias. Bias-cut fabric is used in the gores of man-carrying parachutes for the sake of its extensibility, which involves a change of angle between warp and weft under stress. The behavior of an element of fabric under unequal stresses may be represented by Figure 10. It is convenient to use a cruciform sample having arms of equal width in the unstressed state. Figure 11 shows the original method of stressing this sample. A much larger apparatus has now been constructed using spring balances in

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closed circuits which can be stressed by moving the upper pulleys. This apparatus permits the application of larger loads and will therefore be useful for straight-cut as well as bias-cut fabrics. Soluble nylon is a useful adhesive for overcoming the difficulty of clamping nylon fabrics to sustain large stresses. The framework of the new apparatus is big enough to enclose the table of a standard porosity instrument. The entire assembly is kept in a permanently conditioned room.

For lightly stressed bias-cut fabrics, the experimental results may be analyzed into two relationships:

(1) The dependence of angular deformation on the applied tensions;

(2) The dependence of porosity on deformation.

(1) is shown for nylon fabrics in Figures 12 to 15; (2) is shown in Figure 16. It will be seen that a marked decrease of porosity may result from deformation brought about by tensions which are very small compared with the tensile strength of fabric. Whether this decrease of porosity is accompanied by a corresponding decrease of translucency is not yet known.

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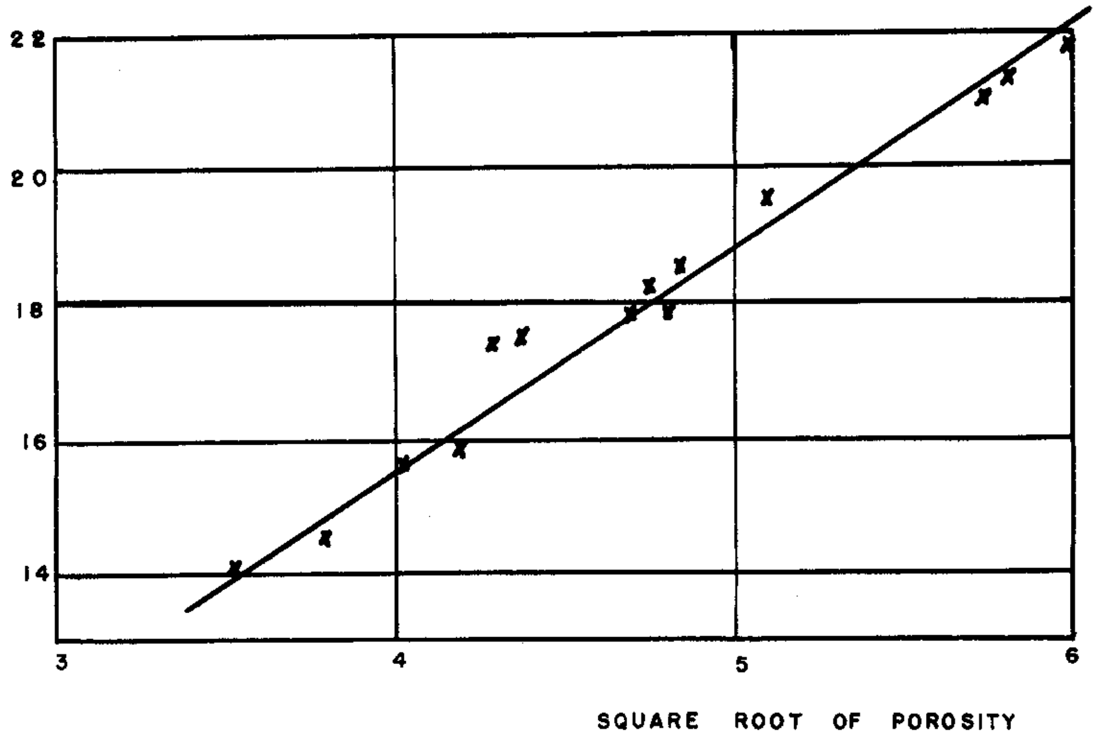

FIGURE 8. RELATION BETWEEN LIGHT TRANSMISSION AND SQUARE ROOT OF POROSITY

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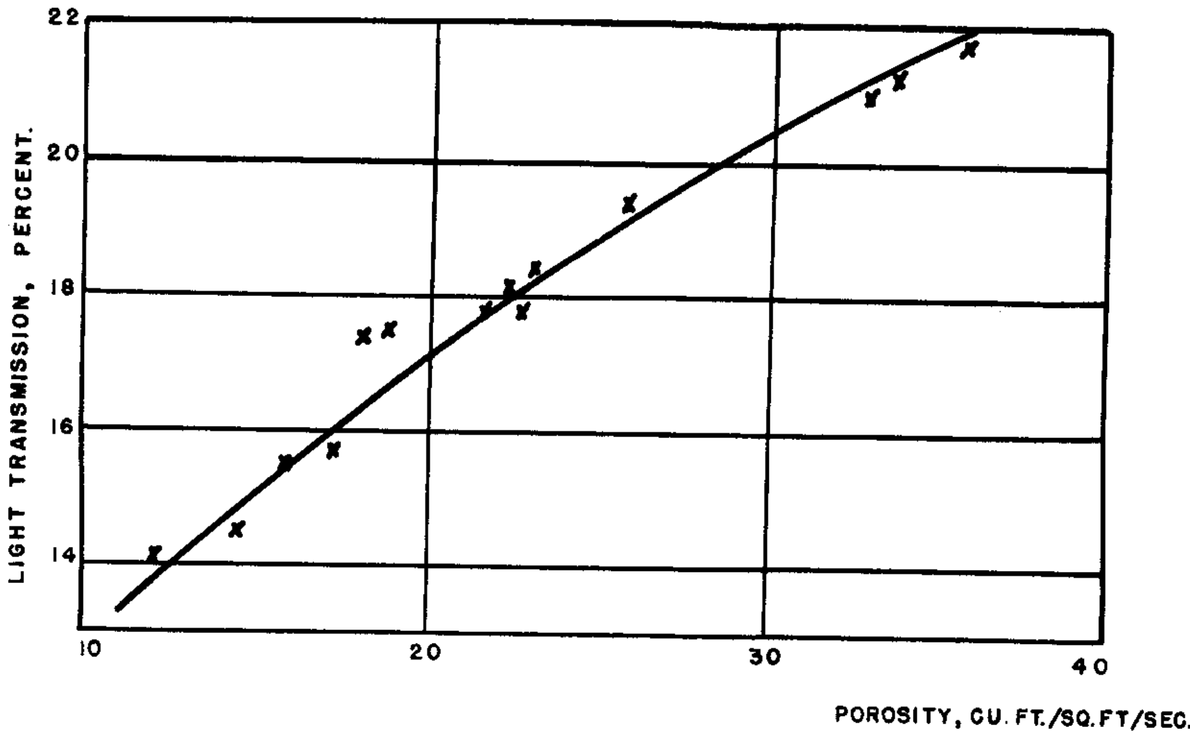

FIGURE 9. RELATION BETWEEN LIGHT TRANSMISSION AND AIR POROSITY OF NYLON FABRICS.

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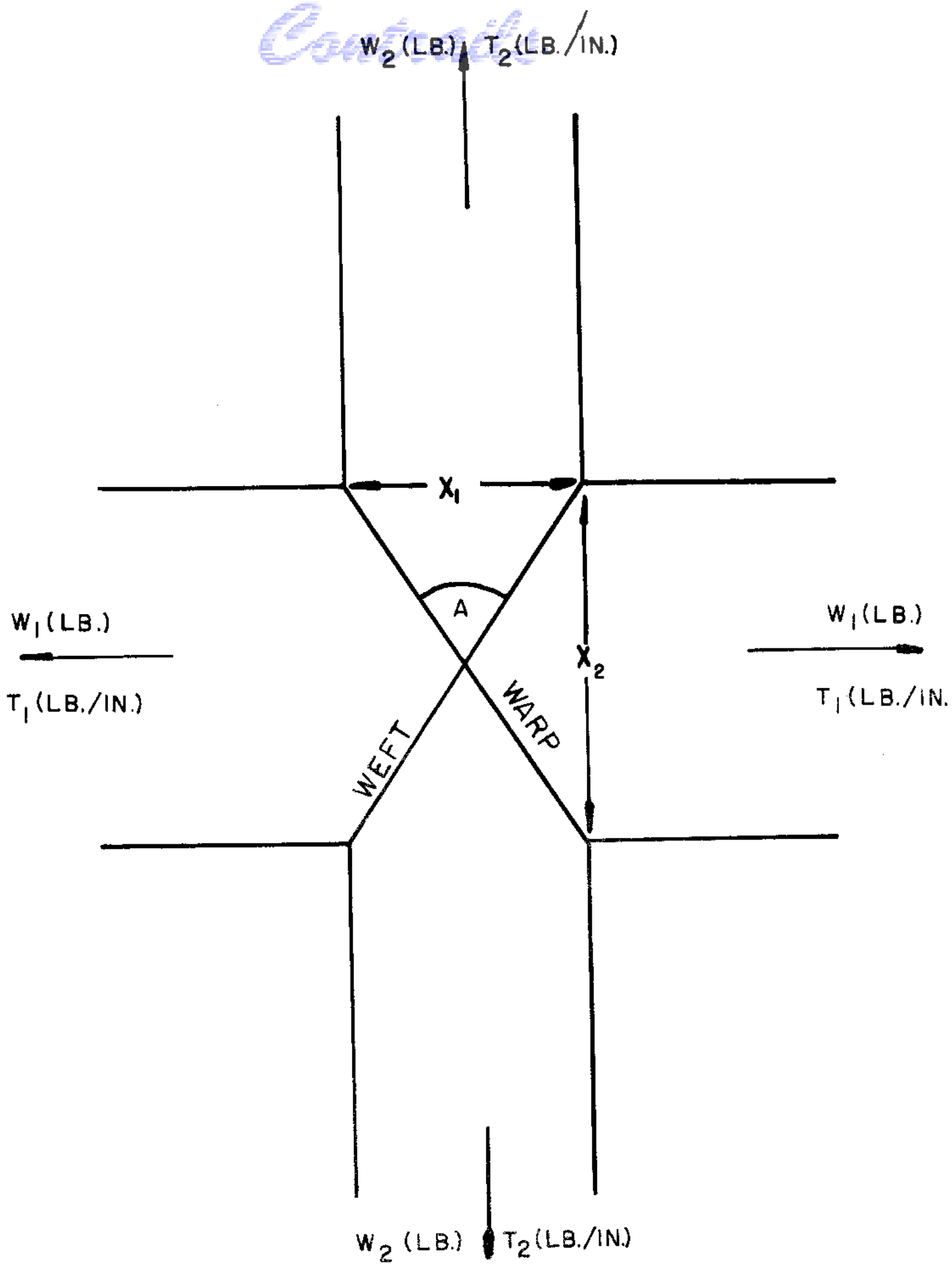

FIGURE 10. DEFORMATION OF CENTRAL PART OF SPECIMEN.

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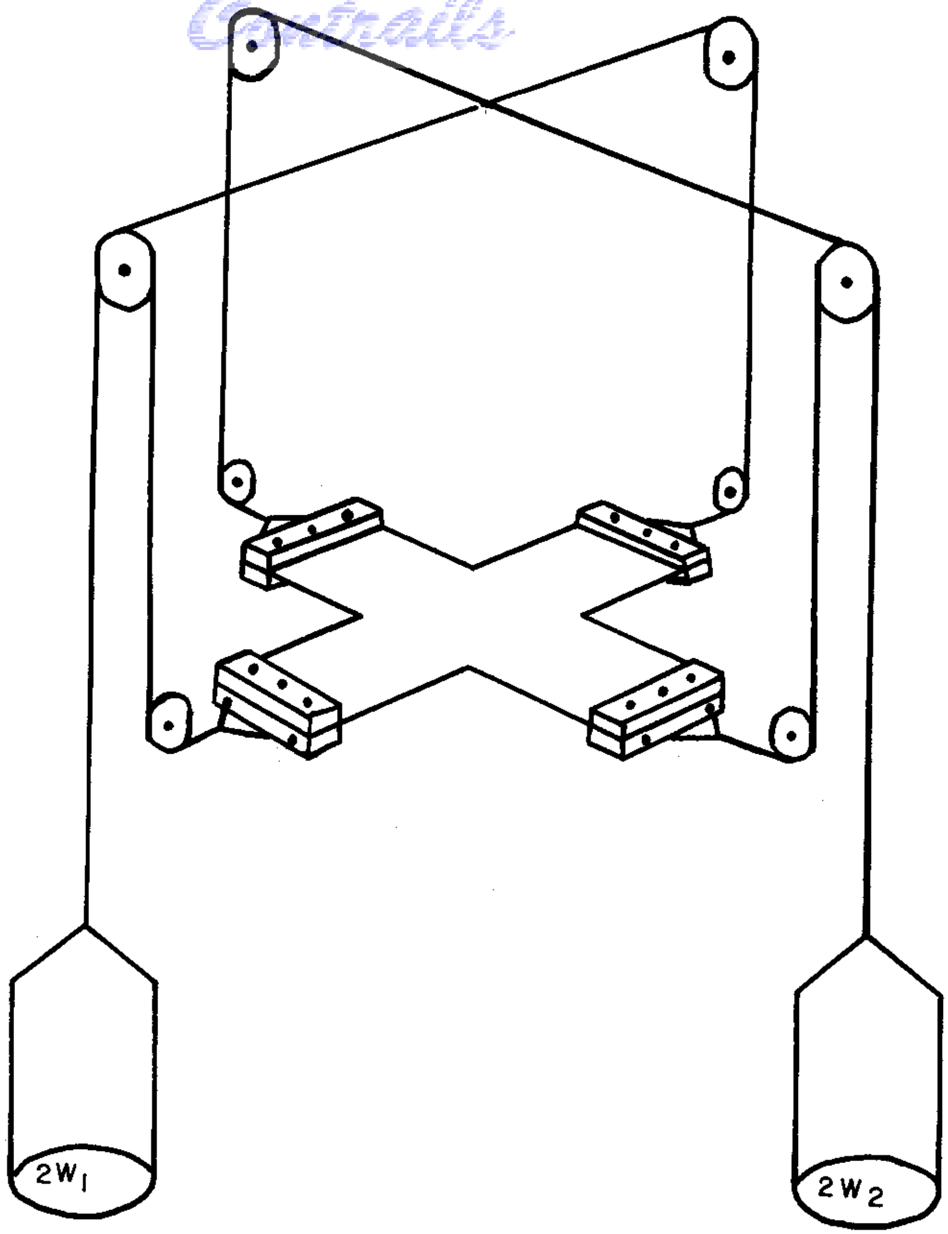

DIAGRAM IN PERSPECTIVE

FIGURE 11. APPARATUS FOR DEFORMING FABRICS

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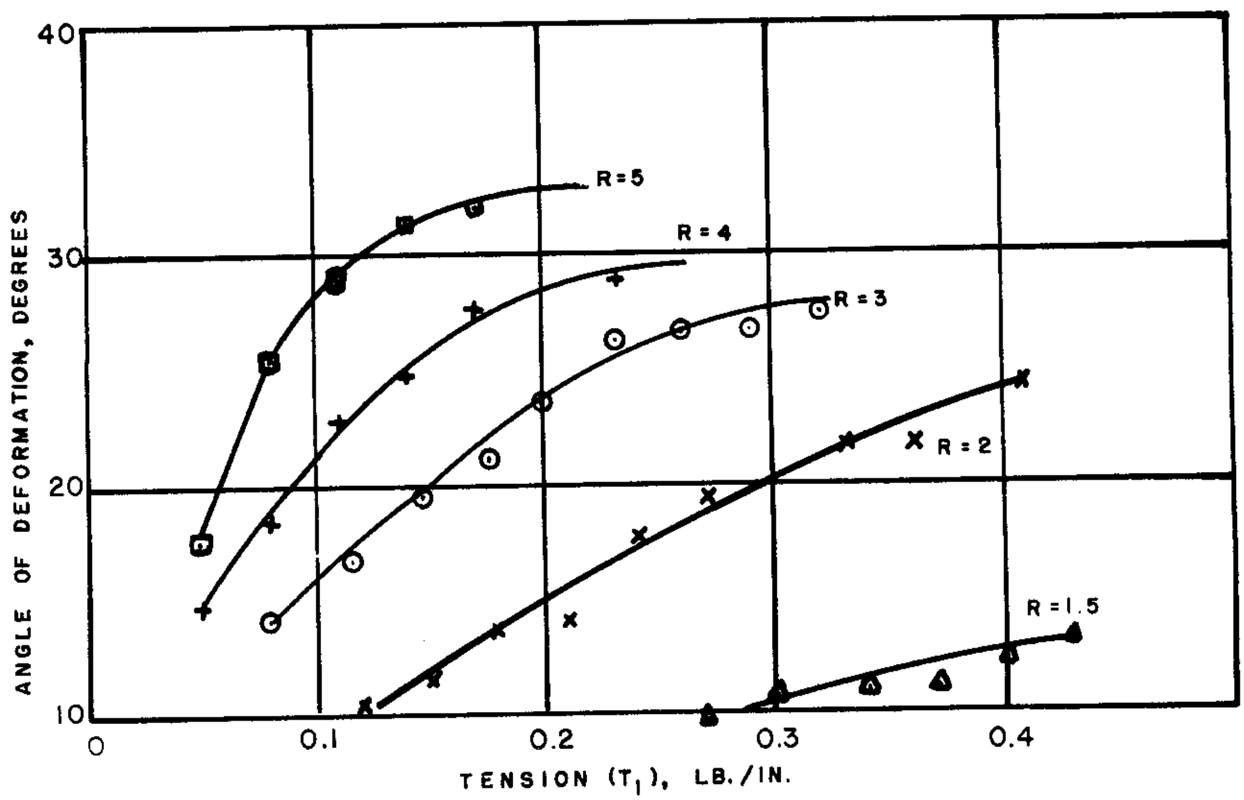

FIGURE 12. DEFORMATION OF NYLON FABRIC D.T.D. 556 A.

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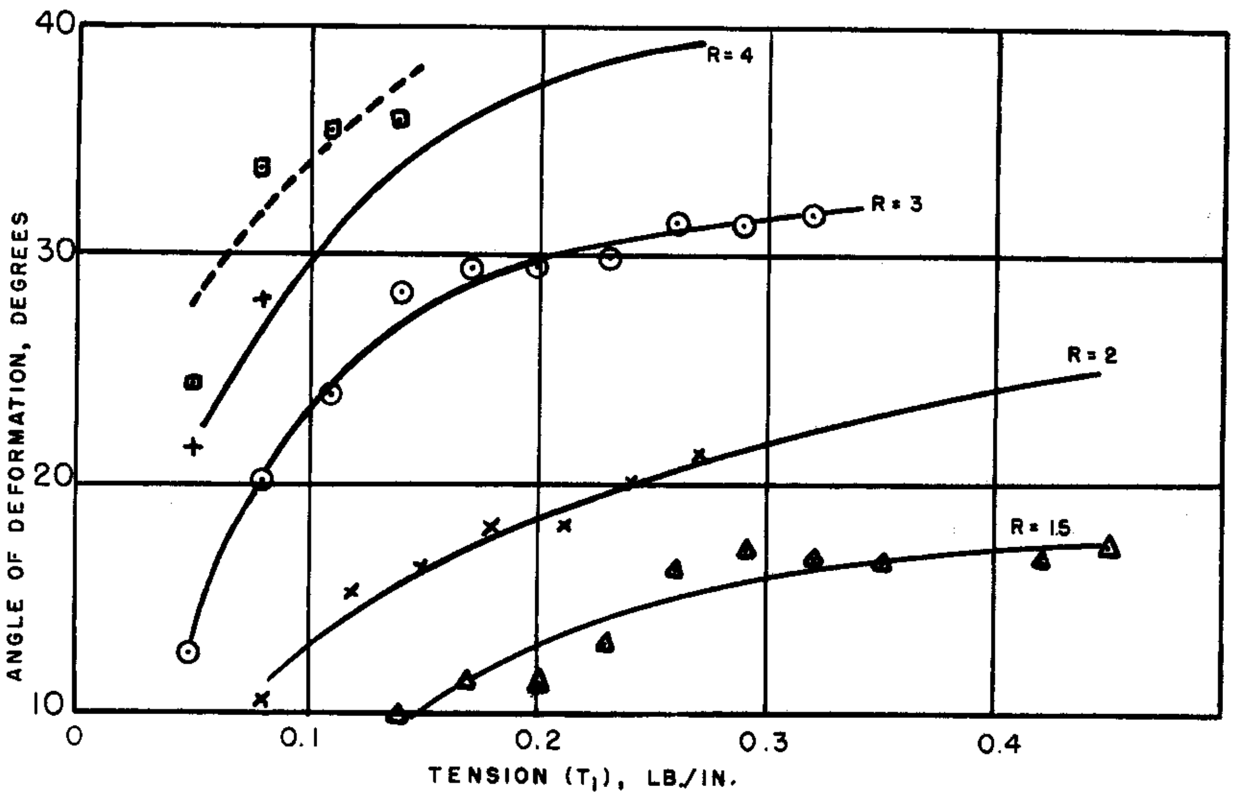

FIGURE 13. DEFORMATION OF NYLON FABRIC D.T.D. 562

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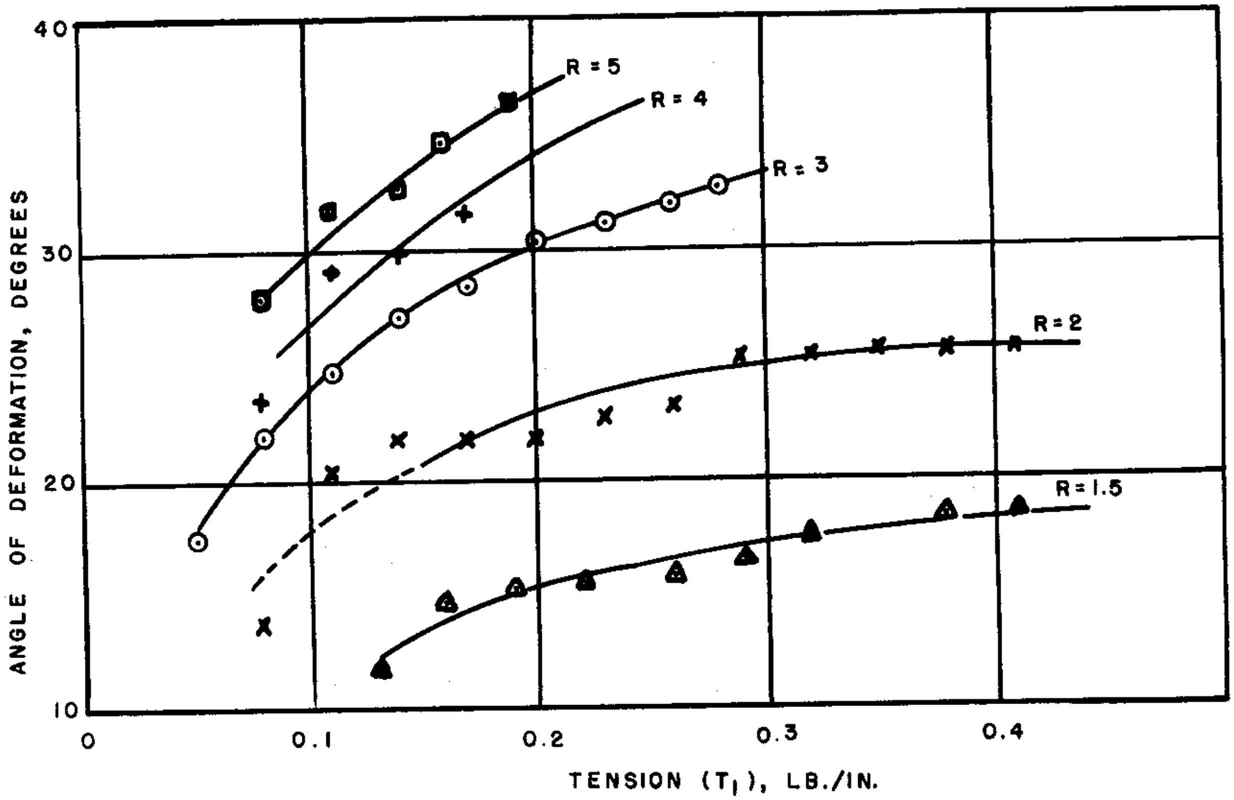

FIGURE 14. DEFORMATION OF NYLON FABRIC D.T.D. 583

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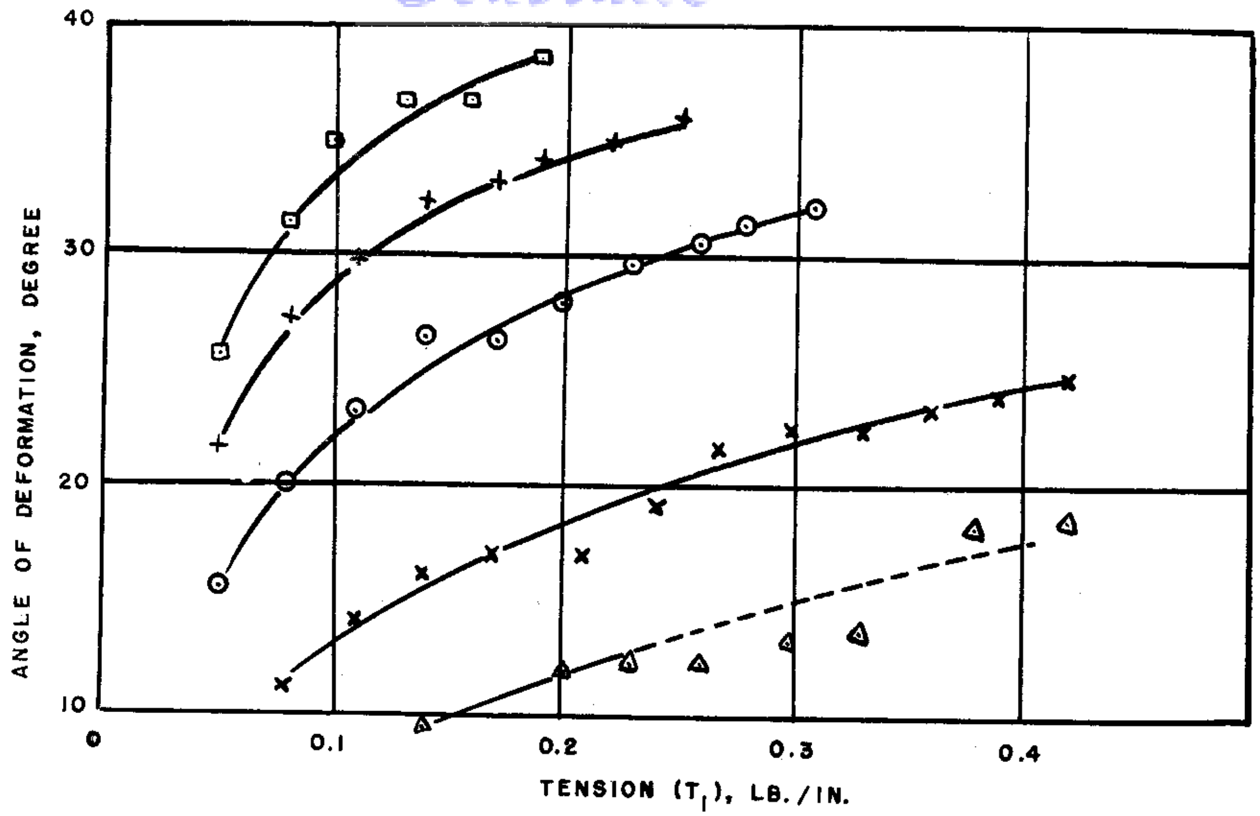

FIGURE 15. DEFORMATION OF NYLON FABRIC D.T.D. 854.

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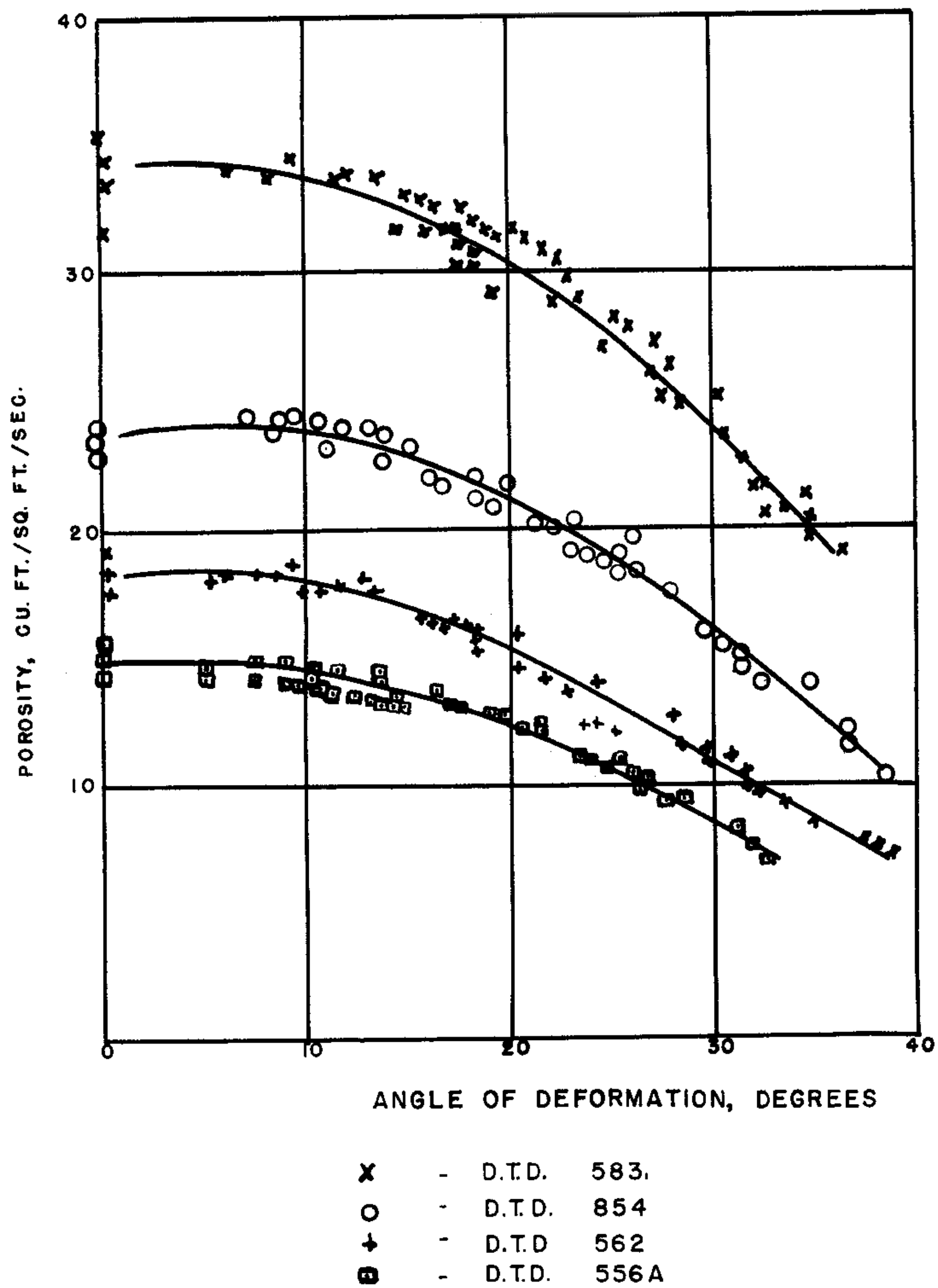

FIGURE 16. DEFORMATION OF NYLON FABRICS VS. POROSITY.

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